In the murine system investigated by us, an inverse correlation between the quantity of MHC I antigens present on the tumour cells and their susceptibility to lysis by LAK cells is clearly supported by our data. It is, however, not clear whether MHC I antigens influence directly the lytic process or the two phenomena are associative only.

1. Ljunggren, H G. and Karre, K, *Immunol. Today*, 1990, **11**, 237–244
2 Wiebke, E. A, Custer, M. C., Rosenberg, S. A. and Lotze, M. T, *J. Biol. Resp Modifiers*, 1990, **9**, 113–126.
3. De Fries, R. U. and Golub, S. H, *Nat. Immun. Cell Growth Regul.*, 1988, **7**, 65–76.
4. Miyatake, S., Kikuchi, H, Oda, Y., Nishioka, T., Takahashi, J, Kondoh, S., Matsumoto, M, Yamasaki, T, Iwasaki, K., Aoki, T., Kasakura, S and Namba, Y., *Cancer Res.*, 1990, **50**, 596–600.
5. Sugawara, S, Abo, T. and Kumagai, K., *J Immunol. Methods*, 1987, **100**, 83–90
6. Sarin, A and Saxena, R K., *Indian J Exp. Biol.*, 1990, **28**, 1017–1020.
7. Sarin, A., Adler, W. H. Saxena, R. K., *Cell. Immunol.*, 1989, **122**, 548–554.

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Pharmacologically active fatty acids of tiger prawn *Penaeus monodon* (Fabricius)

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The fatty acid compositions of the hepatopancreas and body flesh of the exportable prawn *Penaeus monodon* (Fabricius) have been studied by gas liquid chromatography and other chromatographic techniques. Altogether 24 components were detected and estimated. Major fatty acids recorded were palmitic (16:0), stearic (18:0), oleic (18:1 ω9) and linoleic (18:2 ω6). Of the polyunsaturated fatty acids, considerably high levels of pharmacologically active fatty acids, viz. arachidonic pentaenoic (23:4 ω6) eicosapentaenoic (20:5 ω3) and docosahexaenoic (22:6 ω3) were recorded. Thus, the species studied is also a potential source of pharmacologically active fatty acids, particularly belonging to the –ω3 series.

BIOCHEMICAL studies on prawn is necessary for evaluating its nutritional value as well as its possibility of future usage as natural sources for biologically active components. In the present study, efforts have been made to determine various lipid components in the body of the prawn *Panaeus monodon* with special reference to the fatty acid profile of the lipid.

Fresh samples of wild *P. monodon*, collected from fishermen of Sagar Island, West Bengal, were divided into two parts, body flesh and hepatopancreas, weighed and separately extracted as follows. Body flesh and hepatopancreas were homogenized separately with MeOH–$CHCl_3$ (2:1), centrifuged and the residue was again homogenized with MeOH–$CHCl_3$–H_2O (2:1:0.8). After centrifugation the residue was again homogenized with MeOH–$CHCl_3$ (2.1) and recentrifuged. The supernatants were pooled and diluted with $CHCl_3$–H_2O (1:1). The lower $CHCl_3$ layer containing the total lipid was dried over anhydrous Na_2SO_4 (ref. 1). The total lipid was saponified using methanolic KOH in an atmosphere of nitrogen gas, according to Christie[2]. Nonsaponifiables were separated with diethyl ether, after which, acidifying the aqueous layer, fatty acids were obtained by diethylether extraction, dried and methylated using diazomethane[3]. An aliquot of the sample was hydrogenated catalytically to confirm the unsaturated fatty acids[4]. The major components of nonsaponifiables, namely hydrocarbon and sterols were separated by thin layer chromatography (TLC) using 50% diethylether in hexane as the solvent system[5]. Sterol, thus obtained, was estimated colorimetrically using ferric chloride reagent, as described by Kates[6]. The hydrocarbons were estimated by direct weighing. Gas liquid chromatography (GLC) was done on a Hewlett–Packard instrument Model 5890, series II, equipped with a glass column (1.8 m × 2 mm i.d.), packed with 10% diethylene glycol succinate polyester liquid phase supported on 80–100 mesh Chromosorb-W (HP) and a flame ionization detector (FID) was used. Peaks of fatty acid methyl esters were identified according to the methods of Ackman and Burgher[7] and Ackman *et al.*[8].

The present investigation shows that the body flesh of *P. monodon* is a rich source of both eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). The occurrence of considerably higher levels of EPA, DHA and nonsaponifiables (Table 1) in the body flesh is common in the detritivorous benthic animals of Sunderbans estuarine complex[9–12].

About 24 fatty acids are reported from the hepatopancreas and body flesh of *P. monodon* (Table 2) Of

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Table 1. Composition of total lipids, nonsaponifiables, hydrocarbons and sterols of body flesh and hepatopancreas of *P. monodon*

Components	Body flesh	Hepatopancreas
Total lipids [a]	1.53	17.9
Nonsaponifiables [b]	40 2	13 9
Hydrocarbons [b]	3 9	3.7
Sterols [c]	Trace	Trace

[a] Expressed as % w/w of wet tissue.
[b] Expressed as % w/w of total lipids.
[c] Trace quantities, below 1.0%.

Table 2. Fatty acid compositions of hepatopancreas and body flesh of *Penaeus monodon*

Components [a, b, c]	Hepatopancreas [d]	Body flesh [d]
13 iso	0.73	0.50
14:0	5.16	1.35
15:0	1.88	0 88
15:1	–	0.82
16:0	28.37	18.93
16:1 ω9	7.72	2.70
16:2 ω9	–	1.62
17:1	1.05	1.41
18.0	6.37	12.75
18:1 ω9	17.61	14.22
18.2 ω6	6.52	6.71
20:0	0 90	0.50
18:3 ω3	4.79	2.77
18:4 ω6	0.74	0.20
18:4 ω3	1.06	0.88
20:3 ω6	1.06	0 88
20:4 ω6	5.05	12.97
22:2 ω6	2.95	0.39
20:5 ω3	4.96	10.44
24.0	–	0 46
22:4 ω6	0.79	2.03
22:4 ω3	0.68	1.18
22.5 ω6	0 37	1.13
22.6 ω3	1.23	4 03

[a] Short hand notation implies chain length· number of the double bonds.
[b] The ω-values indicate methyl end chain from centre of the double bond furthest removed from carboxyl end.
[c] The data shown are mean of three experiments that are within ± 5% for most of the components.
[d] Values expressed as % w/w of total fatty acids.

the saturated fatty acids, the highest level was of palmitic acid (28.4%) in the hepatopancreas but the acid was 19% in the body flesh. Among the unsaturated fatty acids, the major component was oleic acid (17.6%) in the hepatopancreas and it was 24.2% in the body flesh. EPA, the major bioactive fatty acid, was about 5% in the hepatopancreas and 10.4% in the body flesh. Of the other polyenoic acid, mention could be made of DHA, which was only 1.2% in the hepatopancreas, against 4% in the body flesh.

Omega-3 fatty acids, the principal building blocks of marine fish oils, have a number of health-enhancing properties[13]. These fatty acids, especially the EPA, in the diet reduce concentrations of cholesterol and triglycerides of the plasma by lowering the rate of synthesis of low density lipoprotein and very low density lipoprotein, which are carriers of triglycerides and cholesterol[14], by the liver and vascular tissues. Thus, it is suggested that adult patients with circulatory and other symptoms can be treated medically if EPA is taken regularly in fish-oil capsule form and various heart diseases can be prevented[15, 16]. Similar studies with DHA indicate that it is effective in skin disorders, relieves inflammatory conditions, aids brain development and also forms a good part of the retina of the eye[17].

1. Bligh, E. G. and Dyer, W. J., *Can. J. Biochem. Physiol.*, 1959, **37**, 911–917.
2. Christie, W. W., *Lipid Analysis*, 2nd edn, Pergamon Press, Oxford, 1982, pp. 51–55.
3. Schlenk, H. and Gallerman, J. L., *Anal. Chem.*, 1960, **32**, 1412–1414.
4. Ghosh, A. and Dutta, J., *Trans. Bose Res. Inst.*, 1972, **35**, 13–15.
5. Misra, S., Ghosh, A. and Dutta, J., *J. Sci. Food Agric.*, 1983, **35**, 59–65.
6. Kates, M., *Techniques of Lipidology*, 2nd edn, Elsevier, Amsterdam, 1986, pp. 122.
7. Ackman, R. G. and Burgher, R. D., *J. Am. Oil Chem. Soc.*, 1965, **42**, 38–42.
8. Ackman, R. G., Burgher, R. D. and Jangaard, P. M., *Can. J. Biochem. Physiol.*, 1963, **41**, 1627–1641.
9. Misra, S., Dutta, A. K., Dhar, T., Ghosh, A., Chowdhury, A. and Dutta, J., *J. Sci. Food Agric.*, 1983, **34**, 1413–1418.
10. Misra, S., Ghosh, M. K., Choudhury, A., Dutta, A. K., Pal, P. K. and Ghosh, A., *J. Sci. Food Agric.*, 1985, **36**, 193–196.
11. Dutta, A. K., Pal, P. K., Ghosh, A., Misra, S., Nandi, S. and Choudhury, A., *J. Am. Oil Chem. Soc.*, 1986, **63**, 223–225.
12. Misra, S., Misra, S., Choudhury, A. and Ghosh, A., *Food Chem.*, 1986, **22**, 252–258.
13. Patlak, M., *Res Res. Rep*, 1985, **9**, 1–5.
14. Illingworth, D. R., Harris, W. S. and Connor, W. E., *Artereosclerosis*, 1984, **4**, 270–275.
15. Ackman, R.G., *n-3 News*, 1986, **1**, 1–4.
16. Ackman, R. G., *Food Technol.*, May 1988, pp. 151–155.
17. Lee, T. H., Hoover, R. L., Williams, J. D., Sperling, R. I., Ravalese, J., Spwi, B. W., Robinson, D. R., Corey, E. J, Lewis, R. A. and Austen, K. F., *New Engl. J. Med.*, 1985, **312**, 1217–1224.

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Development of marked basophilia in the liver of *Heteropneustes fossilis* by some selected chemicals

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Picric acid, a-nitrophenol and furadan were ineffective in producing any change in the liver of