VIII. THE EXAMINATION OF SOME INDIAN FOODSTUFFS FOR THEIR VITAMIN CONTENT.

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THE subject of this paper was taken up at the suggestion of Dr J. C. Drummond, with a view to ascertaining whether the principal foodstuffs consumed by the mass of people in Bengal contain adequate amounts of different vitamins or not.

Among the previous workers in this field mention should be made of Chick and her collaborators [1917, 1919], who tested certain cereals and flours and samples of dried fruits for the presence of vitamin *B*, etc. and Greig [1917, 1918], who examined the anti-scorbutic value of Indian grains and lentils. Shorten and Roy [1921] also examined some vegetables for vitamins *B* and *C*. Chick had found that pure white flour is deficient in vitamin *B*. Chick, Greig and Shorten found that vegetables and lentils under certain conditions contained good amounts of anti-scorbutic vitamin.

The problem of supplying foodstuffs which should contain liberal amounts of different vitamins is very important in Bengal. Beri-beri occurs to some extent, and scurvy and rickets are encountered but are not widespread. From this but more from the low resistance of the people to various infectious diseases, and the presence of certain forms of eye-diseases, it may be suggested that the mass of the industrial classes may be living at or below the danger level of vitamin deficiency.

The table given below—quoted from MacCay [1912]—shows typical diets ordinarily in use among the different classes in Bengal.

Table I.

	Cultivators	Middle class (not above indigence)	Middle class (above indi- gence)	Well-to-do
	ozs.	ozs.	ozs.	ozs.
Rice	20	16	6	4
Dal	1	1	1	$\frac{1}{2}$
Vegetables	4	4	4	4
Oil	1	—	1	1
Fish	1	1	2	4
Wheat flour	—	—	6	6
Milk	—	—	8	16
Butter	—	—	1	4
Calories	(about) 2390	2310	2350	2950
				- 3450
			(Meat and eggs also added)	(Meat and eggs are taken, also sweets freely)

From this table it will be seen that so far as calorific values, etc. are concerned, the diets of the people are fairly in compliance with accepted standards. Low resistance to disease, therefore, is probably due to vitamin deficiency—vitamin *A* specially—although MacCay is of opinion that this low resistance is due to want of sufficient protein in food.

The above table may be regarded as roughly accurate, but MacCay omits to emphasise that all classes of the people eat large quantities of fruit during the spring and summer months; also that the amount of lentils consumed by the poorer classes is much higher than that in the table.

The principal "fatty foods" consumed are "ghee," various preparations of butter, mustard oil, and, to a limited extent, coconut oil. These are mainly used in cooking.

EXPERIMENTAL.

This enquiry has been confined to an examination of different samples of "ghee," mustard oil and coconut oil for the presence of vitamin *A*; "dals," i.e. lentils, and some samples of Indian flours, for vitamin *B*.

"Ghee" is made either from cows' milk or buffalo milk. As a rule, the raw milk is first warmed over a low flame for about half-an-hour, and then cooled and inoculated with sour milk. After about 12 hours, when curdling is complete, water is removed and the curd churned until the fats separate out. The fat is removed, clarified, and then cooled into a semi-solid mass of buttery consistency. In some cases this product is allowed to turn rancid and then heated and rendered.

Fresh "ghee" remains good for months if well stored in the dark.

The following table gives the analysis of different "ghees." The results are similar to those quoted by Bolton and Revis [1910].

Table II.

	Reich.-M. value	Sapon. V.	Iodine N.	Free fatty acids
Pure cows' "ghee" (yellow)	28.7	230	31	2.2
Pure cows' "ghee" (remelted) eight months old sample (yellow)	26	229	29	2.6
Pure buffalo "ghee" (white)	38.8	224	27.2	—
Adulterated "ghee" (white)	14.4	213	29.3	—

"Ghee" is frequently adulterated with lard, mutton fat, coconut oil, and almond oil.

Rats about one month old, which were over 50 g. in weight, were selected and put on a diet deficient in vitamin *A* [Drummond and Coward, 1920]. Generally it took about three weeks for the rats to become steady in weight and fit for the feeding experiment. Then each rat was given 0.2 g. of "ghee" every morning in addition to its usual basal diet.

In the majority of cases the rats made steady increase in weight for about ten days (sometimes varying from 10 to 21 days) when they again became

stationary. The amount of "ghee" was then raised to 0.4 g. a day, when the rats again resumed growth.

It is to be noted that the remelted sample did not induce growth, but some of the adulterated samples were fairly active when given as 5 % in basal diet.

It has been shown by Drummond, Coward and Watson [1921] that 0.2-0.4 g. per day of average samples of butter is sufficient to maintain growth for rats.

From the examination of the table of weighings it will be seen that both pure cows' "ghee" and buffalo "ghee" may be as good as European butters.

Table III.

(Showing the growth of rats on *A*-deficient diet and 0.2 g. of pure "ghee." The weighings of the rats during the preparatory period are omitted.) g.

	931, male	835, male
First weighing	91	58
After 10 days	102	74
" 15 "	104	83
" 30 "	124	100
" 40 "	138	110

Table IV.

(Rats on *A*-deficient diet + 0.2 g. of pure "ghee." Sample 2.) g.

	832, male	834, male	940, male
First weighing	80	89	56
After 10 days	85	111	77
" 15 "	90	120	76*
" 30 "	120	150	105
" 40 "	129	162	112

* Amount of "ghee" doubled

Table V.

(Rats on remelted cows' "ghee.") g.

	833, male	836, female	828, male
First weighing	90	55	80
After 10 days	94	60	66
" 15 "	92	52	60
" 30 "	95	—	—
" 40 "	—	—	—

Table VI.

(Rats on pure buffalo "ghee.") g.

	933, male	1176, male	932, female
First weighing	104	76	95
After 10 days	120	105	109
" 15 "	—	—	—
" 30 "	136	150	136
" 40 "	151	—	148

Table VII.

(Rats on adulterated "ghee." Sample I.) g.

	1510, female	1177, male	1176, male
First weighing	72	65	68
After 10 days	78	68	73
" 30 "	75	72	72
" 40 "	80	76	74

Table VIII.

(Rats on adulterated "ghee." Sample II, given as 5 % in basal diet.) g.

	976, female	1300, male
First weighing	80	60
After 10 days	—	—
" 30 "	110	95
" 40 "	125	109

Table IX.

(Rats on coconut oil and *A*-deficient diet. The oil was given in the basal diet 10-20 %.) g.

	1457, male	1456, male	1463, female
First weighing	82	64	76
After 10 days	95	69	94
" 20 "	118	77	105
" 30 "	130	91	102

Table X.

(Rats on mustard oil: 10-20 % in the basal diet.) g.

	1508, male	1483, female	1511, male
First weighing	77	57	64
After 10 days	84	62	76
" 20 "	88	64	85
" 30 "	98	72	92

Some of the adulterated samples gave good results, but as this depends on the adulterants used, the different samples gave widely varying results.

Daniels and Loughlin [1920] and Drummond, Golding, Zilva and Coward [1920] have shown that lard may contain a certain amount of vitamin *A*, the latter authors having shown that this occurs when the pigs have been grass-fed, and it should be borne in mind that lard is a most widely used adulterant in "ghees."

Contrary to the results of previous workers [cf. Jansen, 1920], the samples of coconut oil examined by me did produce fair growth in rats. It should be mentioned here that coconut oil was not administered in the same way as "ghees," but was incorporated in the basal diet in 10 % proportion and replaced hardened fat.

The results obtained with pure mustard oil are also interesting. The oil was administered in large quantities (10–20 % in diet) to the rats, and in some cases actual growth was obtained contrary to the results of previous workers. Both mustard oil and coconut oil were those prepared in India and most probably not so refined as in Europe or America.

The buffalo "ghee" is pure white, and the presence of the growth-promoting vitamin *A* in it confirms Drummond and Coward's work on vitamin *A* and colour [1920].

That renovation under certain conditions does not affect the vitamin content is also in accord with the results found by Drummond, Coward and Watson [1921].

Examination of different samples of lentils.

The procedure for examining the samples of lentils was similar to that adopted in the case of "ghees," except that in these experiments the rats had been previously fed on diet deficient in water-soluble *B*. Each rat, after it had begun to lose weight on this diet (*B*-deficient diet), was given 1 g. of the lentil to be tested, daily.

The *B*-deficient diet was similar to the Drummond-Coward diet (*A*-deficient) except that no yeast extract was given and that butter replaced hardened fat.

The weighed amount of lentil (1 g.) was kneaded with a small portion of the diet and given in the morning before the rat had the main bulk of its food.

The different lentils thus examined included:

1. "But" (yellow variety)—*Cicer arietinum* Linn.
2. "Sona Moong" (golden-yellow in colour)—*Phaseolus Mungo* Linn.
3. "Arhar" (small size, yellow-ochre variety)—*Cejanus Indicus* Spreng.
4. "Lal Moong" (red variety)—*Phaseolus radiatus* Linn.
5. "Mash Kalai" (greenish variety)—*Phaseolus Mungo* Linn.
6. "Bara Lal But" (red variety)—*Cicer arietinum* Linn.

It should be mentioned here that as far back as 1900 Grijns [1901] working in Java found "Katjang Hidjoe"—a variety of *Phaseolus radiatus*—a good cure for both human and avian beri-beri. Hulsoff [1917] also worked with the

anti-neuritic property of Katjong (*Phaseolus radiatus*). A similar result has also been found by Pol [1917].

Table XI. Composition of the various "Dals" (lentils).

Name	H ₂ O %	Ether extract %	Protein %	Soluble carbo- hydrates %	Woody fibre %
5. <i>Phaseolus Mungo</i> Linn.	8.5	0.9	19.5	59.3	4.5
2. " " Yellow	10.99	0.83	20.5	59.0	4.8
4. <i>Phaseolus radiatus</i> . Red	10.0	0.93	22.9	58.9	3.38
1. <i>Cicer arietinum</i> . Yellow	11.4	4.9	18.6	56.3	6.1
6. " " Red	8.6	5.3	15.5	60.1	7.2
3. <i>Cejanus Indicus</i> Spreng.	14.3	1.9	15.8	57.2	5.8

Examination of the tables showing the growth of the rats on the lentils, shows that all the above varieties of lentils contain appreciable amounts of vitamin B.

Table XII.

Rats on B-deficient diet (1 g. of lentil a day). (*Phaseolus Mungo*—greenish variety.) g.

	1262, female	1267 a, female	1267, female
First weighing	90	102	75
After 10 days	117	122	95
" 20 "	133	138	113

Table XIII.

Rats on *Phaseolus Mungo*—golden-yellow variety. g.

	1282, male	1284, male	1285, male
First weighing	92	100	80
After 10 days	109	130	100
" 20 "	122	151	115

Table XIV.

Rats on *Phaseolus radiatus*. g.

	1258, male	1283, male	1259, female
First weighing	72	100	63
After 10 days	82	140	85
" 20 "	86	162	104

Table XV.

Rats on *Cejanus Indicus*. Spreng. g.

	1260, female	1261, male
First weighing	86	95
After 10 days	100	131
" 20 "	115	146

Table XVI.

Rats on *Cicer arietinum*. Yellow variety. g.

	1264, male	1265, female	1266, female
First weighing	76	76	90
After 10 days	68	94	115
" 20 "	78	110	128

Table XVII.

Rats on *Cicer arietinum*. Red variety. g.

	1274, male	1277, male	1276, male	1275, male
First weighing	82	96	80	95
After 10 days	98	130	101	115
" 20 "	105	146	112	127

Table XVIII.

Rats on B-deficient diet and 1 g. of pure unbleached Indian flour. g.

	1278, male	1279, female
First weighing	106	88
After 10 days	120	115
" 20 "	135	120

Table XIX.

Rats on crude "Attah." g.

	1266a, female	1268a, female	1269a, male
First weighing	83	75	65
After 10 days	101	105	98
" 20 "	111	117	117

Table XX.

Rats on bleached Indian flour. g.

	1292a, male	1291a, female	1293a, female
First weighing	81	69	76
After 10 days	80	65	73
" 20 "	79	Dead	Dead

Examination of different samples of Indian flour.

Here the samples examined were only those that are widely used in Bengal. They were:

1. Crude "attah." ("Attah" is a mixture of various flours, *e.g.* wheat, pea and maize, etc., and contains the husks of the cereals in it.)

2. Pure Indian flour. This flour has a finer texture than the "attah." It is machine-ground, but it contains the ground-up husks of the cereals. This flour is not bleached.

3. White flour. This is machine-ground like the pure Indian flour, but it does not contain the husks, and moreover it is bleached perfectly white. Sometimes chlorine is added in the bleaching process.

1 g. of each of the above samples was given daily to the different sets of rats, in the same way as in the case of lentils.

The composition of the different flours is given below.

Table XXI.

	H ₂ O	Ether extract	Carbo- hydrate	Protein N × 5.7	Crude fibre
1. Crude "Attah"	14.6	2.9	67.1	11.5	3.9
2. Pure unbleached flour.	15	2	71.2	11	0.8
3. Bleached white	12	2	71.3	13.5	0.6

The results found are in accord with those of Chick as well as with the facts announced by Col. Hehir [1919, 1, 2] in the Mesopotamia Commission Report on the presence of deficiency diseases in the besieged garrison in Kut. Willcox [1917] has also discussed "attah" as a protective against beri-beri.

Johns and Finks [1920] found that a mixture of pea-flour and wheat-flour produces better growth in rats than simple wheat-flour, and these facts are also corroborated since "attah" is found to be better in promoting growth than pure (unbleached) flour. From the weighings of the rats, fed on the different samples of the flours, it will be seen that with the exception of bleached flour they contain appreciable amounts of vitamin *B*.

CONCLUSION AND SUMMARY.

Samples of pure Indian "ghee" proved to be as good a source of vitamin *A* as pure butter.

Samples of remelted "ghee" ("makkum galana") failed to restore growth in rats whose weights had become stationary on a shortage of fat-soluble *A*.

Two samples of "ghee" whose history is unknown failed to promote growth.

Some samples of adulterated "ghee" only gave growth in rats when administered in large quantities (*e.g.* 5 % of the basal diet).

Certain edible vegetable oils, *e.g.* ("narikel") coconut oil, and pure mustard-seed oil were examined, and these were found to give growth when administered in 10–20 % in the basal diet.

Various samples of lentils were examined and these showed good content of vitamin B.

Bleached (pure white) Indian flour is found to be deficient in vitamin B, but both crude "attah" and unbleached Indian flour have considerable quantities of water-soluble vitamin B.

In conclusion I take the opportunity of expressing my thanks to Dr J. C. Drummond and Miss Katharine H. Coward, for kind help and advice.

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