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STUDIES ON ICE-STORED PRAWNS

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INTRODUCTION

ICING of prawns is a very important step for maintaining good quality of the material. Prawns should be beheaded and stored well-iced immediately after they are taken out of water and should be maintained in this condition until processed in the factories. This may involve a couple of days to a week's storage in ice according to the conditions. During storage of prawns in ice, many changes take place in the muscle of the prawns and attempts have been made by many workers to follow and make use of these changes to assess the quality of the ice-stored prawns. Fieger *et al.* (1956), Campbell and Williams (1952), Fieger and Friloux (1954), Velankar and Govindan (1959), and Iyengar *et al.* (1960) have studied the progressive spoilage in ice-stored prawns by following the chemical, bacteriological and organoleptic changes taking place in the prawn muscle. In all these cases some products of spoilage like trimethylamine, total volatile nitrogen, volatile acid number, volatile reducing substances, etc., as well as total viable plate count and pH changes of the muscle were followed.

While attempting to make use of these indices in assessing the quality of ice-stored prawns, Velankar *et al.* (1961) have observed a regular fall in the total bacterial plate count, total volatile nitrogen and volatile acid number in prawns stored in ice up to a fortnight while the trimethylamine value remained nil throughout this period. Hence these methods do not provide satisfactory basis for the assessment of quality in ice-stored prawns. One probable reason for this is that spoilage is very little in prawns when properly stored in ice and as such these constituents are not likely to be produced in any appreciable quantities in the early days of storage. Further the whole picture is complicated by the two major phenomena taking place in the muscle of ice-stored prawns, *viz.*, leaching of soluble material from the muscle by melting ice and absorption of moisture by the muscle. The spoilage products formed, if any, are washed away by the melting ice along with the other solubles. Velankar and Govindan (1958 and 1959) have followed changes

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in free α-amino-acid nitrogen content in the prawns stored in ice and observed a rapid fall as the number of days of storage in ice increased. Jeff Collins (1961) has held whole raw pink shrimp in ice and observed that as a result of holding in ice the shrimp gained in weight and lost solids and salt as a function of holding time. Govindan (1962) made a study of whole prawns stored in ice and observed that there was a rapid fall in the total nitrogen, water-soluble nitrogen and non-protein nitrogen contents of the muscle along with the number of days of storage. It was thought of interest to extend this work with a view to studying the more significant changes taking place in the prawn muscle during ice storage.

Materials and Methods

The prawns after landing were brought immediately to the laboratory, beheaded, peeled and deveined when necessary and the experiments carried out.

Experimental

The prawns were mixed with two to three times the weight of crushed ice in a flat, rectangular enamel tray (18″ × 12″ × 3″), placed in an insulated ice box and surrounded by ice. Representative samples were drawn from this at intervals and analysis carried out. The water collected in the tray was drained off and ice replenished each time the sample was taken. The prawns were peeled and deveined and blended in a meat mincer and the blended material was used for the experiments.

(*a*) *Moisture.*—Moisture was determined by the method described in A.OA.C. (A.O.A.C., 1960).

(*b*) *Total nitrogen.*—Total nitrogen was determined by the A.O.A.C. method (*loc. cit.*) using 1 gm. of sample and a mixture of copper sulphate and potassium sulphate (1 : 8) as catalyst. Distillation was carried out in the micro kjeldahl distillation apparatus using a suitable aliquot of the made-up solution of the digested material.

(*c*) *Water-soluble nitrogen.*—Between 20 and 30 gm. of the minced flesh was weighed accurately, transferred to a waring blender with about 100 ml. of distilled water and blended for 60 seconds. The blended material was transferred quantitatively to a 250 ml. glass-stoppered graduated measuring cylinder, made up to 250 ml. and shaken thoroughly to mix. It was then filtered through Whatmann No. I Filter-paper. From the filtrate 5 ml. was digested with concentrated sulphuric acid and nitrogen determined as in (*b*).

(*d*) *Non-protein nitrogen.*—To 5 ml. of filtrate from (*c*) 2 ml. of 20% trichloracetic acid was added and filtered into a 25 ml. standard flask. The protein precipitate in the filter-paper was washed repeatedly with 1% trichloracetic acid, made up to 25 ml. and 5 ml. digested and nitrogen determined.

RESULTS

The results obtained in a series of experiments with whole, headless and peeled and deveined prawns are given in Tables I and II.

The rapid fall observed in the total nitrogen, water-soluble nitrogen and non-protein nitrogen is due to the leaching out of soluble nitrogenous constituents from the muscle by the melting ice and the absorption of water by the muscle. An attempt has been made to find out how far these two factors are individually responsible for causing these changes.. Prawns were obtained, peeled and deveined (size: 83/lb. as P and D) and known weights (about 100 gm. each) of the meat were taken in water-tight polythene bags, 3–4 times the weight of crushed ice was added to each bag, the bags tied water-tight and placed in an enamel bucket which was then kept surrounded by ice in an insulated box so that at least a few pieces of ice were present in all the bags at the time of sampling. At intervals one bag was taken and analysed for actual increase in weight of the muscle, solids and nitrogen leached out by melted ice, moisture content, total nitrogen, water-soluble nitrogen and non-protein nitrogen of the muscle. The results are shown in Table III.

Figure 1 shows the changes observed in a similar experiment with peeled and deveined prawns (size: 52/lb. as P and D).

DISCUSSION

As can be seen from the tables, the total nitrogen, water-soluble nitrogen and non-protein nitrogen show a rapid fall during storage in ice while the moisture content of the muscle shows a rapid rise. The rate of these changes increases in the order of whole, headless and peeled and deveined prawns and this may be attributed to the amount of surface area exposed in the respective cases. A comparison of Tables I and II show that the changes are much more rapid in the case of smaller size prawns.

It is seen from Table III that the maximum increase in weight of the muscle is 14·15% of the original weight of the muscle and it has occurred even in the first two days of storage and thereafter it is somewhat constant. The solid material leached out by the melt water is 14·95% of the original

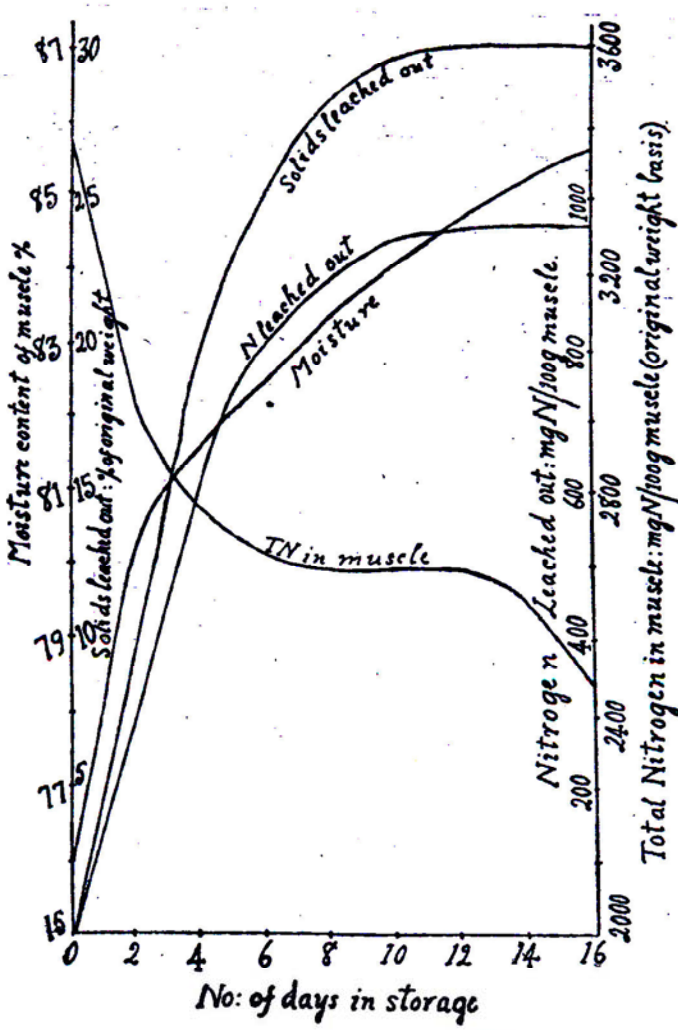

FIG. 1. Changes in moisture and total nitrogen in muscle and nitrogen and solids leached out in peeled and deveined prawns stored in ice.

weight of the muscle in two days storage and it slowly increased to 29·85% in 14 days. The values of total nitrogen, water-soluble nitrogen and non-protein nitrogen given in Table III have been calculated after taking into account the net increase in weight of the meat and hence the changes in these figures are caused by the effect of leaching alone. The net effect of leaching and the absorption of moisture by the muscle, however, is an increase in weight of the muscle. This means that the loss in weight suffered by the muscle by the dissolution of nitrogenous material by melting ice is simultaneously compensated and some extra weight is also gained by the muscle by the absorption of water from melting ice.

Another interesting point is that all earlier attempts to study the quality of ice-stored prawns consisted only in the measurements of the products of

TABLE I

(The values of nitrogen are expressed as mg. N/100 gm. muscle)

A Whole prawns: Size: 15/lb. as whole					B Headless prawns: Size: 44/lb. as headless					C Peeled and deveined prawns Size: 23/lb. as peeled and deveined				
No. of days of storage	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen	No. of days of storage	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen	No. of days of storage	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen
Fresh	75·46	3594	1703	806·3	Fresh	75·5	3619	1738	831·2	Fresh	76·17	3368	1667	828·1
2	77·0	3152	1499	707·9	2	78·48	2915	1383	660·7	2	80·85	2709	1182	553·7
3	80·58	2756	1248	608·7	5	82·0	2563	998·6	415·3	4	82·85	2556	1016	456·9
6	81·16	2672	1115	539·4	7	83·79	2626	821·0	317·8	6	83·14	2441	862·4	369·7
8	82·35	2554	908·6	412·7	9	84·57	2482	730·2	303·9	8	84·43	2127	759·3	263·6
10	83·58	2418	817·4	357·4	12	85·00	2295	636·0	206·6	10	84·59	2254	648·8	241·7
13	84·29	2298	668·5	292·8	15	85·65	2246	615·1	205·0	14	86·72	1965	437·5	125·0
15	84·82	2198	584·1	223·6	17	85·27	2178	575·7	161·4	16	86·84	1923	523·2	138·0
18	84·84	2118	477·4	192·9	19	86·24	1963	502·9	132·1	..	..	..	..	..
20	85·22	2179	429·5	160·5	21	85·74	2065	458·5	126·6	..	..	..	..	..

TABLE II

(The values nitrogen are given as mg. N/ 00 gm. muscle)

A Whole prawns: Size: 91/lb. as whole					B Headless prawns: Size: 100/lb. as headless					C Peeled and deveined prawns: Size: 83/lb. as peeled and deveined				
Duration of storage in ice	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen	No. of days of storage	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen	No. of days of storage	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen
Fresh	77·03	3328	1487	697·2	Fresh	77·64	3358	1445	747·4	Fresh	76·78	3402	1469	939·9
2	81·58	2551	1106	438·3	2	80·61	2982	1213	562·2	2	80·85	2670	842·0	516·5
4	83·71	2332	842·2	288·5	5	82·94	2430	1049	384·1	5	83·77	2384	690·0	341·8
6	84·43	2278	743·2	235·3	7	83·95	2392	970·9	372·7	8	84·05	2081	572·5	267·5
8	85·11	2233	649·8	133·7	9	84·72	2324	790·5	311·0	12	84·96	2270	567·1	306·3
10	85·49	2158	567·1	105·1	12	84·86	2140	751·6	236·3	14	84·01	1968	476·2	204·8
13	85·51	2101	505·3	63·84	14	85·33	2037	720·4	201·4	16	85·04	2118	539·3	236·2
16	85·69	2120	497·5	74·78	16	85·57	2157	697·7	204·9	..	..	..	..	..
18	85·98	2059	303·3	69·61	19	86·26	2093	553·7	146·1	..	..	..	..	..
..	..	..	..	..	21	86·24	2001	666·8	127·5	..	..	..	..	..

TABLE III

(The values of nitrogen are expressed as mg. N/100 gm. muscle on original weight basis)

No. of days of storage	Increase in weight %	Solids leached out as % of original weight on original moisture basis	Total nitrogen in leach water	Moisture %	Total nitrogen	Water-soluble nitrogen	Non-protein nitrogen
Fresh	..	..	..	76·78	3402	1469	939·9
2	14·15	14·95	470·0	80·85	3049	961·6	589·8
5	12·4	22·89	684·5	83·77	2679	775·4	384·1
8	14·13	26·08	776·1	84·05	2374	653·3	305·2
12	11·92	25·41	750·1	84·96	2539	634·5	342·6
14	12·63	29·85	928·5	84·01	2216	536·2	230·5
16	12·63	28·48	918·3	85·04	2384	607·1	266·0

spoilage. As has been pointed out earlier in this paper, spoilage is very little in prawns if stored properly iced and hence these indices cannot be expected to show any noticeable change. Moreover, all these products are highly soluble in water and hence are easily leached away by the melting ice as they are formed along with the other nitrogenous constituents of the muscle. On the contrary it is seen that the most significant changes taking place in ice-stored prawns especially in the first 8–10 days of storage are (1) leaching out of soluble nitrogenous constituents and (2) absorption of moisture by the muscle. Hence some tests depending upon these changes can give a better idea of the quality of the material than the routine spoilage tests. The values of total nitrogen, water-soluble nitrogen and non-protein nitrogen show very rapid change especially during the first 8–10 days. However the rates of these changes are to a certain extent dependent upon the size of the prawns as well as the mode of storage (*i.e.*, whole, headless, or peeled and deveined) and hence separate limits will have to be worked out for the different types of storage and for the broad size groups.

This dissolving out of the soluble nitrogenous constituents may be the reason why prawns stored in ice gradually lose their characteristic fresh flavour until they attain a flat flavour. Such flavour giving compounds as are soluble in water will also be lost along with the nitrogenous constituents. The increase in weight recorded in this work is under laboratory conditions where the individual prawns are wiped gently to remove the adhering water before determining the increase in weight. Under factory conditions this will be much higher as plenty of water will be adhering to the material.

SUMMARY

A quantitative study has been made of the two major changes taking place in prawns stored in ice, *viz.*, the leaching out of soluble nitrogenous constituents from the muscle and absorption of water by the muscle from the melted ice. Under the influence of these two changes, the total nitrogen, water-soluble nitrogen and non-protein nitrogen contents of the prawn muscle show very rapid change especially during the first 8–10 days of storage. These changes also mask the spoilage changes if any during this period. The maximum loss in solids and hence the nutritive value due to leaching is about 30% of the original weight of the muscle, but the loss in weight due to this phenomenon is simultaneously compensated and some increase in weight (10–14% of the original weight) also occurs by the absorption of water by the muscle. The possibility of making use of these changes for determining the quality of ice-stored prawns has been discussed.

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