Reprinted from "Indian Journal of Fisheries", Vol. IX, No. 2 B, 1962

STUDIES ON INDIAN FISHMEALS

Part I. Chemical Composition and Storage Characteristics of Fishmeals Prepared from Different Types of Fishes

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FISHMEAL is highly valued in cattle and poultry nutrition for its content of easily digestible proteins, vitamins and minerals. Extensive experiments on the chickfeeds containing fishmeal registered a better growth response when compared with other feeds. The total world production of fishmeal is estimated at more than 2 million metric tons. The major fishmeal-producing countries are Peru, United States of America, Angola, South Africa, Norway, Denmark and Iceland. It is largely consumed in United States of America, Great Britain, West Germany and Netherlands. Until recently the production and consumption in India is not significant. At present two plants are producing fishmeals for cattle and poultry feeds on a commercial scale with heat treatment. Chari and Pai (1948) while reporting the importance of fishmeals in cattle and poultry nutrition studied the composition of fishmeals prepared by cooking and drying the presscake in the sun, while Negi (1949) studied the composition of fishmeals prepared in the west coast. Venkatraman *et al.* (1953) studied the changes in the fishmeals during storage in sealed tins. Saha *et al.* (1951) studied the storage of fishmeal in gunny bags and glass containers and found that the fishmeal spoiled in four months time.

Lea, Parr and Carpenter (1958), (1960) observed the chemical and nutritional changes in the stored herring meal, and found that the loss in available lysine in the herring meal stored for 12 months at 20° C. is 8 per cent. The losses in the different nitrogenous constituents in the wet reduction processes were studied by the above authors (1962). Previous workers have studied the changes in moisture protein fat and bacterial counts during the storage period. With the increasing knowledge on the importance of non-protein fractions in the colour, flavour of the products a study on the changes of these fractions during storage was undertaken. The meals prepared during

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the study of the nitrogenous losses in wet reduction processed were taken for the storage studies. As the previous investigators have not worked in these aspects with reference to different types of meals prepared under identical conditions the results presented in this paper will throw some light on the behaviour of some of the constituents during the storage of fishmeals.

Material and Methods

The fish utilised were obtained from the trawler catches caught off Cochin and the time lapsed between catching and landing varied from 2–6 hours. The fish immediately on landing were iced and processed on the next day. The fish were cooked in water in the ratio of 1 : 1 for 30 minutes, and the cooked material was pressed in canvas bag with the help of a lever press. The press cake was dried (i) in an hot air oven at 105° C. or (ii) at 5 PSIg in a rotary drier designed at the Institute, or (iii) by drying in the sun for two days. The dried material was powdered in a mill seived and stored in polythene bags (300 guage) in 20 gm. packings. All the meals are dried to less than 10 per cent, moisture level. The polythene bags were stored in a dealwood case to prevent rat infestation. To study the effect of the anti-oxidant on the fat fraction, fishmeal was mixed with NDGA at a concentration of 0·02 per cent. and kept for storage studies along with the control samples.

The proximate chemical composition of the meals was determined by the AOAC (1955) methods. The non-protein nitrogenous constituents were determined in the trichloracetic acid extract at bimonthly intervals while the changes in the fat fraction were estimated in the chloroform extract at monthly intervals, non-protein nitrogen was determined by Kjeldhal's method (AOAC 1955), α-amino nitrogen was estimated by the Pope and Stevens method (1939), TVN was estimated by the Conway's micro diffusion method (1933), Acid value and Iodine value were determined according to AOAC (1955), peroxide value was determined by the method of Tarr (1948). The colour of the chloroform extract was observed and arbitrary indices were given.

All the samples were stored at the room temperature and humidity (the laboratory temperature ranged from 24·1–30·0° C. while the relative humidity during the period was between 76–80 per cent.).

Results and Discussions

From Table I it is seen that the protein content is maximum in the Jew fish and Mackerel meal while it is low in the case of Sardine meal. Negi

TABLE I

Proximate chemical composition of fish meals

Sr. No.	Sample	Moisture %	Protein %	Fat %	Ash %	Acid insolubles	Calcium as Cao %	Phosphorus as P_2O_5 %	Non-protein nitrogen gm, %	Total Volatile nitrogen mg. %	αAmino nitrogen mg. %
1	Caranx ..	8·6	58·9	8·7	23·7	0·2	10·0	12.8	1·1	15·4	95·9
2	Jew Fish .. (Meal)	6·3	65·2	9·3	19·8	0·1	8·8	6·8	0·8	15·0	58·1
3	Sardine Meal (Sun-dried)	6·0	51·5	6·7	34·5	1·6	11·4	8·7	1·2	17·5	160·2
4	Jew Fish Meal	5·1	64·8	8·1	21·7	0·1	9·4	7·2	0·9	14·8	70·8
5	Mackerel Meal	6·3	64·0	6·7	23·8	0·2	9·3	10·7	1·1	9·9	77·0
6	Sardine Meal	7·8	53·2	7·4	27·8	1·7	9·5	9·3	1·2	20·5	169·2
7	Sardine Meal	5·0	56·8	8·6	28·7	0·7	9·4	6·6	1·2	14·7	138·2

(1949) also observed low protein values in the sardine meals. The values recorded for protein in the Caranx and mackerel meal were similar to the values recorded by Chari and Pai (1948). The non-protein nitrogen was more in the sardine meals when compared with Jew fishmeals. This is due to the breakdown of proteins to lower forms during the cooking process. High values of non-protein fractions were recorded by Hughes (1961) in the case of herring. Mrochkov (1958) pointed out that 9–13·5 per cent. of total nitrogen is lost during the fishmeal preparation depending on the processing method. He also observed that the increase in the non-protein fraction is due to break down of protein during the fishmeal preparation. Similar observations were recorded by the above authors (*loc. cit.*) while preparing meals from Caranx, Mackerel, Jew fish and Sardines. The fat content in the Jew fish is higher when compared with other fishes. The ash and insolubles are lower in the Jew fish. The high ash content and insolubles in the sardine meal is due to the large sand ingested along with food in the intestinal tract. High values were observed by Negi (*loc. cit.*) in the sardine meals. The total volatile nitrogen in the fishmeals varied from 9·9–20·5 mg. per cent. While values as high as 49·0 mg. were recorded by Venkatraman *et al.* (*loc. cit.*). High values for α-amino nitrogen were recorded for the sardine meals. Valanju and Sohoni (1954) also observed similar high values. From Table II it is seen that in the mackerel meal the moisture increased by 50 per cent. during the eight months storage period. There is an increase in the non-protein nitrogen during the storage period which is primarily due to the increase in the volatile nitrogen fraction. The fall in the α-amino

TABLE II

Changes in the nitrogenous fractions of the fishmeal during storage

Storage period	Moisture %	α–Amino nitrogen at mg. %*	Total Volatile nitrogen mg. %*	Non-protein nitrogen mg. %*
1. Carnax Meal				
Initial ..	8·6	95·9	15·4	1·1
2 Months ..	9·0	89·3	25·4	1·2
4 Months ..	9·4	92·7	38·6	1·4
6 Months ..	9·8	93·8	39·1	1·5
8 Months ..	9·6	90·2	42·2	1·5
2. Jew Fishmeal				
Initial ..	6·3	58·1	15·0	0·8
2 Months ..	8·7	55·6	19·1	0·9
5 Months ..	9·5	53·7	21·0	0·9
7 Months ..	8·9	54·2	25·3	1·0
3. Sardine Meal (Sun-dried)				
Initial ..	6·0	160·2	17·5	1·2
2 Months ..	10·2	178·7	28·7	1·2
4 Months ..	10·8	173·3	31·5	1·3
6 Months ..	10·1	162·7	31·6	1·4
8 Months ..	10·7	158·0	30·8	1·5
4. Jew Fishmeal				
Initial ..	5·1	70·8	14·8	0·9
2 Months ..	7·7	65·0	22·8	0·9
4 Months ..	8·4	61·2	45·9	0·8
6 Months ..	8·8	63·4	52·5	0·9
8 Months ..	8·6	54·2	53·3	1·0
5. Mackerel Meal				
Initial ..	6·3	77·0	9·9	1·1
2 Months ..	8·6	74·8	15·8	1·3
4 Months ..	9·3	72·2	31·0	1·3
6 Months ..	9·6	68·6	46·8	1·4
8 Months ..	9·4	65·7	42·5	1·5

* Dry basis.

TABLE II (*Contd.*)

Storage period	Moisture %	α–Amino nitrogen mg. %*	Total volatile nitrogen mg. %*	Non-protein nitrogen mg. %*
6. Sardine Meal (Rotary dried)				
Initial ..	7·8	169·3	20·5	1·2
2 Months ..	9·6	176·4	23·3	1·2
4 Months ..	9·4	162·4	35·1	1·2
6 Months ..	9·8	168·2	34·4	1·5
8 Months ..	10·8	160·4	36·7	1·5
7. Sardine Meal (Rotary dried)				
Initial ..	5·0	138·2	14·7	1·2
2 Months ..	7·9	137·1	30·4	1·2
4 Months ..	8·7	137·5	38·7	1·4
6 Months ..	9·6	137·8	45·6	1·5

* Dry basis.

nitrogen fraction was not quite significant during the eight months storage period. Similar trends were observed in the changes in the nitrogenous fractions with Caranx, Sardine and Jew fishmeals.

Venkatraman *et al.* (*loc. cit.*) observed no change in the moisture during the storage of fishmeals in sealed tins. While Saha, Sen and Sen (*loc. cit.*) observed a moisture increase from 8·43–11·56 during the 4½ months storage of fishmeal in glass containers and a decrease in protein content of the meal from 42·70–36·87 during the storage period. The authors have not found any appreciable decrease in the protein content of the meal during the storage period. The initial values for the total volatile base recorded by Venkatraman *et al.* were high compared with the values recorded by the authors. However high values were recorded by the authors only after eight months storage period. The increase in the volatile base during the period of storage is nearly 3–4 times its original values in the case of Mackerel, Caranx, and one sample of Jew fishmeal. All the sardine meal samples registered a slow increase during the storage period.

In Table III the changes in the fat fractions during the storage period were recorded. It is observed that the extractibility of fat was decreased

TABLE III

Changes in the fat during the storage of fishmeal

Storage period	Fat %	Iodine value (Wij's)	Acid value	Peroxide value*	Colour of chloroform extract
1. Caranx Meal					
Initial ..	8·7	105·7	13·4	115·5	Brown +++
1 Month ..	8·4	98·7	18·4	32·3	Brown +++
2 Months ..	8·2	90·2	21·5	12·8	Brown +++
3 Months ..	8·1	86·6	21·4	14·7	Brown +++
4 Months ..	8·2	87·7	21·6	10·5	Brown +++
5 Months ..	7·9	84·8	22·8	13·7	Brown +++
6 Months ..	7·7	83·0	24·3	0·7	Brown +++
7 Months ..	7·4	83·7	26·3	9·7	Brown +++
8 Months ..	7·3	81·9	29·0	4·5	Brown +++
2. Jew Fishmeal					
Initial ..	9·3	109·7	10·4	15·5	Y + Br +++
1 Month ..	9·0	105·0	15·0	7·0	Y + Br +++
2 Months ..	8·9	103·6	16·2	3·9	Y + Br +++
3 Months ..	8·6	104·0	18·1	5·9	Y + Br +++
4 Months ..	8·4	101·8	18·5	6·9	Y + Br +++
5 Months ..	8·1	102·9	18·2	6·2	Y + Br +++
6 Months ..	8·0	101·1	24·9	6·7	Y + Br +++
7 Months ..	7·7	102·2	32·0	9·7	Y + Br +++
8 Months ..	7·5	103·9	35·6	5·5	Y + Br +++
Jew Fishmeal (N.D.G.A. treated)†					
Initial ..	9·3	109·7	10·4	15·5	Y + Br +++
1 Month ..	9·2	108·8	15·0	7·3	Y + Br +++
2 Months ..	9·2	104·2	15·9	3·6	Y + Br +++
3 Months ..	9·1	105·2	18·4	4·1	Y + Br +++
4 Months ..	9·0	104·0	18·3	4·1	Y + Br +++
5 Months ..	8·9	105·2	18·2	3·9	Y + Br +++
6 Months ..	9·0	104·0	20·3	2·8	Y + Br +++
7 Months ..	8·9	105·2	20·0	7·5	Y + Br +++
8 Months ..	8·8	104·0	24·0	8·4	Y + Br +++

* Ml. of 0·002 N Thiosulphate required for 1 gm. of fat.

† 0·02% concentration by weight.

TABLE III (*Contd.*)

Storage period	Fat %	Iodine value (Wij's)	Acid value	Peroxide value*	Colour of chloroform extract
3. Sardine Meal (Sun-dried)					
Initial ..	6·7	74·5	24·2	90·5	Brown +++
1 Month ..	6·5	74·0	25·8	42·1	Brown +++
2 Months ..	6·4	70·5	31·2	23·6	Brown +++
3 Months ..	6·3	64·4	39·2	9·3	Brown +++
4 Months ..	6·5	65·4	40·3	8·0	Brown +++
5 Months ..	6·0	66·4	41·6	11·2	Brown +++
6 Months ..	6·3	63·7	42·4	7·3	Brown +++
7 Months ..	6·3	64·1	42·7	5·4	Brown +++
8 Months ..	6·1	64·5	45·7	13·3	Brown +++
9 Months ..	6·0	64·1	47·2	6·7	Brown +++
4. Jew Fishmeal					
Initial ..	8·1	111·9	9·3	9·3	Y + Br +++
1 Month ..	7·9	112·5	12·6	2·5	Y + Br +++
2 Months ..	7·8	110·9	16·3	0·7	Y + Br +++
3 Months ..	7·7	111·1	18·5	3·2	Y + Br +++
4 Months ..	7·4	109·3	18·9	3·7	Y + Br +++
5 Months ..	6·7	112·1	19·8	5·4	Y + Br +++
6 Months ..	7·6	110·9	20·1	2·8	Y + Br +++
7 Months ..	7·5	109·1	22·3	11·8	Y + Br ++
8 Months ..	7·4	109·1	22·1	9·8	Y + Br ++
5. Mackerel Meal					
Initial ..	6·7	106·1	16·1	42·7	Y + Br +++
1½ Months ..	6·5	108·6	20·4	26·7	Y + Br +++
2½ Months ..	6·2	102·1	25·6	5·6	Y + Br +++
3½ Months ..	6·0	99·5	29·8	8·7	Y + Br ++
4½ Months ..	5·8	97·9	30·7	4·0	Y + Br ++
5½tMonths ..	5·6	101·5	31·6	5·4	Y + Br ++
6½ Months ..	5·5	97·7	33·6	0·4	Y + Br ++
7½ Months ..	5·3	98·1	37·0	14·0	Y + Br ++
8½ Months ..	5·3	97·4	38·1	6·9	Y + Br ++

* Ml. of 0·002 N Thiosulphate required for 1gm of fat.

TABLE III (*Contd.*)

Storage period	Fat %	Iodine value (Wij's)	Acid value	Peroxide value*	Colour of chloroform extract
6. Sardine Meal (Rotary dried)					
Initial ..	7·4	108·4	13·4	67·4	Br +++++
1 Month ..	7·1	102·4	20·7	25·7	Br +++++
2 Months ..	7·1	100·0	21·6	14·8	Br +++++
3 Months ..	6·9	97·9	23·3	10·7	Br +++++
4 Months ..	6·7	99·4	27·3	12·4	Br +++++
5 Months ..	6·6	99·1	29·1	5·6	Br +++++
6 Months ..	6·4	88·3	34·8	13·8	Br +++++
7 Months ..	6·5	87·1	36·7	9·8	Br +++++
Sardine Meal (N.D.G.A. treated)†					
Initial ..	7·4	108·4	13·4	67·4	Dark Brown
2 Months ..	7·2	102·4	20·7	20·7	Dark Brown
3 Months ..	6·9	99·8	19·1	13·4	Dark Brown
4 Months ..	6·8	98·9	23·4	14·9	Dark Brown
5 Months ..	6·7	98·8	24·9	6·2	Dark Brown
6 Months ..	6·6	97·9	26·6	10·5	Dark Brown
7 Months ..	6·7	98·1	26·5	9·4	Dark Brown
7. Sardine Meal (Rotary dried)					
Initial ..	8·6	105·8	18·5	28·9	Br ++++
1 Month ..	8·4	104·2	22·5	17·8	Br ++++
2 Months ..	8·2	99·9	24·4	8·8	Br ++++
3 Months ..	7·9	98·2	25·1	12·2	Br ++++
4 Months ..	7·7	99·2	26·5	7·2	Br ++++
5 Months ..	7·6	98·9	30·5	9·5	Br ++++
6 Months ..	7·5	95·1	36·1	2·9	Br ++++
7 Months ..	7·4	97·9	31·5	15·4	Br ++++
8 Months ..	7·2	95·5	33·7	10·3	Br ++++

* Ml. of 0·002 N Thiosulphate required for 1 gm. of fat

† 0·02 % concentration by weight.

during the storage period. The decrease in the extractibility of fat was not much in the case of samples treated with NDGA. Similar observations were recorded by Venkatraman (*loc. cit.*) and Almquist (1956) and March *et al.* (1961). The acid value of all the fishmeals was increased during the storage period. In the mackerel meal the value was doubled while the decrease in the Iodine value was not quite significant. Venkatraman *et al.* (*loc. cit.*) mentioned that the fish in the free fatty acids with the decrease in fat is due to cleavage of fats while Lovern (personal communication) is of the opinion that the rise in the free fatty acids may be due to the splitting of double bonds to give acidic fission products. The reduction in the Iodine value in Jew fish, Caranx and Mackerel meals during the 8 months storage period is very little. The Iodine value in the case of sardine meal dried in the sun is low when compared with the sardine meal dried in the rotary drier. This may be due to the oxidation of the oil in the sun-dried fishmeal. The initial peroxide value is also high in the sun-dried meal. There is a gradual fall in the peroxide value in all the samples during the storage period. Similar observations were recorded by Almquist (*loc. cit*).. As the peroxides are labile substances they are liable to undergo decomposition. The effect of NDGA on the Sardine and Jew fishmeal showed slight improvement in the protection of fat components during the storage period. Lea, Parr and Carpenter (1958) observed that the addition of BHT at 0·005 per cent. level retarded the oxidation of fat considerably at a storage temperature of 25° C. The latter workers have observed a significant decrease in the Iodine value during the storage of herring meal at 37° and 25° C.

SUMMARY

The chemical composition of fishmeals prepared from different varieties of fish was studied. The changes in the nitrogen and fat components during the storage period were studied. The moisture and TVN increased during the storage period.

The extractibility of Fat and Iodine value were decreased while the Acid value increased during the storage.

ACKNOWLEDGEMENT

The authors express their sincere thanks to Dr. A. N. Bose, Director of the Institute, for his keen interest and guidance in the work. Their sincere thanks are also due to Shri M. C. Perumal, Deputy Director of the Off Shore Fishing Station, for kindly supplying the fish utilized in the investigation.

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