

OBSERVATIONS ON THE INFLUENCE OF HEATING UPON  
THE NUTRIENT VALUE OF MILK AS AN EXCLUSIVE  
DIET FOR YOUNG ANIMALS.

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(1 Figure.)

DURING the year 1904, a year which included four months of hot summer weather, the mortality among infants under one year old in England and Wales was 145·3 per 1000 births. Of this mortality 21·8% died of diarrhoeal diseases and 31·5% from wasting diseases.

Experience shows that these troubles affect hand-fed to a much greater extent than breastfed infants.

Thus, in Paris, in 1898, from the 14th to the 27th of August 550 children died of diarrhoea. Of these 57 are recorded as being breast fed and 493 as artificially fed (Budin, 1907).

In Rouen during 1900 to 1905 out of 550 babies attending a large dispensary 57% were breast fed (1), 7·4% were on breast and artificial feeding (2), 35·6% on artificial feeding only (3). Of these 7·6% of (1) died, 26% of (2) and 35·6% of (3) (Budin, 1907).

Similar statistics have been published for Lille, Elboeuf and other places.

There are no available statistics of any large number of babies in England, but in Finsbury out of 212 infant deaths 21 were due to diarrhoea; of these none were breast fed, 4 were on breast and other foods and 17 were artificially fed (Finsbury Report on Public Health for 1907).

A large proportion of this infantile mortality must be attributed to a harmful or faulty nutriment, and as the diet of children of less than one year old is practically confined to milk, the remedy consists in securing for the infants innocuous milk of adequate nutritive value.

Much of this continual waste of infant life, is no doubt due to bacterial contamination of the milk, a danger which can be nullified by the heating of the milk shortly before its use. Provided that the temperature is sufficiently high and the length of time it is maintained adequate, the destruction of micro-organisms can be ensured, but, to effectively reduce the mortality from infected milk the remedy must be one which can be carried out in the poorest tenement lodging, that is, one which demands a minimum of skill and necessitates no special apparatus.

The raising of milk to the boiling point and allowing it to cool with some sort of covering fulfils these conditions. Why is this simple precautionary measure not put into practice? The reason is, I believe, due to a widespread belief in this country that the boiling of milk deprives it of some properties essential to the infant's well-being. Many medical men are convinced that rickets, scurvy and other troubles follow the use of boiled milk. Infantile scurvy seems, however, to be an uncommon disease and not unusually has been caused by feeding on some patent farinaceous baby-food.

In Paris, where several thousand babies are fed every year on milk that has been boiled for 20 minutes, rickets is rare and scurvy almost unknown; thus Budin (1907, p. 198) has not seen a single case of scurvy among children fed on such milk, and his experience is borne out by Bresset (1888—1905) who has one of the largest milk dispensaries in Paris.

During recent years a mass of valuable evidence has been accumulated in France showing that a diet of milk which has been boiled for 45 minutes gives excellent results.

Budin (1907, p. 173) gives curves showing that the weight of children fed on sterilised milk is almost identical with that of a normal breast fed baby. This does not show that sterilised milk is a desirable substitute for the breast, since an artificially fed child is always in danger of digestive troubles, but it shows that, granted the necessity for artificial feeding, boiled milk is a suitable substitute. A few dispensaries in France use pasteurised milk for the artificially fed infants, but although I have been unable to obtain any published statistics, I understand that the results have not been superior to those obtained with sterilised milk. Nor are there any weight curves available for comparison of babies fed on raw milk, although a few experiments were made by Bresset who did not find it in any way superior to sterilised milk for normal children.

The question of the modification of the nutrient properties of milk by boiling has often been attacked from the experimental side, but owing to the care required in bringing up young animals upon a foreign milk, boiled or unboiled, and the small number of animals used for the experiments, the results are not so satisfactory as could have been wished.

Bolle (1903) states that guinea-pigs fed on boiled milk got Barlow's disease, whereas those fed on raw milk did well. Guinea-pigs are however not suitable for these experiments, and the results have not been confirmed by Bartenstein (1905). This last observer also fed dogs on boiled and preserved milk (two on each). He does not consider that there was any evidence of ill-health, but there appear to have been complications.

Keller (1904) fed mice on raw, boiled, and sterilised milk, and found that all did equally well; young dogs fed both on fresh or sterilised milk also did equally well, no difference being detected after three months.

Price (1904) found that calves fed on raw milk gained weight, much better than on sterilised milk. Whilst fed upon the latter they had diarrhoea. The experiment was only carried on over 8 days for each kind of milk, and moreover, some calves which did badly on raw milk, subsequently improved on pasteurised milk. Price considers the digestibility to be slightly impaired by boiling.

Peiper and Eichoff (1904) found that dogs became anaemic and the bone rarified after prolonged feeding on slightly sterilised milk.

The experiments of Brüning (1906) are especially noteworthy; he finds that when the milk of a foreign species is used, better results are obtained with boiled than with raw milk, and this as a result of prolonged experiments on pigs (omnivora), dogs (carnivora), and rabbits (10 days experiment), guinea-pigs (14 days experiment) and goats (herbivora).

The experimental evidence, therefore, although not absolutely concordant, certainly seems to show that when the milk of another species is used, there is no marked nutritional difference between raw, boiled, or even sterilised milk, a result which the observations about to be described entirely confirm.

### *Experiments.*

Rats were selected for our experiments. The animals were as nearly as possible a fortnight old at the commencement of the

experiment. They were kept in batches of a dozen in airy cages sufficiently large for them to obtain plenty of exercise in climbing about the wires. They were fed twice a day throughout the experiment—morning and evening—on bread and milk, both bread and milk being weighed daily, and adjusted as nearly as possible, so that, although they had plenty to eat, there should be no stale food left in the cages.

The rats in each case were weighed daily all together; in the following figure the results were obtained by dividing the weight by the number of rats.

*Series A* received bread and milk from the Walker Gordon Laboratories delivered fresh and kept at 0° C. in the cold room until just before use.

*Series B* received bread and the same milk as *Series A*, but raised to 96° C. just before using.

*Series C* received bread and sterilised milk. The sterilised milk used was made from the full-cream dried milk of the West Central

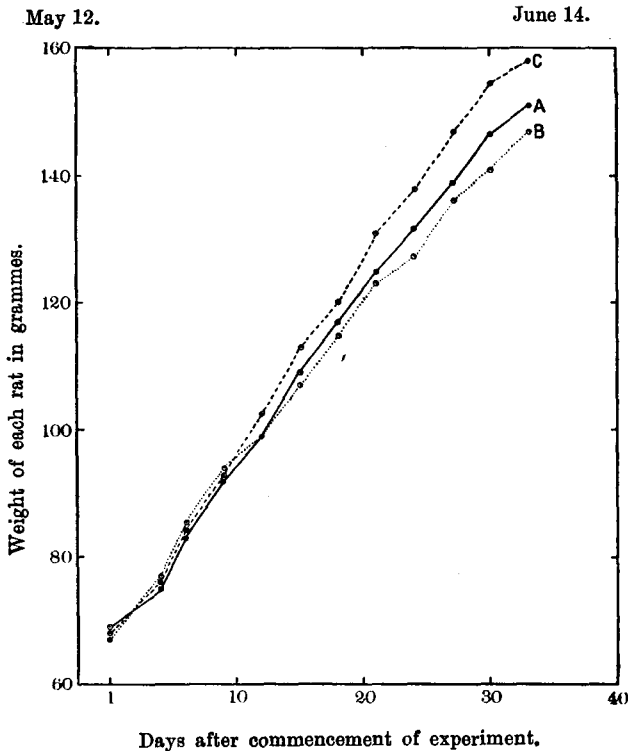


Fig. 1. Showing growth of rats in grammes.

Surrey Dairy, in a 14% solution, this being almost precisely the average composition of cow's milk.

The details of the results are given in the Table.

Table showing weight of rats used in Series A, B, C.

Date	Series A (Raw milk)			Series B (Boiled milk)			Series C (Sterilised milk)			Food in % of body weight	
	Total wt. in grams	No. of rats	Average wt. per rat	Total wt. in grams	No. of rats	Average wt. per rat	Total wt. in grams	No. of rats	Average wt. per rat	Bread	Milk
May 12	837	12	69.7	800	12	66.6	815	12	67.9	20 %	30 %
„ 15	900	12	75.0	919	12	76.5	912	12	76.0	—	—
„ 18	1002	12	83.5	1027	12	85.5	930	11	84.5	—	—
„ 21	1107	12	92.2	1120	12	93.3	1020	11	92.7	—	—
„ 24	1187	12	98.9	1185	12	98.7	1132	11	102.9	16	24
„ 27	1310	12	109.1	1285	12	107.0	1242	11	112.9	—	—
„ 30	1403	12	116.9	1382	12	115.1	1322	11	120.1	—	—
June 2	1490	12	124.1	1470	12	122.5	1438	11	130.7	13	20
„ 5	1582	12	131.8	1552	12	129.3	1820	11	138.1	—	—
„ 8	1670	12	139.1	1632	12	136.0	1625	11	147.7	11	16
„ 11	1755	12	146.2	1688	12	140.6	1710	11	154.5	—	—
„ 14	1820	12	151.6	1770	12	147.5	1740	11	158.1	10	15
	Increase % = 217.5			Increase % = 221.5			Increase % = 232.8				

Of the three dozen rats, one died in Series A a few days after the beginning of the experiment. Of the others it would be difficult to say which batch seemed the healthiest: they all did splendidly: no evidence was obtained of any digestive disturbance; the coats of all were in perfect condition, and the rats exceptionally fine. That they were neither anaemic nor rickety was sufficiently evidenced by their great agility in climbing about the cages, nor was any evidence of such obtained by examination.

The experiments were brought to an end by the detection of an early pregnancy in one of the rats of Series C, evidently about the twelfth day; 12 days were therefore knocked off the experiment, so that no complications appear on the curve here given. About a week after the discovery of the first pregnancy, nearly all the females in all three series were found to be pregnant: they went to term and had large families of healthy rats.

In Figure 1 it will be seen that the rats of Series C (sterilised milk) gained slightly more weight than the other series. The

curve of Series *A* rises higher than *B*, but the initial weight was greater; the actual gain per cent. of *B* was greater than that of *A*, as shown in the table. In another series of experiments also on rats, with raw and boiled milk, the rats fed on raw milk did slightly better as regards weight than the series on boiled milk, but two died of each lot and the rats fed on boiled milk had what appeared to be a nasal catarrh for some weeks during the experiments, which probably contributed to the slight difference in weight: both series were in splendid condition, and all the females had large and healthy families at the age of about eleven weeks.

There would, therefore, appear to be no diminution in nutritive properties for rats, by boiling or even evaporating and drying the milk at 120° C.

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