XXXII. A COMPARISON OF DRIED AND EVAPORATED MILKS BY A DIETETIC METHOD.

BY GLADYS ANNIE HARTWELL.

*From the Physiological Laboratory, Household and Social Science Department,
King's College for Women, Kensington, London, W. 8.*

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At the present time there are a great number of dried and evaporated milks on the market, and many of them appear to have been used successfully in infant feeding. In fact, some makes are regarded as superior to fresh cow's milk, in that there is no possibility of the milks turning sour. Dried milks are made by one of two methods, either the "roller" or the "spraying" process being used. There seems to be no conclusive evidence as to which method supplies the best results, except with regard to vitamin C, when less destruction is claimed with the "roller" process [Jephcott and Bacharach, 1921; Hart, Steenbock and Ellis, 1921]. Experimental work on this subject has been done by various observers, a survey of the literature being given in the report of the Medical Research Council [1924].

The experiments to be described in this paper were started in the hope of obtaining information as to the vitamin B content of dried and evaporated milks. It had been found previously [Hartwell, 1921] that an excess of protein in the lactating rat's diet resulted in the offspring's suffering from spasms, etc., and that the young rarely survived. Later [Hartwell, 1922] it was shown that the addition of 100 cc. of whole cow's milk to the mother's excess protein diet entirely prevented the abnormal symptoms in the sucklings. Therefore it seemed possible that this fact might be utilised as a basis for comparison of different kinds of dried and evaporated milks.

EXPERIMENTAL.

1. *General Principle of Method.*

A diet was chosen which had been found to cause death of the offspring, while the mother remained fit and well. To this basal diet were added different quantities of fresh cow's milk in order to find the least amount necessary to protect the young from spasms. Dried or evaporated milks were then substituted in turn for the fresh cow's milk and the results compared.

2. *Diets.*

The basal diet consisted of bread and food casein [Hartwell, 1922] fed in the proportion of 15 g. bread to 6 g. food casein. To this basal diet were added successively 75, 50, 33, 24, 18 and 12 cc. of fresh cow's milk, water being added when necessary to make the mixture into a paste.

(a) *For the dried milks* the following proportions were used:

Dried milk, full cream,	12 g.	to 100 cc. water.
" " half "	10.5 g.	" 100 " "
" " skim,	9 g.	" 100 " "

These amounts were used in place of 100 cc. of cow's milk. They were chosen in accordance with the directions on the tin, the object being to use the same amount of powder as would be taken by the average person making up the milk from the given directions. Therefore different people were asked to measure out the amount stated on the tin and these amounts were weighed. For example, take x tablespoonfuls of dried milk to y pints of water. Twenty people were asked to measure x tablespoonfuls; these different quantities were then weighed and the average obtained. This amount was used with y pints (converted to cc.) of water. It is interesting that the figure obtained in this way is near the average of 12.4 % given for total solids in milk [Plimmer, 1921], but, of course, using this proportion does not allow for any water in the dried milk.

(b) *For evaporated milks*, the dilution used was that given on the tin, and this diluted milk was substituted for cow's milk. The specific gravity of the liquid was approximately that of fresh cow's milk.

The control mothers were fed on bread and milk, 15 g. bread to 50 cc. cow's milk (or its equivalent).

3. *Method.*

At least three mother rats were given each diet, and they received food *ad lib*. The mother and young were weighed daily. The babies were watched carefully for any abnormal symptoms. The mother rats had a good mixed diet during gestation and only litters of good weight at birth were used in these experiments. The special diet was given as soon as possible after the birth of the litter. In all, 171 mother rats and litters with 6 young to a litter were used in these experiments.

RESULTS.

The results are given in the Table, p. 228. In every case the condition of the young became worse as the mothers received smaller proportions of milk (Fig. 1, cow's milk is given as illustration). It is obvious that fresh and dried milks much excel the evaporated milks in vitamin B content. For example, it is significant that 75 cc. of diluted evaporated milk are insufficient to prevent spasms in the young, while 33 cc. of cow's milk or the equivalent amount of some dried milks are almost sufficient, no spasms and only slight

Proportions of Milk added to Basal Diet of Mother Rat.

Sample Cow's	Control 50 cc. milk to 15 g. bread	I. 75 cc. Normal condition. Growth curve de- pressed	II. 50 cc. Same as I	III. 33 cc. Growth about the same as in I, but animals not quite normal, slight inco- ordination shown. 1 out of 18 died	IV. 24 cc. Growth more de- pressed than in I, II and III. All 3 litters showed spasms and 1 litter had screaming fits	V. 18 cc. Growth similar to IV, but curve flat- tened from 15th day, some loss of weight. All 3 litters had spasms and screaming fits. 1 out of 18 died	VI. 12 cc. Condition of young very bad from 12th day. All 3 litters showed typi- cal symptoms and 2 whole litters died, i.e. 12 out of 18	Remarks —
<i>Dried.</i>								
A ("roller")	Rate of growth of sucklings equal to that obtained with cow's milk	—	Same as with cow's milk	Growth not quite so good as in II. Slight spasms shown. 1 out of 18 died	Growth about same as III. All 3 litters showed incoordina- tion. 1 litter had spasms and scream- ing fits. None died	Growth similar to III. 2 litters spasms and 1 litter scream- ing fits. 1 out of 18 died	Growth slower but 2 litters successfully weaned, although all 3 litters abnor- mal. Two young died	Slightly better than cow's milk
B ("roller")	Do.	—	Same as with cow's milk, but slight in- coordination in 1 litter. 1 baby died	Same as II	Growth about the same as II, but all 3 litters had spasms and screaming fits. 1 baby died	Growth and con- dition very poor, 2 whole litters and 2 other young died, i.e. 14 out of 18 died	Condition very bad from 12th day. 1 whole litter died, and 5 from each of the other litters, i.e. 16 died	Slightly worse than cow's milk
C ("roller")	Do.	—	Same as II B	Growth depressed, all 3 litters spasms; 1 litter did not gain weight after the 14th day	Similar to III	Condition of young poor. 2 whole litters died, the other showed no gain after the 15th day	Condition very bad but 7 survived	Slightly worse than cow's milk and similar to sample B
D 1 ("roller") (full cream)	Do.	—	Growth depressed, 2 litters had spasms, and in addition had screaming fits, i.e. only 1 litter was normal	Growth same as II. All 3 litters had spasms, and 1 litter screaming fits	Growth depressed and curves very flattened from 14th day. All 3 litters had bad spasms and 2 had screaming fits. 1 out of 18 died	Condition very bad, all 3 litters died	—	Worse than cow's milk
D 2 ("roller") (half cream)	Not quite so good as D full cream	—	Very poor growth; all 3 litters had spasms and scream- ing fits. 5 died	Same as II, but only 1 died	Same as III, only 1 died	—	—	Not quite so good as D full cream

E ("spray") F 1 (full cream) ("spray")	Normal	—	All 3 litters had spasms and 3 young died	—	—	All 3 litters had spasms and 1 whole litter died	—	About the same as D full cream
F 2 (skim) ("spray")	Rate of growth of sucklings equal to that obtained with cow's milk	—	Growth quite good, condition normal	Same as II; no spasms	—	All 3 litters had spasms and screaming fits. Growth curve flattened from 14th day. None died	All litters had spasms. 1 whole litter and 2 other babies died, i.e. 8	Slightly better than cow's milk; equal to A
Evaporated. G	Almost maximal growth	—	Growth good, but not up to standard. No spasms	Growth good. 2 litters had spasms and all 3 showed incoordination	—	Growth curve very depressed, all 3 litters spasms. 1 whole litter died	—	Not so good as F 1
H	Rate of growth a little slower than with cow's milk; young rats had thin coats and were very limp to the touch	—	Same as I, but condition of young just worse. All 3 litters had spasms and screaming fits. 1 died	Very slow growth of young. All 3 litters showed spasms and screaming fits. 1 died	Same as III, but 2 died	Condition worse than IV, 1 whole litter and 2 other young died	—	Not quite so good as D 1, distinctly poorer than cow's milk
I	Similar to G and H	—	Growth very poor indeed, 2 litters ceased to gain weight from the 14th day. All 3 litters had spasms and screaming fits. 2 died	Condition similar to 2, but worse. 9 died	Similar to III. 8 died	Condition worse than IV. 12 died	—	Not quite so good as G
J*	—	—	Growth curve depressed. 1 litter had bad spasms. 5 died	—	—	—	—	—
	Growth fairly good, but 1 litter had spasms and 1 litter screaming fits	—	—	—	—	—	—	—

* It was impossible to obtain any more of sample J.

incoordination being noted. A comparison of some of the samples is shown in Fig. 2.

The control experiments (where the mother rats were fed on bread and milk alone, *i.e.* no extra protein) also are interesting, in that they support

Fig. 1. Effect of adding different proportions of cow's milk to a basal diet of "excess" protein.
Mothers' diets.

- 674. 15 g. bread, 50 cc. cow's milk. Control.
- ▲—▲ 612. 15 " " 6 g. food casein, 50 cc. cow's milk.
- △—△ 678. 15 " " 6 " " " 24 " " "
- 722. 15 " " 6 " " " 12 " " "

the general view that evaporated milks are not so good as the dried varieties. The young belonging to the mothers fed with dried milk and bread were

normal, and appeared equal in all respects to the young whose mothers had bread and fresh cow's milk. The young whose mothers received evaporated

Fig. 2. Effect of adding equivalent amounts of cow's, dried and evaporated milks to a basal diet of "excess" protein.

Mothers' diets.

- 674. Bread and cow's milk. Control.
- ▲—▲ 680. Basal diet + cow's milk.
- +—+ 696. " " + dried milk; sample A.
- 701. " " + " milk; " D1.
- △—△ 829. " " + evaporated milk; sample G.
- 830. " " + " milk; " H.

milks were by no means up to standard. Their weights certainly were quite good, though slightly below normal, but their coats were poor and the baby

rats were limp to the feel. In other words they were just not fit. Confirmatory results were obtained in a series of experiments, to be published shortly, on the growth of weanling rats on dried, evaporated and fresh cow's milk. Summing up one can say that samples A and F1 (dried milks) are just better than cow's milk, and samples B and C (also dried milks) just less good, while samples G, H, I and J (evaporated milks) are distinctly inferior as compared with cow's milk in regard to vitamin B content.

COMMENTS AND CONCLUSIONS.

The evidence is quite conclusive that evaporated milks are poorer in vitamin B content than is fresh cow's milk (heated to 70°). With dried milks on the other hand, there is no definite evidence as to which method ("spray" or "roller" process) produces the better results, since sample F1 ("spray") is quite as good as sample A ("roller"), while sample E ("spray") is as poor as sample D1 ("roller"). It is quite possible that some individual differences in manufacture are responsible for these variations.

As pointed out by Heineman [1919] dried milks prepared by the "spray" process are more easily soluble in water than are those prepared by the "roller" process. Also the former are easily clotted by rennet, *e.g.* sample E clots in approximately the same time as cow's milk, while a true junket is not obtainable from samples A and B. It may be that the manufacturing method most suitable for preserving the physical properties of milk is one which results in a greater destruction of vitamin B, and that a method safeguarding vitamin B results in an alteration in the physical condition of the proteins, etc., of the milk. It would be interesting to know if vitamin A suffers any similar destruction.

SUMMARY.

1. A dietetic method is described for the comparison of cow's, dried and evaporated milks as regards vitamin B content.
2. The vitamin B content of evaporated milks is lower than that of dried milks and of fresh milk.
3. Dried milks vary in their vitamin B content, which may be slightly greater or slightly less than that of fresh milk. This variation does not run parallel with the method of manufacture.
4. Dried skim and half-cream milks are not quite so good as the same makes in full-cream.

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