ASSESSMENT OF NUTRITIONAL VALUE OF PROCESSED SHARK FINS IN DIFFERENT SPECIES

by

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ABSTRACT

The aim of this study was to introduce a method for processing of shark fins and to assess the nutritional value of processed fins belonging to different shark species. Complete sets of fins of silky shark (*Carcharinus falciformis*), hammerhead shark (*Sphyrina lewini*), blue shark (*Prionace glauca*), whitetip shark (*C. longimanus*) and thresher shark (*Alopas pelagicus*) were processed using 3% acetic acid (food grade) and the total yield by weight was determined. Dry matter, ash, protein, fat, glycogen, non-protein nitrogen, amino acid profile and calorific value of processed fins were studied.

Significantly higher ($p<0.05$) processed fin yield (17.6%) was recorded by hammerhead shark compared to the other four species used in this study. Thresher shark gave significantly lower ($p<0.05$) fin yield (2%). Silky, white tip and blue sharks showed intermediate values (14, 13.5 and 12.7%) respectively. Moisture content of fins varied between 10.3-13%. Blue shark fins recorded the lowest ash content (0.16%). However, ash content varied between 1- 0.16%. Fat content in the fins of all shark species recorded negligible values. White tip shark recorded the highest nitrogen content (14.8%) and it was not significantly different ($p<0.05$) with that of hammerhead shark (14.4%), thresher shark (14.4%) and silky shark (14.2%). Significantly lowest nitrogen content was recorded in blue shark (13.4%) compared to other species. Non-protein nitrogen content was varying between 0.13 – 0.52%. The lowest glycogen content was recorded by thresher shark (0.33%) while the highest value was recorded by hammerhead shark (0.87%).

The highest total amino acid content was recorded by fins of blue shark (8795 μmoles/g) followed by that in hammerhead shark (7525 μmoles/g) and white tip shark (7415 μmoles/g). Significantly ($P<0.05$) a higher percentage of essential amino acid (of total amino acid) was obtained from white tip shark (40.2%) compared to other species. Silky shark showed the lowest value (28.1%) and this value was not significantly different from that of thresher (28.3%) and blue sharks (28.5%). Hammerhead shark recorded an intermediate value (33.3%). Thresher shark recorded the highest energy content 5525 cal/g while that of hammerhead was the lowest (4863 cal/g). White tip, blue and silky sharks showed intermediate values (5264, 5142 & 4884 cal/g).

This study demonstrated that hammerhead shark recorded the highest yield of processed fins when the acetic acid processing technique was used. However, the nutritional value of fins of white tip shark was higher compared to other species.

INTRODUCTION

Shark have soft collagen and elastin fibres in their fins which are in great demand as a raw material for food specialities. Dried shark fins are a valuable commercial product, exported from Sri Lanka. Export earnings from dried shark fins showed a rapid growth during the last decade. In 1994, Sri Lanka exported 70 mt of dried shark fins valued at Rs 20 million, and export earnings had increased to Rs 206 million in 1997.

Major markets were Singapore and Hong-Kong where dried fins would be further processed to value-added fin rays.

Amarasooriya (1993) has identified forty-six shark species belonging to five orders and fifteen families in Sri Lanka. According to the species composition there are 6-7 species which commonly occur in the catch. The highest catch was reported by silky shark (61%) followed by blue shark (12.3%), white tip shark (6.3%), hammerhead (5.3%), thresher shark (4.6%) and other requiem shark species (4%) (Joseph, 1997). In Sri Lanka shark fins from all species are accepted for export but fins fetch highly varying prices. The selling price (FOB) of large size (<30cm fin base length) dried silky, white tip and hammerhead shark fins varies between 50-70 US$ per kg. The average selling price of large fins of species such as blue and thresher sharks is 50 US$ per Kg. Medium size wet fins (25-30cm) are sold at 40 US$ per kg while smaller fins are (<25cm) sold at 25 US$ per kg in dry form by the shark fin traders.

Many researchers (Ramachandran and Madhavan, 1974; Jayawardena, 1980; Clucas, 1992; Ka-Keong, 1983; Govindan, 1985) have reported shark fin processing technologies for extraction of fin rays. However, literature on the nutritional value of fin rays related to different shark species is not available. Therefore, this study was conducted to improve and introduce a method for the preparation of processed fins and assess the yield and nutritional value of the fins from different shark species in Sri Lanka.

EXPERIMENTAL

A complete set of fins from a shark which consists of lower lobe of tail fin, two pectoral fins, 1st dorsal fin, 2nd dorsal fin, anal fin and pelvic fins (Fig.1) were used in this study.

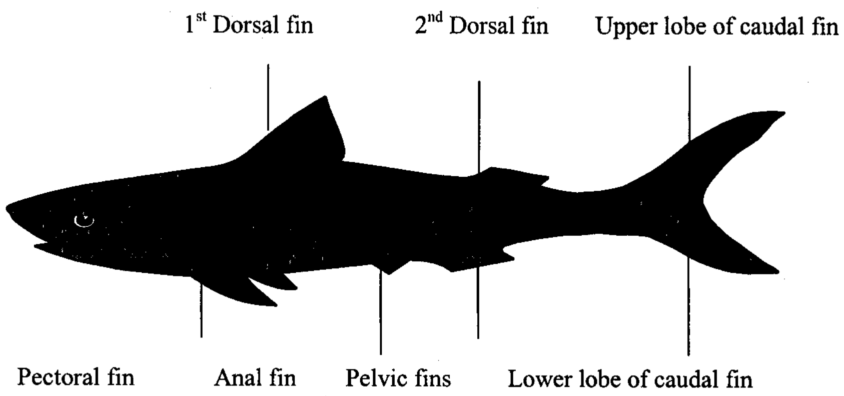

Fig. 1. Lateral view of a shark.

Complete sets of fins of silky shark (*Carcharinus falciformis*), hammerhead shark (*Sphyrina lewini*), blue shark *(Prionace glauca)*, whitetip shark (*C. longimanus*) and thresher shark (*Alopias pelagicus*) were processed using 3% acetic acid.

Flow chart for processing of shark fins

Wet shark fins

↓

Soaked in 3% food grade acetic acid or coconut vinegar

↓

Remove the skin and wash with water

↓

Remove meat attached to the fin and cartilaginous platelets and wash

↓

Dip in 5% hydrogen peroxide solution for 30 minutes

↓

Wash with clean water

↓

Dry in an oven (40 -50°C) or under the sun

↓

Processed fin

Total yield of processed fins by weight, moisture, ash (AOAC, 1980), total nitrogen, non-protein nitrogen (Kjeldhal method), fat (Soxhlet method) and acid insoluble ash were determined. Glycogen content was measured according to Giese (1967). Calorie values of processed fins of different shark species were obtained by using a bomb calorie meter (Shimadzu CA-4P, Japan).

Amino acid composition was determined by the Pico-tag method (Cohen *et al.*, 1989).

Data on yield and chemical composition were analysed by a one way ANOVA. Significance was accepted at a probability of 5% or less. Bonferroni's multiple comparison was used to identify the means which were significantly different from each other (Zar, 1984).

RESULTS

Colour of the processed fins of all shark species varied from colourless to light yellow. Yield of the processed dry fins is shown in Fig.2. Significantly higher ($p<0.05$) processed fin yield (17.6%) was recorded by hammerhead shark compared to other four species used in this study. Thresher shark gave significantly lower ($p<0.05$) yield (2%) while silky, white tip and blue sharks reported intermediate yields 14, 13.5 and 12.7% respectively.

Yields of processed fins (dried) of different fin types on a dry basis are shown in Fig.3. Highest fin yield among pectoral fins was recorded by silky sharks (13.7%) followed by white tip (12.5%) and hammerhead (10.6%) sharks. Among the first dorsal fins hammerhead sharks gave the highest fin yield (28.5%) while thresher sharks gave the lowest yield. Second dorsal fins of white tip sharks produced the highest fin yield (25.2%) among the five species. Lower lobe fins of silky sharks showed highest yield (28.0%) followed by blue (27.8%) and hammerhead (25.5%) sharks. Anal fins of whitetip sharks produced the highest fin yield (26.9%) out of five species. All fins of thresher sharks recorded the lowest fin yield compared with other shark species.

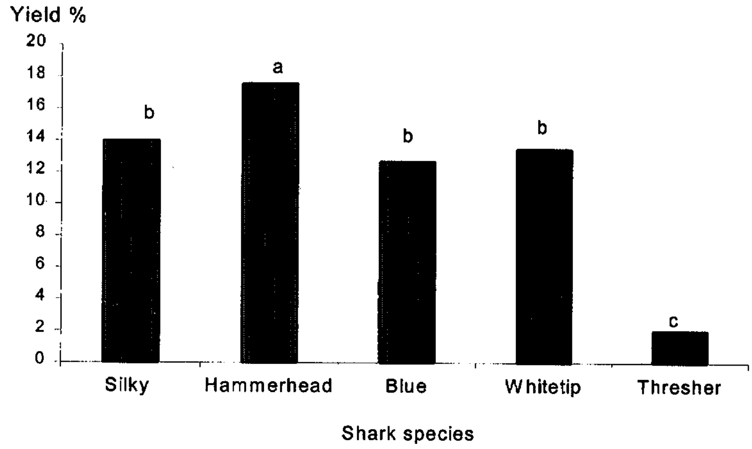

Fig 2. Fin yield % of processed fins of different shark species.

Proximate composition of processed fins are shown in Table 1. Significantly ($p<0.05$) lower moisture content in white tip shark (10.3%) compared to the other species used in the study. The highest moisture content was in hammerhead shark (13%) and this was significantly different from blue, silky and thresher sharks.

Table 1. Proximate composition of fins of different shark species.

Parameter	**Silky Shark**	**Hammerhead shark**	**Blue shark**	**Oceanic White tip shark**	**Thresher shark**
Moisture %	11.3^{b} *	13^{a}	11.1^{b}	10.3^{b}	11.7^{b}
Ash %	0.5^{b}±.00	1.0^{a}±.22	0.16^{bc}±.01	0.2^{bc} ±.02	0.4^{b}±.03
Total nitrogen %	14.2^{a}	14.4^{a}	13.4^{b}	14.8^{a}	14.4^{a}
Non protein nitrogen %	0.46^{ab}±.01	0.34^{b} ±.0	0.33^{b}±.0	0.52^{a}±.05	0.13^{c}±.02
Fat %	Nil	Nil	Nil	Nil	Nil
Acid insoluble ash %	Nil	Nil	Nil	Nil	Nil
Glycogen %	0.73^{a} ±.02	0.87^{a} ±.07	0.78^{a} ±.1	0.65^{a} ±.13	0.33^{b} ±.10

* *Values in the same row not sharing the same superscript letters difference significantly ($p<0.05$), when analysed by the Bonferroni test. All means were presented with their standard deviations (SD).*

Ash content of all processed shark fins showed very low values, i.e. blue shark fins recorded the lowest ash content (0.16%). The highest value was recorded by hammerhead shark (1%). Acid insoluble ash content and fat content of all shark fins were negligible.

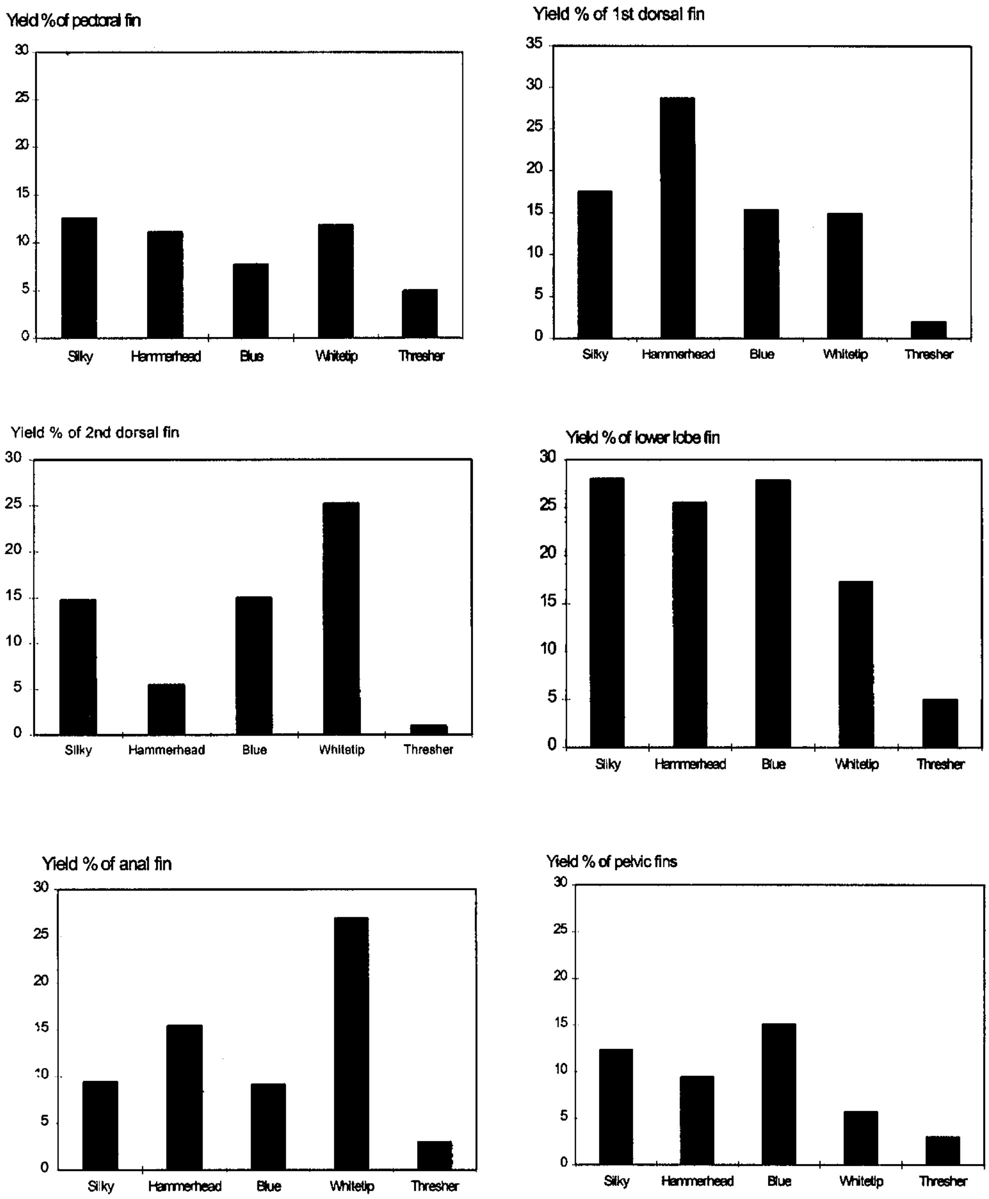

Fig. 3. Fin (wet raw fin → processed dry fin) yield % of different shark species.

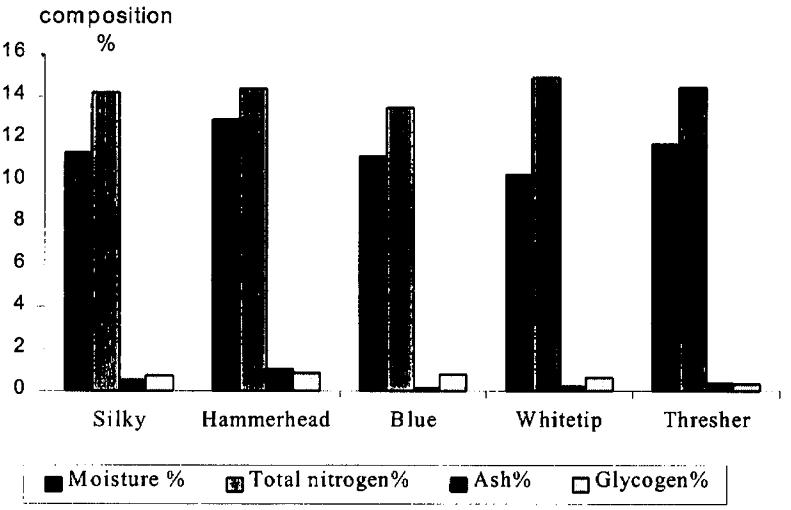

Fig. 4. Proximate composition of processed fins of different shark species.

Similar values for total nitrogen content were recorded by white tip shark (14.8%), hammerhead shark (14.4%), thresher shark (14.4%) and silky shark (14.2%) (Fig.4). The lowest nitrogen content was reported by blue shark (13.4%) ($p<0.05$) compared to other species used in the study. Non-protein nitrogen contents of all shark species varied between 0.13 and 0.52%. The lowest non protein nitrogen content was reported by thresher shark (0.13%) ($p<0.05$) compared to the other species.

A significantly higher glycogen percentages were recorded by hammerhead shark (0.87%) and blue shark (0.78%), silky shark (0.73%) and white tip shark (0.65%). The lowest value was recorded from thresher shark (0.33%) compared to the other species.

Thresher shark recorded the highest energy content of 5525 cal/g while that of hammerhead was the lowest (4863cal/g). Whitetip, blue and silky sharks showed intermediate values (5264, 5142 & 4884 cal/g) (Fig.5).

The highest total amino acid content was observed in blue shark (8795 μmol/g) followed by hammerhead shark (7525 μmol/g) and white tip shark (7415 μmol/g) (Table 2). The highest total essential amino acid content was recorded in white tip shark (2125 μmol/g) followed by that in blue (1950μmol/g) and hammerhead (1880μmol/g) sharks. A higher content of essential amino acids as a percentage of total amino acids was found in oceanic white tip shark (40.2%) ($P<0.05$). Silky shark showed the lowest value (28.1%) and this value was not significantly different from that of thresher (28.3%) and blue sharks (28.5%). Hammerhead shark recorded an intermediate value (33.3%).

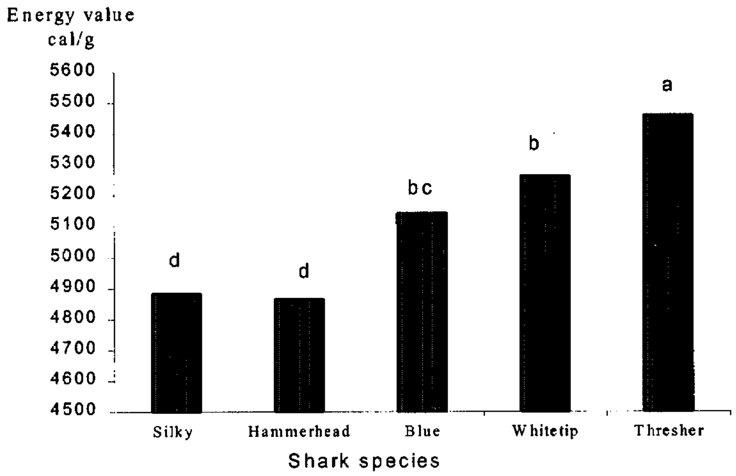

Fig. 5. Calorific value of processed fins of different shark species.

Table 2. Amino acid content of processed fins of different shark species.

Amino acid	Concentration µ mols/g				
	Silky shark	Hammerhead shark	Blue shark	Whitetip shark	Thresher shark
Aspartic acid	145	340	320	585	125
Glutamic acid	195	550	430	705	185
Serine	190	195	330	35	230
Glycine	2115	1845	2885	2095	2150
Histidine	240	325	295	260	255
Arginine + Threonine	435	535	595	630	455
Alanine	640	800	900	815	610
Proline	1220	1570	1560	550	1320
Tyrosine	260	320	385	390	245
Valine	160	250	240	265	165
Methionine	80	85	105	160	75
Cysteine	50	25	35	115	50
Isoleucine	110	160	150	190	115
Leucine	100	170	140	185	95
Phenylalanine	110	170	145	165	115
Lysine	120	185	280	270	115
[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

*Values in the same raw not sharing the same superscript letters difference significantly ($p<0.05$), when analysed by the Bonferroni test.

DISCUSSION

The extraction technique (3% acetic acid followed by 5% hydrogen peroxide) described in this study was easy to practice and it was very useful to generate self-employment at the small-scale industry level in Sri Lanka. Tsuchiya and Nomura (1953) reported four extraction procedures i.e., water-soaking method, water boiling method, lime water/acetic acid/sodium carbonate treated method and NaOH treated method for the extraction of fin rays. Jayawardana (1980) indicated that dilute HCl solution (1%) could be safely used for quicker and easier extraction of shark fin rays from the fin. However, many authors (Clucas, 1982; Ka-Keong, 1983) recommended a water-boiling method for extraction of shark fin rays. Ka-Keong (1983) described the processing method with five steps, which are preliminary soaking, de-scaling and skinning, removing the meat, removing blood and bleaching and finally drying. Govindan (1985) also described a technique similar to the present study and reported that the proteinaceous matter left behind after separation of the rays can be concentrated to yield a glue with excellent sticking properties.

Acetic acid is useful in softening the outer skin of fin during the soaking period. It also helps to soften the flesh and the rays are separated by hand (Nair and Madhavan, 1974). This softening could be due to the greater hydrolysing effect of the collagenous threads into gelatine (Jayawardena, 1980).

Result showed that the lower lobe of silky, hammerhead and blue sharks contain higher amounts of fin rays than other fin types. Unlike other fin types, the lower lobe consists of many fin rays. The first dorsal, pectoral and upper lobe fins are heavy, but contain fewer fin rays. As these fins are supported by many bone like cartilages, the fins are heavy and produce a low fin yield. Ramachandran and Madavan (1974) showed that only the lowest portion of caudal fin contains ray though it appears bulky.

Concerning the nutritional value of the fin rays and fin yield of the sharks used in the study, the fins of oceanic white tip and hammerhead sharks could be categorized as top grade. However, Ka-Keong (1983) reported that the grading of shark fins depends on their size, thickness and their fin needle content. He also reported that hammerhead, mako and blue shark fins are top grade. White and thresher shark fins are 1st grade while oceanic whitetip and tiger shark fins are 2nd grade. Fins of smaller shark's are in grade three. Pectoral, dorsal and anal fins of sharks are exceptionally tasty and nutritious, and are therefore in great demand in the international markets (Anon, 1967)

However, according to the traditional grading system, fins are sold in a complete set of first dorsal fin, two pectoral fins and a caudal fin (whole tail). The second dorsal, ventral and anal fins and the fins from small sharks are not sold as a set but as mixed fins after processing (Ka-Keong, 1983).

The chemical composition of fin rays showed higher total nitrogen and very low ash content. These results are in accordance with Jayawardena (1980) who reported that the approximate chemical composition of fin rays of *Carcharhinus sp. and Sphyrna sp.* showed a very high crude protein content (82%), very low ash content (0.23%) (the balance may be moisture and carbohydrates). In whale shark (*Rhiniodon typus smith*), the total nitrogen content is about 15-16% (dry basis), ash content is in the range of 0.5 to 0.9% and no acid insoluble ash (Ramachandran and Sankar, 1990). This shows that nitrogen compounds are major constituents of fin rays. Tsuchiya and Nomura (1953) observed the materials used in different methods and showed that there were no remarkable differences of moisture, ash and total nitrogen content in different fin types.

Amino acid composition of the shark fin rays showed that one-third of the amino acids are essential amino acids. These results are contradictory with Jayawardena (1980) who reported that due to lack of essential amino acids shark fin rays have no food value. Shark fins are commercially valuable because of the gelatine they contain (Anon, 1975). They are used in Asia for shark fin soup, a delicacy that fetches up to US$ 150 per bowl (Lemonick, 1997).

The market for shark fins is incredibly profitable. Sharks have a primitive but highly immune system, which may play an important role. For some reason, sharks rarely get tumours, a surprising fact that could lead to new cancer treatments (Lemonick, 1997).

CONCLUSIONS

A low-cost and convenient acetic acid/Vinegar processing technique can be introduced as a cottage industry. The highest yield of processed fins is from hammerhead shark and the lowest, thresher shark. All the species as well as the types of fins are nutritious; highest nutritive value is found in white tip shark and thresher shark.

REFERENCES

Amarasooriya. 1993. A species identification of shark catches landed in the West and the South West coasts of Sri Lanka, Proceedings of the 1st Annual Scientific Sessions, 2nd November, National Aquatic Resources Research and Development Agency, Colombo 15, Sri Lanka.

Anon. 1967. Fishing News International, September.

Anon. 1975. Australian Fisheries, May, 1975, pp 31-2.

Anon. 1998. Sri Lanka Fisheries Year Book 1998, Published by Socio-economic and Marketing Research Division, National Aquatic Resources Research and Development Agency, Colombo 15, Sri Lanka.

AOAC 1980. Official Methods of Analysis, The Association of Official Analytical Chemists, Washington DC.

Clucas, I.J. 1982. Food by Products; In Fish Handling, Preservation and Processing in the Tropics: Part II, G145, Tropical Development and Research Institute.

Cohen, S.A, Meys, M. and T.L. Tarvin. 1989. The Pico-Tag method in a Manual of Advanced Techniques for Amino Acid Analysis, Published by Millipore Corporation, U.S.A.

Giese, A.C. 1967. Some methods for the study of the biochemical constitution of marine invertebrates, Oceanography and Marine Biology, Annual Review, 5, pp 159-86.

Govindan, T.K. 1985. Fish Processing Technology, Oxford and IBH Publishing Co Pvt Ltd, New Delhi, Bombay, Calcutta, pp 209-10.

Jayawardana, K.M. 1980. Improved chemical methods for extraction of fin rays from shark fins, Bulletin of Fish Research Station, Sri Lanka, Vol. 30, pp 41-51.

Joseph, L. 1997. Management of shark fisheries in Sri Lanka, December 1997, Report published by Asian Development Bank Programme, Ministry of Fisheries, Sri Lanka.

Ka-Keong, E.L. 1983. Shark Fins- Processing and Marketing in Hong-Kong, INFOFISH Marketing Digest No 5. pp 35-9.

Lemonick, M.D. 1997. Under attack in 'Time', September, 1997, pp 30-6.

Molyneux, F. 1973. Shark fishery by product technology, Food Technology in Australia, August, 1973.

Ramachandran, A. and Sankar, T.V. 1990. Fins and fin rays from Whale shark (*Rhiniodos typus smith)*, Fishery Technology, Vol. 27, pp 138-40.

Ramachandran, A., Nair, K.G. and Madhavan, P. 1974. Shark fin rays-technology of extraction, Fishery Technology Vol xi, No1.

Tsuchiya, Y. and Nomura, T. 1953. Chemical nature of the shark fin fibre, Tohoku Journal of Agricultural Research IV (1), pp 43-53.

Zar, J.H. 1984. Bio Statistical Analysis, (2nd edition) London, Prentice Hall.