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Formation of Histamine in Flying Fish (*Hirundichthys coramandelensis*) at Ambient Temperature and in Ice

P.K. Vijayan, Jose Joseph and K. Gopakumar
Fish Processing Division
Central Institute of Fisheries Technology
Cochin - 682 029, India

Histamine formation in flying fish (*Hirundichthys coramandelensis*) at ambient temperature (30±2°C) and in ice was studied along with other non-protein components and sensory qualities. The histamine content was within the limits on storage up to 9 h at ambient temperature, while at 11 h it was at the limit of acceptability. A positive relation was noticed between histamine content and TMAN-TVBN content as well as sensory qualities. During iced storage the histamine formation was negligible, reaching only 0.22 mg $100g^{-1}$ fish by 17 days.

The flying fish, mainly represented by two species namely *Hirundichthys coramandelensis* (Coramandel flying fish) and *Cypselurus suttoni* (Sutton's flying fish), form an important seasonal fishery along the coramandel coast of Tamil Nadu. On an average the fishery contributes to more than 2000 tonnes of flying fish annually (Anon, 1988). The fishermen use traditional fishing crafts (*Kattumaram*) and gears for the capture of flying fish and hence much time is spent for reaching the fishing grounds and back to the landing centres. This results in landing of catches late in the evening and quality of the fish landed ranges from fair to poor. Many of the landing centres do not have facilities for iced storage or chilled storage. Hence the fishermen are forced to dry the catch. The traditional practice of drying is to split open the fish, remove the entrails, wash in sea water and dry in the sun without salt. Since the fish is taken for drying on the next day, the quality of the fish deteriorates further and often develops ammoniacal or putrid odour.

High amounts of histamine formation have been reported in many fishes during storage at high temperature (Kimata & Kawai 1953; Baldrati, *et al.*, 1980; Frank *et al.*, 1981; Vijayan, *et al.*, 1991). Since the flying fish caught by conventional methods is exposed to high ambient temperature for a long period the possibilities for the production of histamine cannot be ruled out. Hence this work was undertaken to find out the formation of histamine in flying fish at ambient temperature and in ice along with other spoilage parameters and sensory qualities.

Materials and Methods

Flying fish, *Hirundichthys coramandelensis* was collected in pre-rigor condition onboard from a mechanised fishing vessel operated from Thirumulaivasal on the east coast of Tamil Nadu in the month of July, 1991. A portion of the fish was iced immediately and a second lot was kept at ambient temperature (30±2°C). Fishes dressed into fillets without bone and skin, were used in all analyses. The proximate composition of the fish was determined and the samples were analysed at regular intervals for non protein nitrogen (NPN), total volatile base

nitrogen (TVBN), trimethylamine nitrogen (TMAN), α-amino nitrogen and histamine.

Moisture, fat, protein, ash and non-protein nitrogen were determined by the methods of AOAC (1975). TVBN and TMAN were determined by the method of Conway (1947), α- amino nitrogen by the method of Pope & Stevens (1939) and histamine by the method of Hardy & Smith (1976).

Results and Discussion

Flying fish, *H. coramandelensis* (Average weight: 56 g) had an average moisture content of 77.17%, 20.38% Protein, 0.4% fat and 1.10% ash. The meat was white in colour, sweet in odour and taste. In pre-rigor the meat was slightly tough, whereas 4 to 5 h after catch the meat became tender and juicy.

Table 1. *Changes in NPN, TVBN, TMAN and histamine in flying fish, Hirundichthys coramandelensis during storage at ambient temperature (30±2°C)*

Storage period, h	NPN, mg 100g^{-1}	TVBN, mg 100g^{-1}	TMAN, mg 100g^{-1}	Histamine, mg 100g^{-1}
0	424	3.26	Nil	Nil
5	458	4.84	2.21	1.85
9	553	27.05	2.81	3.52
11	635	39.28	6.42	19.86
13	594	61.10	11.11	55.53
17	664	105.63	14.00	60.95-113.70
21	790	172.20	49.00	80.95-142.13
24	1065	212.80	47.80	154.08-160.66

Table 1 shows the changes in NPN, TVBN, TMAN and histamine during storage at ambient temperature (30±2°C). The initial samples (0 h) did not contain any histamine, and in the early stages of storage (up to 9 h) the histamine production was negligible (3.52 mg 100g^{-1}). By 11 h the histamine content was 19.86 mg 100g^{-1}, i.e. at the border line of acceptability (the limit of acceptability is 20 mg histamine per 100 g fish; Anon, 1987). But by 13 h the histamine level reached values (55.53 mg 100g^{-1}) much higher than the acceptable level. The increase in histamine content was rapid on further storage.

The increase in the non-protein nitrogen (NPN) was slow in the early stages of storage. But an appreciable increase in the NPN content occurred from 17 h onwards and a very high value was reached by 24 h storage. The TVBN and TMAN values also showed a similar trend. The increase in TVBN up to 5 h was negligible (4.84 mg 100g^{-1}), but increased rapidly thereafter. Similarly the TMAN content which was negligible in the early stages of storage increased slowly till 11 h and by 21 h a very high value of 49.00 mg 100g^{-1} was reached. It was seen that the histamine increased proportionally to the increase in TVBN and TMAN.

Table 2 shows the sensory characteristics of flying fish during storage at ambient temperature. The fresh characteristics of flying fish were retained for no more than 5 h. The fish deteriorated slightly by 9 h and had reached border line of acceptability by 11 h. Spoilage thereafter was very rapid and by 13 h the fish was in the un-acceptable condition. By 13 h, the belly portion was barely intact; the cooked meat had a pale dark appearance and on chewing, gave a burning and itching sensation to the tongue. The burning sensation could be due to the cumulative effect of different types of amines, especially histamine formed during the storage.

Table 3 shows the changes in the non-protein nitrogen fractions of ice stored flying fish. The NPN values, which showed significant fall during iced storage, indicate

Table 2. *Changes in sensory characteristics of Hirundichthys coramandelensis during storage at ambient temperature (30±2°C)*

Storage period, h	Physical Characteristics of fresh fish	Organoleptic charcteristics of cooked meat	Apparent quality
0	Muscle firm, skin smooth and shining; eyes convex with clear protruding lens; gills bright red; in pre-rigor	White flesh, sweet taste; slightly tough	Excellent
5	Muscle firm; skin smooth, shining slightly lost; gills bright red, no slime; eyes convex; in resolving stage of rigor	White flesh, sweet odour and taste, flesh firm, juicy and tender	Excellent
9	Muscle some what soft but no finger impression remains; gills red, slight decayed weedy odour; eyes slimy, slightly sunken, slight yellow colour around the eyes; smoothness of skin lost; stomach intact; no decayed odour	Colour of the meat slightly faded, sweetness reduced, soft	Fair
11	Mucle soft, finger impression recovers slowly; gills, slightly bleached; slightly decayed odour; eyes sunken, red pink colour around it; skin dry and rough; belly content slightly decayed	Meat colour slightly faded, bland taste, no off taste	Fair-Poor
13	Muscle soft; finger impression retained; gills bleached, slimy, spoiled odour; eyes sunken, pink colour around it, slimy; decayed at the belly portion; skin dry	Meat colour faded; burning or itching sensation on chewing	Poor and unacceptable

Table 3. *Changes in NPN, TVBN, TMAN, α- amino nitrogen and histamine in Hirundichthys coramandelensis during ice storage*

Storage period in days	NPN mg 100g^{-1}	TVBN mg 100g^{-1}	TMAN mg 100g^{-1}	α-amino N mg 100g^{-1}	Histamine
0	424	4.6	Nil	45.5	Nil
3	420	5.2	Nil	43.0	0.46
5	395	8.4	Nil	42.0	Nil
7	427	10.8	Nil	31.5	0.65
10	348	12.6	1.8	38.5	1.38
12	287	12.6	1.4	35.0	1.26
14	256	7.0	1.4	38.5	0.42
16	-	-	-	-	0.54
17	226	14.0	3.2	26.0	0.22

that these fractions are perhaps lost by leaching in melting ice. The amino nitrogen contributing to the odour and flavour of the fresh fish showed a decreasing trend, typical for ice stored fish. The TVBN values increased but the rate of increase was not appreciable (14.00 mg 100mg^{-1} fish after 17 days). The TMAN values also showed a similar trend and was only 3.2 mg 100g^{-1} even after 17 days of iced storage.

The histamine formation during iced storage was quite insignificant and only 0.22 mg 100g^{-1} histamine was formed by 17 days iced storage. The very low level of histamine produced during iced storage may be due to the poor growth of bacteria responsible for the production of histamine (Ota & Kaneko, 1958; Edmunds & Eitenmuller, 1975; Kalyani & Bai, 1965).

The sensory characteristics of ice stored flying fish are given in Table 4. The initial characteristics of flying fish were retained for 3 days and on 5th day slight changes were noticed in the original characteristics. Afterwards the sensory changes were faster and by 12 days storage the scales had become loose and off odour developed gradually along with slime on the gills. The protruding convex eye balls became flat and then sunk with an yellow colouration developing around the eyes by 10 days storage. In physical appearance the fish was acceptable even after 17 days storage except for slight discolouration, shrinkage at the belly portion and development of slight off odour at the gills and belly portion.

Organoleptic assessment of the cooked fish showed that the ice stored samples had a shelf life of 14 days. The fish were in good condition up to 7 days. By 14 days the cooked meat developed off odour and taste and a slight burning and itching sensation on continued chewing. The burning and itching sensations of ice stored flying fish could not be attributed to histamine, since its level was quite insignificant. But it could be due to the formation of other decomposition products such as putrescine and cadaverine (Bjeldanes *et al.*, 1978).

The above observations indicate that histamine is produced in flying fish *H. coramandelensis* at ambient temperature storage and significant levels are formed after just 11 h storage. But in ice storage the

Table 4. *Changes in sensory characteristics of Hirundichthys coramandelensis during iced storage*

Storage period, days	Physical characteristics of fresh fish	Organoleptic charcteristics of cooked meat	Apparent quality
0	Muscle firm; skin smooth and shining; convex eyes with protruding and clear lens; eyes clean; gills bright red/purple; pre-rigor/in rigor	White flesh, sweet odour, taste, slightly tough, firm, less juicy and tender	Excellent
3	Muscle firm, skin smooth; in rigor; convex eyes, protruding lens; gills bright red and characteristic odour.	White and firm flesh; sweet odour; slightly tough, juicy, sweet taste	"
5	Skin smooth, less shining; no finger impressions remain; rigor resolved; convex eyes, but less shining, slight clouding of lens; gills brightness reduced	White meat, juicy and tender, no off flavour, slightly sweet	"
7	Smoothness of skin reduced, no shining; slightly bleached gills, mucous; flattening of eyes, slight clouding of the lens	Whiteness reduced, soft and tender meat, slightly sweet	Good
10	Skin not smooth, no finger impressions remain; bleached gills, slight off odour, eyes flat, cloudy, yellowing at the eye cap; no off odour	Pale white colour; flaky; slightly sweet taste, no off taste; not tough or pasty	Good-Fair
12	Bleached/dark coloured gills; slight decayed weedy odour; muscle soft; slight yellow colour at the belly portion; belly portion slightly shrunken	Faded white colour; muscle flaky, firm not juicy, no off taste	Fair
14	Bleached/dark gills; slight decayed odour at the gills; belly contents decayed; spoiled odour; scales detached from skin	White colour faded, slight off odour, flaky, slight off taste; slight itching on continued chewing	Fair-Poor
16	Gills bleached; dark soft muscle; scales detaching from skin; spoiled odour at belly portion	Dull colour, slight decayed odour; itching & burning sensation on the tongue on chewing	Poor

conditions were not favourable for histamine production. One of the prime requisites for histamine production is the availability of sufficient amount of histidine decarboxylase enzyme and in fishes its sources are the different bacterial flora capable of producing the enzyme (Arnold & Brown, 1978; Edmunds & Eitenmuller, 1975; Niven *et al.*, 1981). It is reported that histamine producing bacteria were killed or unable to produce histamine at low temperature (ranging from 0 to 10°C) (Ota & Kaneko, 1958; Edmunds & Eitenmuller, 1975). Some workers have reported that small amount of histamine was produced when the fish was stored at 2-6°C but no histamine was produced at -20°C even in two months time (Dabrowski, 1968; Cattaneo & Cantoni 1978; Baldrati *et al.*, 1980).

The present study indicates that the flying fish can not be stored for more than 11 h at ambient temperature (30±2°C) because of high histamine production. But the storage of flying fish in ice prevents the formation of histamine and only very low levels are formed even when the flying fish is unsuitable for consumption.

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