

## A Tropical Milk Supply.

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WITH a view to establishing standards for milk produced under tropical conditions, a series of analyses has been made of the milk of cows and buffaloes in the city of Colombo. Five hundred genuine samples of milk from cows and 500 from buffaloes, 1000 in all, were examined to give the necessary data.

In going over different dairies it was found impossible to get 250 individuals; hence the milk from some dairies, representing the milk from animals previously examined, had to be re-examined. The question of seasonal variations is eliminated, as there are no seasons in the Tropics as in the temperate climates.

**Cows' MILK.**—The samples examined were drawn from 16 dairies. The breeds found were Scind, Nellore, Cross Bred, Cape and Nellore, Australian and South Indian, Native and Coast; of these the Scind animal is the favourite with the dairies, and 101 animals of this class were selected. The South Indian also seems fairly common, and of these 67 were chosen. Of the others there were 4 Australian, 12 Nellore, 23 Cross Bred, 25 Native, and 17 Coast. The condition of all was generally good. The usual times for milking in Colombo are between 4 and 5 a.m., and between 1 and 2 p.m., so that usually 16 hours intervene between

evening and morning milking. Owing to these unequal intervals between milking, the yield of the morning milk was greater than that of evening milk, and the milk was of poorer quality.

The average composition of the different breeds is given in the following table:

TABLE I. (AVERAGE OF ALL SAMPLES.)

Breed	No. of Cows	Average Daily Yield in Pints	Specific Gravity	Total Solids Per Cent.	Fat Per Cent.	Solids not Fat Per Cent.	Ash Per Cent.
Scind .. ..	101	7·34	1030·2	13·48	4·92	8·56	0·73
South India .. ..	90	6·46	1030·0	13·72	5·02	8·70	0·68
Native .. ..	18	2·92	1029·1	12·95	4·49	8·46	0·70
Nellore .. ..	14	5·86	1029·2	13·45	4·85	8·60	0·73
Cross-Bred Coast ..	12	6·54	1031·7	14·25	5·12	9·13	0·72

The averages of the 250 morning and 250 evening samples were found to be as follows:—

	Morning	Evening	Total Average
Specific gravity .. ..	1030·5	1028·4	1029·5
Total solids, per cent. .. ..	12·81	14·45	13·63
Fat „ .. ..	4·16	5·89	5·03
Solids not fat „ .. ..	8·65	8·58	8·60
Water „ .. ..	87·19	85·55	86·37
Ash .. ..	0·71	0·69	0·70

All the estimations were made directly by standard methods, as the formula worked out by Richmond might not have been found to be accurate for the tropics; although only in a few cases has there been found a difference between the results calculated by Richmond's formula and those obtained by actual estimation.

If we collate the results with those obtained by Richmond for the Aylesbury Dairy Co. (*Dairy Chemistry*, 3rd ed., p. 306), we get the following comparative figures:—

	Morning Aylesbury	Evening Aylesbury	Morning Colombo	Evening Colombo
Total solids, per cent. ..	12·47	12·81	12·81	14·45
Fat „ ..	3·57	3·92	4·16	5·89
Solids not fat „ ..	8·90	8·89	8·65	8·56
Ash „ ..	—	—	0·71	0·69
Specific gravity .. ..	1·0322	1·0319	1030·5	1028·4

and the average is :

	Aylesbury Per Cent.	Colombo Per Cent.
Total solids .. ..	12·64	13·63
Fat .. ..	3·75	5·03
Solids not fat .. ..	8·89	8·60
Ash .. ..	0·75	0·70
Specific gravity .. ..	1·0320	1·0295

It will be seen from these results that Colombo milk is very markedly richer in fat than English milk.

On the general results of the analyses one may say that the high percentage of fat in the milk is due to the breed and the richer feeding. Poonacs (crushed oil cakes), and such like oily foods, being common to the country, are easily and cheaply obtained.

The specific gravity is a little lower than that of English milk, this being due to the large percentage of fat present. The total solids, however, are in excess of those of English milk, owing to the high percentage of fat present in the milk. From analyses not given in detail it has been found that the proteins are slightly higher than in English milk, and the sugar is a little less, whilst the average ash is also slightly less.

The ash of the milk was also analysed in order to find if it differed much from that of English milk; the following are the results:—

## ANALYSES OF MILK ASH.

				Morning Per Cent.	Evening Per Cent.	Average English Analysis Per Cent.
Iron	..	..	..	Trace	Trace	0.53
Lime	..	..	..	21.45	23.04	22.0
Magnesia	..	..	..	3.46	3.31	3.05
Potassium oxide	..	..	..	14.98	14.36	24.67
Sodium oxide	..	..	..	13.48	13.56	9.70
Phosphoric acid	..	..	..	39.04	38.40	28.45
Sulphuric anhydride	..	..	..	Trace	Trace	0.30
Chlorine	..	..	..	9.70	10.00	14.28

The figures represent the average of a number of samples. As each sample of milk came in and was tested, the ash left from the ash estimation was brushed into a bottle and reserved for the ash analyses. The analyses, it will be seen, agree fairly well with those obtained with English milk, but the phosphoric acid and sodium oxide are higher, potassium oxide and chlorine lower. As a means of forming an opinion as to the genuineness of milk, the hydrometer is of little use in this country, as cows' milk can be adjusted by the use of water, coconut milk or buffalo milk. The percentage of fat is of interest, but cannot be relied upon without confirmation, as milks have been examined which would pass the fat standard, but which, nevertheless, were not genuine. The most important figure is "solids not fat," and this falls whenever water is added. In some cases jaggery sugar is added, but this is easily detected by the usual methods used for recognising cane sugar. Coconut milk is used as an adulterant, the high percentage of fat being the useful constituent. If the fat is separated and tested in the refractometer, any considerable admixture should be detected.\*

\* NOTE.—Coconut oil gives butyro-refractometer readings of 33.5 to 35.5 at 40 C. and butter fat readings of 40 to 44, whereas on the oleo-refractometer butter gives readings of -29 to -35 at 45 C. and coconut oil about -59. Adulteration is generally "added water"; rarely does a case of "cream removed" occur.

**BUFFALO MILK.**—The average composition of 500 samples of buffalo milk was as follows:—

TABLE II.

	Yield in Pints	Specific Gravity	Total Solids Per Cent.	Fat Per Cent.	Solids not Fat Per Cent.	Sugar and Protein Per Cent.	Ash Per Cent.
Morning	4.54	1030.7	17.31	7.96	9.35	8.53	0.82
Evening	3.20	1029.4	18.43	8.97	9.46	8.66	0.80
Average	3.82	1030.0	17.87	8.47	9.40	8.59	0.81

Some of the fats ran as high as 12 per cent. and solids-not-fat to 15 per cent. The analytical methods used were those adopted for the cows' milks, and the results may be compared with some of the few data given by other workers:—

		Colombo (Cochrane)	Indian (Barry)	Transylvanian (Strohmer)	Egyptian		Average 500 Col.
					(Pappel & Richmond)	(Pappel & Hogan)	
Specific gr.	...	1.0275	1.031	1.0319	1.0354	1.032.4	1.030
Total solids, per cent.	..	17.18	18.67	18.28	15.95	17.91	17.87
Fat	..	7.86	7.78	9.02	5.56	7.95	8.47
Solids not fat	..	9.32	10.89	9.26	10.39	9.95	9.40
Ash	..	0.82	—	0.77	—	0.78	0.81

It will be seen from these figures that buffalo milk is much richer than cows' milk, and a comparison is not out of place.

	Average of 500 Samples	Specific Gravity	Total Solids Per Cent.	Fat Per Cent.	Solids not Fat Per Cent.	Sugar and Casein Per Cent.	Ash Per Cent.
Cows	.. ..	1029.5	13.65	5.03	8.62	7.92	0.70
Buffaloes	.. ..	1030.0	17.87	8.47	9.40	8.59	0.81

A series of nitrogen determinations was also made, the results being:—

				Nitrogen Per Cent.	Proteins Per Cent.
Morning	..	..	..	0.73	4.56 (average of 18 samples)
Evening	..	..	..	0.74	4.63 ( " " 27 " )
Average	..	..	..	0.735	4.59 ( " " 45 " )
Pappel & Hogan (Egyptian Buffalo)	..			—	4.16 ( " " 16 " )

It will be seen that the percentage of nitrogen is higher than that in either English or Colombo cows' milk, which usually contain 0.5 and 0.6 per cent. respectively. Richmond considers that English milk should never contain less than 0.5 per cent. of nitrogen.

RATIONS.—The foods and rations used during the investigation are of interest, as they show a difference on comparison with the usual English Dairy ration:—

## ANALYSES OF CATTLE FOOD.

	Rice Bran Per Cent.	Dhall Husk Per Cent.	Rice Conjee Per Cent.	Wheat Pollard "A" Per Cent.	Wheat Pollard "B" Per Cent.
Moisture (loss at 100° C.)	10.00	11.30	95.74	12.50	11.80
Ether extract	7.60	2.30	0.66	3.50	3.80
Proteins	13.81	8.12	0.10	13.62	13.81
Carbohydrates	52.20	41.43	2.81	61.48	58.59
Fibre	6.75	29.65	0.07	6.20	8.40
Ash	9.64	7.20	0.62	2.70	3.60
	100.00	100.00	100.00	100.00	100.00
Soluble ash (water)	2.44	1.80	0.57	1.20	1.66
Containing nitrogen	2.21	1.30	0.016	2.16	2.21
Food units	105.7	67.4	3.2	104.3	102.6
Nutritive ratio	1.5	1.5.7	1.29.5	1.5.1	1.5

	Cotton Seed Cake Per Cent.	Poloondu Per Cent.	Gingelly Poonac Per Cent.	Mauritius Grass Per Cent.
Moisture loss at 100° C.	9.50	11.60	10.80	83.00
Ether extract	17.90	1.50	13.40	0.21
Proteins	15.75	22.75	31.75	2.01
Carbohydrates	32.74	53.59	29.00	7.67
Fibre	20.35	4.80	3.65	5.61
Ash	3.76	5.76	11.40	1.50
	100.00	100.00	100.00	100.00
Soluble ash (water)	1.36	1.32	1.50	0.89
Containing nitrogen	2.52	3.64	5.08	0.33
Food units	116.8	114.2	141.9	13.2
Nutritive ratio	1.4.7	1.2.5	1.1.9	1.4

It will be seen that the Ceylon ration is richer in fat and protein matter and poorer in carbohydrates than the English ration. In the latter the fat is about 0.4 lb. per day, proteins 2.5 lbs., carbohydrates 12.5 lbs., with a nutritive ratio of 1.5.4, whilst the Ceylon ration is about:—Fat, 2.5 lbs., per day, proteins 2.75 lbs., and carbohydrates 6.2 lbs., with a nutritive ratio of 1.4.2.

No inference can be drawn from the variation of ration on the yield and quality of milk, as the animals differed in breed, and conditions generally varied.

TABLE III.  
A COMPARATIVE TABLE SHOWING THE VARIOUS YIELDS FROM DIFFERENT DAIRIES AND THE PERCENTAGE COMPOSITION OF THE DIFFERENT BUFFALO MILKS.

Average of Buffaloes	Average Yield		Average Total Solids		Average Fat		Average Non-Fatty Solids		Average Water		Average Sugar and Protein		Average Ash		Average Specific Gravity	
	Morn.	Even.	Morn.	Even.	Morn.	Even.	Morn.	Even.	Morn.	Even.	Morn.	Even.	Morn.	Even.	Morn.	Even.
48	5.05	3.45	17.56	18.38	7.92	9.11	9.64	9.27	82.44	81.62	8.82	8.46	0.82	0.81	1029.2	1028.4
37	4.41	2.97	17.21	17.94	7.02	8.10	10.19	9.84	82.79	82.06	9.37	9.05	0.82	0.79	1030.6	1030.7
61	4.23	3.14	17.26	18.74	7.84	8.68	9.42	10.06	82.74	81.26	8.59	9.27	0.83	0.79	1031.6	1029.3
49	4.27	2.74	17.49	18.25	7.47	8.14	10.02	10.11	82.51	81.75	9.23	9.33	0.79	0.78	1030.8	1028.4
29	4.33	2.89	16.25	17.76	8.04	9.05	8.21	8.71	83.75	82.24	7.40	7.91	0.81	0.80	1031.4	1030.0
6	4.54	3.04	18.55	19.06	8.91	10.16	9.64	8.90	81.45	80.94	8.81	8.07	0.83	0.83	1031.1	1030.9
20	4.94	3.49	16.86	18.90	8.52	9.53	8.34	9.37	83.14	81.10	7.51	8.57	0.83	0.80	1030.4	1028.5
Average 4.54	3.20		17.31	18.43	7.96	8.97	9.35	9.46	82.69	81.57	8.53	8.66	0.82	0.80	1030.7	1029.4

Average for morning and evening—  
3.82 17.87

8.47 9.40 82.13 8.59 0.81 1030.05

# RATIONS AS SUPPLIED TO MILCH COWS AND BUFFALOES IN COLOMBO DAIRIES.

No. of Dairy Food	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.	Lb.
Gingelly Poonac	5	2	6	—	6	4	4	4	5	2	4	2	4	2
Rice Bran	6	—	2	—	1	1	2	1	—	1	1	$\frac{1}{2}$	2	—
Rice Conjee	1	—	—	1	1	—	—	—	$\frac{1}{2}$	1	1	$\frac{1}{2}$	1	—
Cotton seed	4	—	2	2	4	4	4	4	1	2	2	1	4	1
Grass	50	40	40	20	50	50	36	40	40	50	50	40	40	20
Pollard	—	6	—	—	—	—	—	—	4	—	—	—	—	—
Ulundu	2	1	—	—	—	—	—	—	1	—	—	—	—	—
Total quantity in lb.	68	49	50	23	62	59	46	49	51 $\frac{1}{2}$	56	58	44	51	23
Digestible protein	4.72	2.48	3.31	0.72	3.69	3.05	2.90	2.84	3.22	2.34	2.85	2.14	2.98	1.2
Digestible carbohydrates	10.83	7.91	6.50	2.21	7.46	6.83	6.27	6.06	7.86	3.13	6.47	5.25	6.61	2.44
Fat (ether extract)	4.55	1.32	3.21	0.92	3.91	2.06	3.4	2.25	2.48	1.9	2.49	1.55	3.41	1.12
Nutritive ratio	1:4.5	1:4.4	1:4.2	1:6	1:4.4	1:3.8	1:4.8	1:3.9	1:4.2	1:3.2	1:4.2	1:4.1	1:4.8	1:4

## DISCUSSION.

Mr. H. DROOP RICHMOND said that in his opinion the specific gravities of milk in tropical climates were slightly lower than they would be if determined in England. With his brother he had established the fact that the fat in milk, when drawn, was liquid and of lower specific gravity than when it solidified, and also that the solidification was a slow process when the milk was cooled, and *a fortiori* it would be still slower when the atmospheric temperature was high. In a tropical climate the fat would therefore be largely retained in the liquid state, and the maximum specific gravity which was usually accepted as the normal would not be attained. Mr. Bruce's figures for ash and for the composition of the ash would appear to indicate that the estimation was made at a somewhat high temperature, with consequent volatilisation of chlorides of the alkalis; the percentages of ash given were rather below those found in cows' milk elsewhere, and both the alkalis and the chlorine were lower in the ash than in English milk, and roughly to the equivalent extent. The higher phosphoric acid was in accord with the higher amount of proteins found, as the chief protein (casein) contained phosphorus which was found in the ash as phosphoric acid. It was to be regretted that Mr. Bruce had given neither his minimum percentages, nor the standards he deduced.

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