FATTY ACID COMPONENT OF BLUBBER OIL OF AMAZON RIVER DOLPHIN

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ABSTRACT

The oils contained in 12 blubbers of Amazon dolphin, *Inia geoffrensis*, were studied for total lipid contents, chemical properties and fatty acid components. The oil contents of these blubbers had the range from 31.6% to 63.9%. The fatty acid components of sample oils were analyzed by gas liquid chromatography. The analysis showed the presence of fatty acids with chain lengths from 5 to 24 carbon atoms and with zero to six double bonds. Eight kinds of fatty acids (*iso*-C_{12}, C_{12}, *iso*-C_{14}, C_{14}, $C_{14:1}$, C_{16}, $C_{16:1}$ and $C_{18:1}$) accounted for the range from 77.69% to 84.03% of the total fatty acid contents; 41 other acids were contained in low quantities. The fatty acid compositions of blubber oils in melon, lower jaw and root area of tail fin deviated distinctly from them of other blubber oils.

INTRODUCTION

There are a few literatures on the oil of the dolphin in fresh water habitats. They are the literatures on the oil of Ganges river dolphin, *Platanista indi* and *gangetica* by Pathak *et al* (1956), Pilleri (1971), and Tsuyuki and Itoh (1971, 1972).

As to the study on the oil of Amazon dolphin, *Inia geoffrensis*, the lipid compositions of the dorsal blubber and the lower jaw fats have been reported in the literature by Ackman *et al* (1972).

This investigation was conducted to identify the fatty acid components in the various blubber oils of Amazon dolphin, and to examine if the fatty acid compositions or distribution patterns characterized different blubbers.

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MATERIALS AND METHODS

The material in this study was a 203 cm long, 80 kg weight, adult female Amazon dolphin, *Inia geoffrensis*. She was captured in 1969 at Leticia City (an upper stream of the Amazon river) in Brazil. She had been raised in the aquarium of " Kamogawa Seaworld " (Kamogawa City, Chiba Pref.). The sample blubbers were

TABLE 1. PROPERTIES OF OILS CONTAINED IN VARIOUS BLUBBERS OF AMAZON DOLPHIN.

Parts of blubber	Oil content (%)	Acid value	Iodine value	Sapon. value	Unsapon. matters (%)
Hind part of blow hole	56.7	1.53	93.2	161.4	0.81
Root area of dorsal fin					
inner	59.3	1.36	96.2	180.2	0.85
outer	41.2	1.81	98.5	170.6	0.82
Abdominal side of ventral fin	44.2	1.27	87.8	184.7	0.95
Abdominal side of anus					
inner	52.0	1.54	99.4	180.6	1.04
outer	40.6	1.28	106.3	172.8	0.97
Upper side of ventral fin	40.2	1.33	95.9	173.0	0.56
Below side of dorsal fin					
inner	51.9	1.29	98.9	178.1	0.50
outer	43.6	1.52	100.1	176.5	0.44
Root area of tail fin	31.6	1.35	49.1	181.9	11.20
Melon	40.8	1.92	47.2	188.2	7.62
Lower jaw	63.9	1.04	28.6	165.6	28.66

obtained from 12 parts of her body within two days after she died in spring 1972.

The materials as inner blubber were obtained from the hind part of blow hole, the root area of dorsal fin, the abdominal side of ventral fin and anus, the upper side of ventral fin and the below side of dorsal fin. These inner blubbers were about 20–30 mm thick and attached to meat. The materials as outer blubbers were recovered from the root area of dorsal fin, the abdominal side of ventral fin, the below side of ventral fin and the root area of tail fin, and had skin attached. The blubbers from the melon and the lower jaw had no skin.

The sample oils were obtained from these blubbers by extracting in a blender with chloroform/methanol(2/1, v/v), drying over sodium sulfate and taking off all solvents under nitrogen atmosphere. The properties of the sample oils were shown in Table 1. The fatty acid methyl esters from the sample oils were respectively prepared by the method of Metcalfe *et al* (1966), using BF_3—methanol reagent. To remove unsaponifiable matters, crude methyl esters were then subjected to preparative thin layer chromatography on 0.75 mm thick layers of Wakogel B—5 (Wako Junyaku Kogyo) developed with petroleum ether—ethyl ether—glacial acetic acid (90: 10: 1, v/v/v).

Gas liquid chromatography (GLC) analysis of the purified methyl esters was quantitatively carried out on a Shimadzu Gas Chromatograph Model 4PTF equipped with a FID and 267 cm ×3 mm I.D. glass column packed with 15% DEGS 60/80 mesh on Shimalite. Further, additional GLC analysis was carried out by 168 cm ×3 mm I.D. glass column packed with 3% EGSS—X 60/80 mesh on Chromosorb W. The flow rates of nitrogen as carrier gas were 30 ml per minute for DEGS column and 45 ml per minute for EGSS—X column. The EGSS—X column was employed isothermaly at 195°C by injecting on column and the DEGS column was programmed in the range of 70–190°C with a temperature rise of 4°C

per minute by injecting on column. Carbon chain length and degree of unsaturation of methyl esters were identified by plotting log of retention volumes of each peaks and by comparing with standard mixtures (Applied Science Laboratories), according to Hofstetter and Holman (1965). Also, identification of them was verified by GLC analysis of the methyl ester samples using hydrogenation at regular intervals. The method of hydrogenation of the methyl esters was carried by shaking in a small flask with a pinch of platinum black as a catalyst for 3–4 hours under 2.0 kg/cm^2 of hydrogen. Quantitation of the methyl esters was determined by application of formula of the products of the peak height and the base at one-half height, and corrected by the method of Ackman and Sipos (1964). The ratio of results was converted from weight per cent to molecule per cent fatty acid (Table 2).

RESULTS AND DISCUSSION

The chemical properties of blubber oils of Amazon dolphin are a close resemblance except those of melon, lower jaw and root area of tail fin oils shown in Table 1. Iodine values of oils contained in melon, lower jaw and root area of tail fin have considerably a low level, while saponification values and unsaponifiable contents of them have notably a higher level than those of the blubber oils. In a comparison of the chemical properties of inner and outer blubber oils in root area of dorsal fin, abdominal side of anus and below side of dorsal fin, acid values and iodine values of each outer blubber oil are slightly higher than those of inner blubbers. But saponification values and unsaponifiable contents of each outer blubber oil are conversely lower levels than those of inner blubber oils.

The fatty acid components of various blubber oils of Amazon dolphin are shown in Table 2. It is revealed the presence of fatty acids of 5–24 carbon atoms with zero to six double bonds. With the exception of oils in melon, lower jaw and root area of tail fin blubbers, the fatty acid components and distributions in other blubber oils are nearly to be the same pattern. But the fatty acid proportion of inner and outer blubbers in root area of dorsal fin, abdominal side of anus and below side of dorsal fin has a few difference in the fatty acids of saturated C_{16}, unsaturated C_{16} monoenoic and C_{18} monoenoic acids. The proportions of saturated C_{16} and unsaturated C_{18} monoenoic acids of inner blubber oils are slightly high levels, although the proportion of unsaturated C_{16} monoenoic acid of outer blubber oils is reversely higher than that of inner blubber oils. Also, in the ratio of total saturated and unsaturated acids, total saturated acid of inner blubber oils is a higher level than that of outer blubber oils.

In the case of the oil in root area blubber of tail fin, the fatty acid components and distribution patterns are probably resemblance to other blubber oils. But the proportion of fatty acid is seemed to be considerably different to other blubber oils. The main fatty acids of the blubber oils are *iso* C_{12}, C_{12}, *iso* C_{14}, C_{14} and C_{16} as saturated acid, and C_{16} and C_{18} monoenoic as unsaturated acid, but there are small quantities of unsaturated acids such as C_{18} monoenoic and dienoic acids, and unsaturated acids more than 20 carbon atoms.

TABLE 2. FATTY ACID COMPONENTS OF OILS CONTAINED IN VARIOUS BLUBBERS OF AMAZON DOLPHIN (%).

Blubbers → / Fatty acids ↓	Hind part of blow hole	Root area of dorsal fin		Abdominal side of ventral fin	Abdominal side of anus		Upper side of ventral fin	Below side of dorsal fin		Root area of tail fin	Melon	Lower jaw
		inner	outer		inner	outer		inner	outer			
Iso–5 : 0	0.24	0.11	tr	0.97	tr	0.49	1.02	0.13	tr	0.79	0.22	0.44
5 : 0	—	—	—	0.20	—	—	0.15	0.03	—	0.07	0.17	0.09
8 : 0	—	—	—	—	—	tr	tr	tr	—	—	0.05	—
Iso–10 : 0	—	—	—	—	—	—	—	—	—	0.29	0.15	0.42
10 : 0	0.33	0.18	0.20	0.35	0.29	0.44	0.22	0.18	0.31	0.57	1.30	3.43
Iso–11 : 0	—	—	—	—	—	—	—	—	—	0.27	0.51	0.46
Anteiso–11 : 0	—	—	—	—	—	—	—	—	—	0.16	0.52	0.41
11 : 0	0.21	0.04	0.17	0.28	—	0.36	0.11	0.02	0.05	0.62	0.86	0.81
Iso–12 : 0	0.19	0.14	0.12	0.10	0.05	0.15	0.20	0.05	0.13	7.85	8.70	3.93
12 : 0	2.40	1.38	2.22	1.57	1.70	2.75	1.89	2.03	2.87	18.74	19.94	17.62
12 : 1	0.17	0.37	0.96	0.40	0.12	0.81	0.35	0.18	0.45	4.29	4.14	2.98
Iso–13 : 0	0.11	0.04	0.07	0.15	0.10	0.13	0.12	0.47	0.15	1.14	1.86	1.97
Anteiso–13 : 0	0.07	0.01	0.03	0.03	0.52	0.09	0.07	0.10	0.03	0.25	0.63	0.57
13 : 0	0.41	0.43	0.66	0.40	0.32	0.84	0.49	0.25	0.28	0.93	1.18	1.56
Iso–14 : 0	0.38	0.30	0.29	0.12	0.16	0.36	0.19	0.22	0.18	6.28	4.85	5.34
14 : 0	10.99	8.27	7.95	10.23	8.02	8.36	11.32	9.04	9.55	23.57	24.63	27.16
14 : 1	2.19	2.67	4.38	3.55	3.61	3.05	4.55	4.03	4.81	6.46	9.28	8.17
Iso–15 : 0	0.59	0.68	0.67	0.77	0.53	0.46	0.93	0.49	0.51	1.39	0.65	1.05
Anteiso–15 : 0	0.18	0.21	0.17	0.35	0.13	0.30	0.46	0.15	0.19	0.41	0.36	0.52
15 : 0	0.96	0.98	0.89	1.12	1.02	1.62	1.04	1.27	1.15	1.34	0.37	0.92
15 : 1	0.02	0.03	tr	0.05	0.07	0.07	0.04	0.06	0.04	0.02	0.16	0.27
Iso–16 : 0	0.21	0.24	0.35	0.13	0.16	0.21	0.15	0.03	0.17	1.51	1.20	1.96
16 : 0	21.39	20.44	18.34	25.25	24.28	19.30	20.17	21.45	19.42	6.34	8.68	11.30
16 : 1	24.27	22.82	24.67	18.98	21.50	24.19	22.30	20.81	23.47	11.40	7.86	7.19

16 : 2	0.52	0.83	0.93	0.41	0.59	0.81	0.77	0.88	0.75	0.23	0.07	0.21
16 : 3	0.55	0.45	0.70	0.37	0.26	0.72	0.35	0.68	0.46	0.19	0.12	—
Iso–17 : 0	0.27	0.25	0.31	0.56	0.34	0.53	0.27	0.54	0.33	0.10	0.04	0.05
17 : 0	0.43	0.63	0.80	0.93	0.79	0.78	0.51	0.96	0.79	0.33	0.02	0.07
Iso–18 : 0	0.03	0.09	0.16	0.02	0.03	0.11	0.05	0.08	0.03	0.19	0.32	0.03
18 : 0	2.88	3.67	3.76	3.43	3.12	3.20	2.58	2.62	2.87	0.75	1.02	0.41
18 : 1	20.71	21.67	20.81	22.27	23.21	19.74	19.76	23.29	20.85	2.71	0.09	0.55
18 : 2	4.16	5.57	4.32	2.36	3.32	4.38	4.55	4.04	4.37	0.26	0.02	—
18 : 3	1.31	1.95	1.44	1.16	1.27	1.69	1.30	1.37	1.43	0.13	0.02	—
18 : 4	0.36	0.73	0.20	0.50	0.35	0.31	0.11	0.22	0.49	0.08	—	—
19 : 0	0.25	0.10	0.13	0.15	0.08	0.13	0.09	0.10	0.37	0.02	0.01	—
20 : 0	0.09	0.18	0.15	1.25	0.10	0.14	0.08	0.07	0.19	0.01	—	—
20 : 1	0.79	0.80	0.73	0.45	1.07	1.33	1.31	1.41	0.45	0.02	—	—
20 : 2	0.13	0.09	0.17	0.13	0.08	0.09	0.06	0.07	0.11	tr	—	—
20 : 3	0.11	0.13	0.27	0.04	0.06	0.08	0.05	0.04	0.06	0.03	—	—
20 : 4	0.16	0.17	0.83	0.02	0.14	0.49	0.18	0.18	0.07	0.06	—	—
20 : 5	0.10	0.26	0.23	0.66	0.42	0.27	0.25	0.51	0.38	0.01	—	—
21 : 0	0.13	0.05	0.06	—	0.05	—	—	0.04	—	—	—	—
22 : 1	0.08	0.16	0.07	0.05	0.13	0.03	0.13	0.02	0.06	tr	—	—
22 : 2	0.29	0.56	0.25	—	0.34	0.13	0.26	0.33	0.19	tr	—	—
22 : 3	—	0.13	0.08	—	—	0.10	—	0.04	0.17	—	—	—
22 : 4	0.08	0.12	0.11	—	0.09	0.08	0.08	0.03	0.40	0.01	—	—
22 : 5	0.39	0.48	0.27	0.07	0.38	0.20	0.31	0.35	0.26	0.07	—	—
22 : 6	0.74	1.43	1.00	0.06	1.09	0.68	1.11	1.10	1.13	0.11	—	—
24 : 1	0.15	0.16	0.08	—	0.11	—	0.07	0.05	0.05	—	—	—
Saturated	42.64	38.42	37.50	48.47	41.79	40.75	42.11	40.31	39.57	73.92	78.24	80.63
Unsaturated	57.36	61.58	62.50	51.53	58.21	59.25	57.89	59.69	60.53	26.08	21.76	19.37

On the other hand, the fatty acid components and distribution patterns of melon and lower jaw oils are entirely different with the oils in other blubbers, and also the levels of individual and groups of fatty acids are unique to these samples. They perhaps can be characterized by high levels of saturated, isomer and short carbon length acids with less than 14 carbon atoms, while the level of fatty acids with more than 18 carbon atoms has very low or no proportions. The proportion of total saturated acid containing *iso* C_5, C_{10}, C_{11}, C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{17} and C_{18} carbon atoms is evidently abundant. The ratio of total saturated and unsaturated acids is 78.24% of melon oil or 80.63% of lower jaw oil *vs* respectively 21.76% or 19.38%. The eight main acids which represented the levels of 96.78% (melon oil) or 84.14% (lower jaw oil) of each total acid are followed in order of ascending proportion; $C_{14:0}$, $C_{12:0}$, $C_{14:1}$, *iso* $C_{12:0}$, $C_{16:0}$, $C_{16:1}$, *iso* $C_{14:0}$ and $C_{12:1}$ as melon oil, and $C_{14:0}$, $C_{12:0}$, $C_{16:0}$, $C_{14:1}$, $C_{16:1}$, *iso* $C_{14:0}$, *iso* $C_{12:0}$ and $C_{10:0}$ as lower jaw oil. The long chain acids with more than 18 carbon atoms which represented the levels of 32.33% (blubber oil of upper side of ventral fin)—38.50% (inner blubber oil of root area of dorsal fin) of each total acid in other blubber oils with the exception of root area of tail fin oil, are only minor components or are not present at all in melon and lower jaw oils.

The fatty acid components and distribution pattern of each blubber oil of Amazon dolphin in this investigation bears a close resemblance to those of blubber oil according to Ackman *et al* (1972), but the levels of *iso* $C_{12:0}$ and *iso* $C_{14:0}$ have a few difference.

In comparison with Ganges river dolphin oil (Tsuyuki and Itoh, 1971, 1972) and Amazon dolphin oil, they have a few difference. As concerned with the chemical properties, iodine value of Ganges river dolphin oil is generally seemed to be higher than that of Amazon dolphin oil. With a few exception, the fatty acid components and distribution patterns of Amazon dolphin oil and Ganges river dolphin oil are nearly similar in both species. The proportions of $C_{16:1}$ acid (21.96–23.21%) and $C_{18:1}$ acid (28.21–28.27%) in Ganges river dolphin oil are larger than those in Amazon dolphin oil, however the proportions of $C_{16:0}$ acid (13.95–17.30%) in Ganges river dolphin oil is somewhat smaller. The most notable deviations are the high levels of $C_{16:1}$ acid (38.97%) and $C_{18:1}$ acid (21.31%), and the low levels of $C_{12:0}$ acid and $C_{14:0}$ acid (7.08%) in melon oil of Ganges river dolphin. Although, they are respectively $C_{16:1}$ acid (7.86%), $C_{18:1}$ acid (0.09%), $C_{12:0}$ acid (19.94%) and $C_{14:0}$ acid (24.63%) in the levels of melon oil of Amazon dolphin. Also, *anteiso* acids such as $C_{11:0}$, $C_{13:0}$ and $C_{15:0}$ were detected a few presence in blubber oil of Amazon dolphin, but they were no presence in blubber oil of Ganges river dolphin.

SUMMARY

1. The properties of oils contained in 12 part blubbers of Amazon dolphin, *Inia geoffrensis*, were studied.

2. The fatty acid components of Amazon dolphin oils were analyzed by GLC on DEGS and EGSS—X columns.

3. The fatty acid components were shown the presence of 49 fatty acids with chain lengths from 5 to 24 carbon atoms and with zero to six double bonds.

4. The fatty acid components and distribution patterns were relatively a resemblance in various blubber oils of Amazon dolphin with exceptions of oils contained in blubbers of melon, lower jaw and root area of tail fin.

5. The main fatty acids in various blubber oils of Amazon dolphin with exceptions of oils contained in blubbers of melon, lower jaw and root area of tail fin were $C_{14:0}$ acid (7.95–11.32%), $C_{16:0}$ acid (18.34–25.25%), $C_{16:1}$ acid (18.98–24.67%) and $C_{18:1}$ acid (19.74–23.29%).

6. The fatty acid components of oils contained in blubbers of melon, lower jaw and root area of tail fin were seemed to be contained the high proportions of saturated acids with short carbon chain lengths.

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