macronucleus. It is to be assumed that in a normal nucleus capable of mitosis, a definite protein-nucleic acid ratio exists, and should be maintained. It is only on the basis of this assumption that the interaction between these two substances makes mitosis possible. Quantitative studies have shown that the chromosome which is more or less entirely a nucleoprotein, contains a 40:60 ratio of nucleic acid and protein.[7] Therefore it would seem necessary that a certain basic protein equipment would be required for the building of a chromosome. Any disturbance of this protein-nucleic acid ratio must have a deterrent effect on mitosis and must produce a condition when mitosis does not occur at all or is so disturbed that it degenerates into amitosis. On this view we may find an answer to the behaviour of the ciliate macronucleus. Of the two substances which alone are known to form the chromosomes, one of them, *i.e.*, desoxyribose nucleic acid, is present in it. And yet no chromosomes are formed. The reason probably is, as set out earlier, the protein-nucleic acid ratio has been upset, with the result that the chromosomes are not formed, and no mitosis occurs.

Why and how this ratio is upset may now be briefly examined. The behaviour of the conjugating ciliate immediately after syngamy appears to provide an answer. The synkaryon is capable of mitosis and divides a number of times. A distribution of the resulting nuclei among the daughter individuals takes place so that each comes to possess the normal nuclear equipment. Concomitant with this is the enlargement of some of the nuclei to become the macronuclei, while the others that do not enlarge, remain as the micronuclei. It is significant that the nuclei which do not enlarge retain the faculty for mitotic division, while those that do, lose it.

We would regard this enlargement as a process of acquisition of cytoplasmic nucleotides. On this basis, it is clear that against a known and fixed protein equipment of the original small nucleus, the addition of enormous quantities of nucleotides has so overloaded it with nucleic acid that the functional ratio between it and the protein has been upset, with the result that the macronucleus has been dispossessed of its vital attributes of chromosome formation and mitosis.

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VITAMIN A IN FISH LIVER OILS AND CAROTENE IN FOODSTUFFS

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THE vitamin A activity of some fish oils and foodstuffs has been reported previously from these Laboratories.[1–9] It was observed that the liver oils of some of the fishes that abound the waters along the coast of India are much richer in vitamin A than Norwegian cod liver oils. A number of fish oils has since been assayed for vitamin A and this paper embodies the results of such assays. The non-saponifiable fractions of the oils were used for the assays. The method adopted was either tintometric or spectrographic or both and was the same as described by Rajagopal.[7] The factor adopted for conversion of Carr-Price value of the oils into International Units of vitamin A per gramme was 53.

Some samples of foodstuffs and carotene concentrates were assayed for their carotene content by the tintometric method as described by Sekhon.[8]

Results

Table I

Vitamin A content of shark liver oils estimated by the tintometric and spectrographic methods

Source	C.P. value on non-sap	Vitamin A. I.U./g (by the spectrographic method)	I.U. of vitamin A/g (Spectrograph method)
	C.P. value on non-sap.		C.P. value on non-sap.
(1)	(2)	(3)	(4)
Calicut	1,003	46 550	46·4
do.	839	36,510	43·6
do.	551	28 490	51·7
do.	577	27 500	47·7
do.	382	20,640	54·2
do.	272	15,140	55·7
do	239	14,940	62·6
do.	298	14,910	50·1
do.	291	14 000	48·1
do.	107	6,860	64·2
do.	117	6,000	51·3
do.	56	2,780	49·8
do.	37	1,780	48·0
Ceylon	164	7,890	48·0
do.	69	3,870	56·2
Average	319	16 524	51·8

TABLE II. *Vitamin A content of shark liver oils estimated by the tintometric method*

Source	No. of Samples	Vitamin A in I.U. per g.		
		Max.	Min.	Average
Alleppey ..	2	16,250	6,900	11,575
Baroda ..	1	4,000	4,000	4,000
Bombay ..	2	11,370	7,700	9,535
Calicut ..	4	12,780	6,250	8,498
Ceylon ..	7	7,400	1,180	2,736
Karachi ..	19	37,900	1,470	9,829
Trivandrum ..	17	18 500	1,090	8,533
Average ..	52	37,900	1,090	8,287

TABLE III. *Vitamin A content of blended fish liver oils appearing on the market as substitute for cod liver oil*

Source	No. of Samples	Vitamin A in I.U. per g.		
		Max.	Min.	Average
Bombay ..	4	2,400	1,360	1,743
Calicut ..	7	1,600	700	1,251
Ceylon ..	2	1,680	1,000	1,340
Karachi ..	5	1,300	400	369
Kolhapur ..	1	1,140	1,140	1,140
Madras ..	13	1,200	76	396
Average ..	32	2,400	76	872

TABLE IV. *Carotene content of foodstuffs, red palm oils and concentrates*

	Botanical name	Source	Carotene content in μg. per g.
Carotene concentrate (3 samples) ..	—	Bombay	47,360
,, crystals (prepared from grass) ..	—	Calcutta	24,540
,, concentrate ..		Bombay	17,400
,, ,, (type 150°) (4 samples) ..	—	,,	12,600
Red palm oil (2 samples) ..	*Elæis guineensis*	Manmad	600
,, (4 samples) ..	do.	Travancore	440
Amaranth, green ..	*Amaranthus gangeticus*	Coimbatore	120
do., red	do.	,,	105
do., spiny	*A. spinosus*	,,	101
do., Rangoon	*Amaranthus gangeticus*	,,	77
Carrot, red	*Daucus carota*	Ootacamund	105
do., violet	do.	,,	8·4
do., white	do.	,,	1·3
Palm fruit, juice	*Borassus flabellifer*	Cochin	33·8
Margarine (4 samples)	—	Bombay	9·3
Red gram, red	*Cajanus indicus*	Central Provinces	0·9
do., white	do.	,,	0·9
Spent yeast	—	Bihar	0·8
Cashew nut oil	*Anacardium occidentale*	Coimbatore	0·8
Soya bean milk	*Glycine hispida*	—	0·4
White ragi	*Eleusine coracana*	—	0·1
"Bel Vita" (a marmite substitute) ..	—	Bihar	Trace
Vanaspati (12 brands) ..	—	Sind	Nil

DISCUSSION

It will be seen from Tables I and II that most shark liver oils are very rich in vitamin A. Similar high values have been recorded for Indian fish liver oils by workers in other laboratories.[10–14] Column 4 of Table I indicates that the conversion factor 53, used for conversion of Carr-Price value into International Units per gramme, is justified. The average value for vitamin A assayed is of the order of 10,000 I.U. per gramme. Hence, merely by mixing of the oils, shark liver oil of this potency can be placed on the market which will be useful for infants and invalids who are unable to tolerate large doses of oil.

Table III indicates the desirability of having proper legislation to protect the interests of the consumer. Of the 32 samples assayed, only 15 were found to have a value of 1,000 or more I.U. of vitamin A per gramme. Hence it is essential that the law should insist that the vitamin A content of oils put on the market as substitutes for cod liver oil should have a minimum potency of 1,000 I.U. per gramme (B.P. standard).

It should be borne in mind that it is only the red carrot that is rich in carotene; the white and violet varieties are very poor in this constituent (Table IV).

SUMMARY

1. Sixty-seven samples of shark liver oils, obtained from various parts of India, were found to have an average vitamin A potency of 10,130 I.U. per gramme. It is concluded that a 'high potency' shark liver oil (10,000 I.U. per g.) can be placed on the market involving little effort.

2. Thirty-two samples of 'blended' fish liver oils had, on an average, 870 I.U. of vitamin A per g. The importance of enforcing standardization of vitamin A products by legislation is emphasized.

3. The carotene content of a few foodstuffs and concentrates is reported.

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