MARKETING

SPECIAL REPORT

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RAPPORT SPÉCIAL

PRESERVATION OF SKIN COLOUR IN ATLANTIC REDFISH

Canada

PRESERVATION OF SKIN COLOUR IN ATLANTIC REDFISH

MARKETING DIRECTORATE
DEPARTMENT OF FISHERIES AND OCEANS
OTTAWA, ONTARIO, CANADA
K1A 0E6

FOREWORD

At the Japan Fisheries Workshops conducted in Halifax, Moncton, and St. John's in March 1983, redfish was discussed as a species of major interest to the huge Japanese fish market. It was estimated that Japan has an annual requirement of 30 000 tonnes of various species of redfish, including the Canadian East coast species, Sebastes marinus. Several Japanese trading companies have expressed keen interest in sourcing redfish from Canada. These buyers have made it abundantly clear that the redfish must meet the required high standards of quality in terms of freshness, red colour and presence of scales. In addition to proper handling and processing to preserve freshness and scales, use of additives acceptable to the Japanese health authorities was recommended to prevent loss in red colour.

While the use of colour preservatives in redfish has been proven successful under Japanese harvesting and processing (at sea) conditions, this practice is new to Canadians, whose methods of catching, handling and processing redfish are considerably different from those of the Japanese. Obviously, there was a need to determine whether known redfish colour preserving compounds would be effective on Canadian redfish under Canadian harvesting, handling, processing and storage conditions.

In response to a specific request from industry, the Marketing Directorate initiated a study to determine the effects of two approved compounds, erythorbic acid and vitamin E, in the preservation of skin colour in Atlantic redfish. Hurley Fisheries Consulting of Dartmouth, Nova Scotia, was contracted to undertake the project in July 1983, under the supervision of Vince Gobuyan of the Marketing Directorate.

What follows is the final report submitted to the Department by the consultant. The conclusions drawn from the study are those of the consultant and do not necessarily represent the views of the Department of Fisheries and Oceans.

Comments are welcome.

Joshua John
Director General
Marketing Directorate

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INTRODUCTION

2. INTRODUCTION

One of the major selling features of redfish is its red color, particularly in Japan where fresh fish is highly prized and is often eaten raw (Higashi, 1982). Loss of red color can be associated with loss of quality, even though the two conditions can be mutually exclusive (Longard & Regier, 1971; Dyer et al, 1956). At a recent Japan Fisheries Workshop held in various locations in Atlantic Canada, it was pointed out that redfish imported from Canada are often of unacceptable color quality and that although several methods exist for preserving color in fish,none of them are presently used by the Canadian fishing industry (Higashi, ibid). Because loss of color is associated with oxidation of skin pigments (Anon, 1982; Longard & Regier, 1974), fat oxidation and protein denaturation (Fox, 1976; Dryde, 1979), most methods of color preservation are aimed at controlling or retarding the rate at which these reactions occur. Successful efforts provide the dual function of preserving both color and quality. Possible methods to preserve both color and quality might be freezing at sea, gutting, and the use of color preservatives. Some suitable preservatives with antioxidizing properties reported by Higashi (ibid), are sodium erythorbate, vitamins such as ascorbic acid and the tocopherals, and other vegetable resins.

Most recent scientific research on this subject at the Fisheries & Oceans Canada Halifax laboratory was done in the early 1970's and is yet unpublished. This work dealt with the use of sodium erythorbate as a color preservative on redfish fillets held in frozen cold storage. The chemical was not applied at the time of capture

on board the vessel, but rather a few days later at the plant. No comparison was made between iced and frozen-at-sea fish. The results showed that the fish treated with sodium erythorbate showed better color and quality during cold storage particularly at higher temperatures than untreated fish (D. Lemon, pers. comm.)

Duchaine (unpublished manuscript) & Dyer et al.(1956) both found that application of ascorbic acid to fish onshore before freezing acted to retard color deterioration during cold storage. Duchaine (ibid) also reported that samples of redfish which were frozen-at-sea showed better color preservation than samples which were iced and later frozen on shore.

The present study investigates the effects of industrial erythorbic acid ($C_6H_7OH_6-H_2O$) and vitamin E (D-α-tocopheral)(supplied courtesy of Nippon Suisan Kaisha Ltd.) on preservation of skin color in Atlantic redfish (Sebastes marinus). These substances have been approved by the Canadian Food and Drug Act for use as preservatives in food but only erythorbic acid and its salts have been approved for use in seafood products. Industrial preservatives may also contain other vegetable resins and polysaccharides(Higashi, 1982) An example of the chemical makeup of one of these commercially available antioxidants of Japanese origin is given in Appendix I. The experimental design attempted to simulate existing and potential harvesting and processing conditions found in the Canadian Atlantic fishing industry.

The aim of the study is to investigate for the first time the following:

(1) Comparison of the effect of preservatives on color between frozen-at-sea and iced fish.

(2) Comparison of the effect of preservatives on color between round and gutted fish.

(3) Comparison of the relative effect of a water soluble preservative erythorbic acid and a fat soluble preservative (Vitamin E).

(4) The first trials at manufacturing and applying ice made of a solution of water and perservative.

MATERIALS & METHODS

3. MATERIALS & METHODS

3.1 AT SEA

Preservatives were applied to some samples both at sea and on shore. Some samples were frozen-at-sea while others were iced according to the outline in Figure 1.

An effort was made to collect all samples in one tow during the same trip. Due to scarcity of fish, the attempt was unsuccessful and therefore, 2 lots of samples were collected on two separate fishing trips. Samples for treatment numbers 2,5,7,8,9 & 10 were collected on Western Bank along with about 2000Kg of Pollock while aboard the M/V. J. B. Nickerson on June 21, 1982. Samples for treatments 1,3 & 4,which represented almost the entire catch for that tow, were collected on Middle Bank while on board the M/V Gulf Georgetown on July 6, 1982. The location of both capture sites is shown on the map in Figure 2.

Each sample consisted of approximately 50 fish which were washed and put into 90 litre plastic boxes. Initial washing of the sampled redfish along with the other fish in the catch took place in large vats with running water. The fish were shovelled onto a conveyor system for transport of about 5 meters to the site in the vessel where the samples were sorted and the preservatives applied. Redfish take on the M/V J.B. Nickerson had spent one and a half to two hours after capture in the holding pens and/or the washing vat before samples could be taken. Samples were sorted and treated on the M/V Georgetown within one-half hour of capture.

Samples 1,2,3,4,9 & 10 were iced in the ratio 2 ice:1 fish. The ice for samples 9 & 10 was made by freezing a 0.3% aqueous solution of erythorbic acid and vitamin E respectively using a chest freezer aboard the vessel. The solutions were stirred constantly during freezing to help prevent precipitation of the preservative. After freezing, the ice was crushed manually. Samples 3,4,7 & 8 were headed and gutted at sea while the remaining fish were left round. All frozen-at-sea samples (5,7 & 8) were frozen using dry ice (CO_2) stored in pressurized cylinders. Samples 1,3,5 & 7 were dipped in an aqueous solution of 0.3% erythorbic acid for 30 seconds. All samples were prepared within one to two hours after capture. Unfortunately, due to a scarcity of fish a sample for treatment 6 (round, frozen-at-sea, no preservative) was not collected.

3.2 ON SHORE

All samples were transported to the Canadian Institute of Fisheries Technology at the Technical University of Nova Scotia in Halifax within 24 hours of capture. All iced samples were re-iced in the same boxes and stored at +1°C until the ninth day after capture. This procedure simulated the maximum length of time that fish would normally be expected to stay on ice if they were caught near the beginning of a trip aboard a typical Canadian wetfish trawler. All frozen-at-sea samples were repackaged into cardboard boxes containing inner poly bags and stored at -30°C.

On the second, seventh and ninth days after capture, a subsample of 5 or 6 fish from each frozen sample was withdrawn and thawed at

room temperature. A subsample of the same size from each of the iced samples was withdrawn and allowed to warm briefly. Each of these subsamples were washed to remove slime and eggs and were then graded for color and quality. Quality assessment consisted of a visual evaluation of skin color and quality, odour and eye condition. Color assessment consisted of a visual ranking usually by three trained graders, and an instrumental evaluation of skin color. Instrumental color measurements were made using a Gardner Color difference meter. The mean of ten measurements was calculated for gutted and round fish in each of two or three areas respectively as illustrated in Figure 3. These measurements utilized the "L", "a", "b" system of color evaluation as described by Clydesdale (1978), in which "L" is a measure of intensity, "a" predicts redness (positive values) or greenness (negative values) and "b" predicts yellowness (positive values) or blueness (negative values). A measure of total color is achieved by combining those parameters into various functions. With these values three functions namely, a/b, $(a+b)^{\frac{1}{2}}$ and $\cot^{-1}a/b$ were computed. Since Clydesdale (ibid) recommended the $\cot^{-1}a/b$ function as the best estimator of human visual perception it was used in the analysis of the results. Area C (Figure 3) color values were used in the final analysis since it was the only area common to both round and gutted samples.

Color photographs were taken of the subsamples material, and the sub-samples were frozen in 10 lb. shatterpack cartons. The following day the frozen subsamples were removed from the plate freezer, lightly sprayed with water for glazing, ranked visually according to intensity of red color, and refrozen.

On day 9, in addition to the regular sampling as described, all remaining fresh material was headed and gutted if necessary, divided into two halves, dipped in either preservative (A) or water (B) and plate-frozen in 10 lb. shatterpack cartons. All "A" samples were dipped in a 0.3% erythorbic acid except treatment sample 10 where 0.3% Vitamin E was used. The next day, treated samples were removed from the plate freezer, glazed with tap water and stored at -30°C. Frozen-at-sea samples on day 9 were divided into two halves, glazed in preservative or water for "A" & "B" treatments and placed back into storage at -30°C. Fish from treatment 5 were left round to simulate long term frozen cold storage aboard a freezer trawler before processing.

On July 27, 1982, one subsample from each treatment sample was removed to a +2°C coldroom and left overnight to defrost. Samples were ranked visually according to color in the frozen state. Instrumental color measurements and photographs were taken on July 28, 1982. The two groups of samples (according to date received) were either 22 days (treatments 1,3 & 4) or 36 days (treatments 2,5,7,8, 9 & 10) old and had been stored for either 13 or 27 days in the frozen state after day 9. After evaulation of "A" & "B" subsamples, fish were refrozen in 5 lb. fillet cartons for possible future analysis. On August 25, 1982, the last sampling day of the experiment, all treatment samples were subsampled and assessed as described for July 28. At this time samples 1,3 & 4 were 51 days old and had spent 42 days in frozen cold storage after day 9. Samples 2,5,7,8,9 & 10 were 65 days old and had been frozen for 56 days after day 9.

All material measured on days 2,7 & 9 which had been frozen after analysis was defrosted and reevaluated for color only, in late August, to determine the effect of freezing and thawing on color. The color scores resulting from this reevaluation are referred to as "repeat values" for the remainder of this report.

As of the writing of this report, all samples are being retained in frozen cold storage for possible future examination.

4. RESULTS

4.1 Comparison of Visual & Colorimeter Rankings

In this experiment an instrumental measurement of color was needed which accurately reflected human color preference and also could detect small color differences. Regression analysis and a Spearman's rank correlation test revealed that the ranking obtained from the $\cot^{-1}a/b$ reduction of colorimeter "L", "a", "b" data corresponded closely to visual colour ranking (Fig.4). Comparisons were made between visual and instrumental rank only on July 27 and August 25, 1982 since these were the only two days on which samples from the two lots could be ranked together.

4.2 Colorimeter Values & Rankings

The history of colorimeter values and rankings for each treatment are given in Table 1. Because intense redness, indicated by high "a" values result in small $\cot^{-1}a/b$ values, decreasing redness is represented in this system, by decreasing $\cot^{-1}a/b$ values.

Although the order in which treatments are ranked remain fairly constant after day 9,it is clear from Table 1 that the actual color of the treatment samples changed. On day 2, the range in colorimeter values for all treatments was 0.129. By day 9, this range had increased to 0.295 and by August 25, the last sampling date, it had increased again to 0.332 (B values).

RESULTS

Comparison of rank orders for "A" & "B" treatments show that the application of color preservative on day 9 had very little effect on treatment preference. A paired t-test comparing "A" & "B" colorimeter values on the last two sampling days gave insignificant t values for both days ($t_{22/36} = 1.02$, $t_{51/65} = 0.69$, $d=0.05, df=8$), indicating that reapplication or delayed application of preservative in this experiment had little effect on the final color of the frozen product. Consequently, all further analysis was done only on "B" values.

Figure 5 shows the percent change of actual color over time for each treatment relative to its initial day 2 value. Of all treatments, the control #2 showed the greatest color loss during iced storge (>30% by Day 9). Treatments 1,3 & 4 actually showed net color gains particularly during storage on ice before day 9 (>15% by August 25). All other treatments (5,7,8 & 10) did not show any obvious trends but rather fluctuated approximately 10% around the initial day 2 value.

Analysis of variance of the colorimeter values ($\cot^{-1}a/b$) and a Newman-Keuls Range Q test confirmed these observations reveal significant differences in means between treatment 9 and treatments 1,3 & 4 and also between treatment 2 and treatment 3 ($F=3.41$, $Fc=2.25$ at $\alpha = 0.05$). These differences are reflected in the rank orders after day 9 (Table 1) in which treatments 1,3 & 4 occupy the top three positions, numbers 2 & 9 are ranked last and all other treatments occupy intermediate positions. As explained above, the relative

net gains and losses of color in these particular samples probably explain why no significant differences in mean color scores were detected between sampling days ($F=0.44$, $Fc=2.67$ at $\alpha = 0.05$).

4.3 Effect of Freezing & Thawing on Color

Since some color readings in Table 1 were done on samples that had undergone one thawing cycle, while others were done on samples which had never been frozen, the effect of freezing and thawing on color was investigated.

In order to test the assumption that frozen storage time had no effect on color over the duration of the experiment, the color scores of frozen-at-sea samples (5,7 & 8), all of which had undergone one thawing cycle only were compared. An analysis of variance did not reveal any significant differences between sampling day means ($F=0.39$, $Fc=3.84$ at $\alpha=0.05$), indicating that color in these treatments did not change appreciably over 65 days of frozen cold storage.

Since there did, in fact, appear to be no effect of frozen cold storage on color, repeat colorimeter values for iced samples read in late August from samples frozen on days 2,7 & 9 were ranked with the original colorimeter values of frozen-at-sea samples. This combination of values enabled a comparison to be made between treatment samples which had all undergone one freezing and thawing cycle. Analysis of variance and a Newman-Keuls Range Q test showed

that treatments 2 & 9 were significantly different from all other treatments (vs only a few treatments without thawing, see above) but were not different from each other ($F=8.33$, $Fc=2.59$ at $\alpha=0.05$). There were no differences between any other treatment means. Again, none of the mean color scores for sampling days were significantly different ($F=1.72$, $Fc=3.63$ at $\alpha=0.05$).

4.4 Quality Assessment

The differences between treatments as explained by the colorimeter $Cot^{-1}a/b$ data were not reflected by differences in any other quality indicator. In fact, only one noticeable difference in quality of fish between treatments occurred during the experiment. On day 9, fish from treatment 10 exhibited a distinctly sour odour which was not evident in fish from any other treatment.

DISCUSSION

5. DISCUSSION

Redfish samples caught by both vessels showed a high degree of red color immediately after capture while they were on the deck of the vessel. Unfortunately the colorimeter was not considered portable enough nor did vessel operating conditions permit the taking of colorimeter readings aboard the vessel on Day one.

Messrs. Y. Santo and A Matono of Nippon Suisan Kaisha, Ltd. and Mr. J. Lindsay of National Sea Products, Ltd. kindly consented to appraise the color photographs of representative fish from all samples on Day 2 (the first day back at the laboratory). They observed that a good deal of color had been lost already, and therefore found relative grading of the samples difficult. This agrees with the relatively low variation in colorimeter values for Day 2 (Table 1). All fish were considered as being of only average red quality for the Japanese market. They remarked on the obvious areas of scale loss on the fish which they indicated was due to rough handling. They concluded that the existing conditions aboard Canadian wetfish trawlers as regards prolonged 'batch' washing and mechanical handling of redfish were not conducive to color preservation nor prevention of scale loss. Our own observations of considerable amounts of red pigment in the ice melt of the boxed samples on Day 2 confirmed their observations and conclusions. The Japan Fisheries Workshop recommended individually washing each fish while minimizing the amount of water used.

It would seem that the comparison of relative color in our own experiment had been only based on observation of residual color which

may discount any meaningful interpretation of the post-Day 2 results. However the consistently increasing between-sample variation in colorimeter values from Day 2 to the last sampling date (Day 51/65) indicates that the various treatments had different affects on preserving color particularly during iced storage which may allow for some general comparisons to be made based on the experimental results presented here. The differences in pre-treatment storage time, species composition and size of the catches and possible areal differences in natural color between the two lots of samples may mitigate against a valid comparison of all treatments as presented here. However treatments within a particular sample lot can be compared more validly.

Instrumental assessment of color and visual perception of color were found to be quite similar on this study. Clydesdale (1978) reported that, historically, the $\tan^{-1}a/b$ reduction function of the "L", "a", "b" system of color evaluation has been used successfully to simulate human perception of color. He recommends, however, that because there are geometric problems associated with the tan function, that the $\cot^{-1}a/b$ function should be used instead. For those reasons, colorimeter values based on mean $\cot^{-1}a/b$ readings were chosen to represent visual assessment of color throughout this experiment.

Duchaine (unpublished manuscript) reported that the color of filleted fish deteriorated over time in storage, but that application of ascorbic acid to fish on shore before freezing halted this deterioration for up to 3 months in storage. Dyer et al.(1956) and

D. Lemon (pers.comm.) obtained similar results for long term storage using ascorbic acid and sodium erythorbate respectively on redfish fillets. Higashi (1982), while recommending that preservative be applied to fish immediately after capture, also stated that the delayed application would have some effect in retarding color loss.

In this experiment, the application of color preservative to fish on day 9 simulated the situation where fish are not treated with perservative until they arrive at a processing plant. The results of this study showed that the delayed application of preservative had no effect on color, even with samples which had not been previously treated with preservative. For most iced treatments, the major changes in color occurred before processing and freezing on day 9. The previously noted significant loss of color before Day 2 may account for the discrepancy with historical data along with differences in the duration of both iced and frozen storage time. Reexamination of the treatment samples at a future date may determine if the delayed application has had any effect on color over long term storage as suggested by other researchers.

All of the applied treatments from the M/V J.B. Nickerson sample lot preserved color as well, or better than the control treatment (round,iced only).

The frozen-at-sea treatments (5,7 & 8) showed the least variation of all treatments after the Day 2 (including the iced samples from the M/V Georgetown sample lot). According to Duchaine

(unpublished manuscript) and the recommendations of Higashi (1982) frozen-at-sea redfish retain their color longer than iced-at-sea fish. Within the Nickersen sample lot only treatment 10 (Vitamin E) fish showed color values in the range of the frozen-at-sea samples. This may have been the result for two reasons:

1) the dry ice used to freeze treatment samples 5,7 and 8 in this experiment, had a detrimental effect on color by changing the biochemical environment around the skin or by physically disrupting cell membranes during rapid freezing. Previous experiments in preserving fish or shrimp color have generally had good results using gaseous CO_2 bubbled through sea water (Bullard and Collins, 1978; Collins et. al., 1980; Longard and Regier, 1974; Nelson and Barnett, 1971), however, none of them investigated the use of solid CO_2 for preservation.

2) Vitamin E is a significantly better agent for color preservation than is erythorbic acid. Much of this superiority probably lies in the fact that the most abundant pigment in redfish skin is astaxanthin (Hoyniewicecka, 1964) which is a fat soluble compound (Fox, 1976). Vitamin E, as a fat soluble preservative, may react better to this pigment than does the water soluble erythorbic acid (Higashi, 1982). Because of this fact, Vitamin E probably did not leach from the skin surface as rapidly as erythorbic acid did during melting of the ice. The apparent benefits of using Vitamin E as a preservative, however, are offset somewhat by the fact that Vitamin E after day 9 seemed to impart to the fish, a distinctly unpleasant odour which may influence their commercial acceptability.

Part of the increased variation in colorimeter values with increased iced/frozen storage may have been due to too few fish used in subsamples. Comparisons in color were based on 5 or 6 fish in a subsample on a particular date using the means of 10 colorimeter readings in one region of the skin surface. Differential leaching of color from individual fish on Day 1 due to the amount of time spent in the washer/holding pens or volume of overlying ice in the sample box probably contributed to this variation. It is difficult to believe that fish from treatments 1,3 and 4 actually showed a net gain in color with storage.

Duchaine (unpublished manuscript) noted that some color on frozen ocean perch fillets was lost during the defrosting process. A similar color loss was also noted in this experiment particularly for the control (treatment 2) and treatment 9. In the comparison of treatments using repeat values for iced samples, the segregation between treatments 1,3 and 4 and the frozen-at-sea treatments was reduced, indicating that thawing did have a leaching effect on the color of frozen fish.

The attempt to preserve color in fish by icing with a frozen solution or erythorbic acid failed. Color scores for treatment 9 indicate that the preserving power of frozen 0.3% erythorbic acid is equivalent to that of ice without preservative. It was noted that even though the solutions for treatments 9 & 10 were stirred constantly during freezing, the preservatives tended to precipitate out of solution

resulting in an uneven distribution of preservative in the crushed ice on board the vessel, therefore uneven contact between preservative and fish skin. Because erythorbic acid is a water soluble compound its rate of leaching may have been accelerated during melting of the ice. Dipped samples were coated evenly by the erythorbic acid which probably gave the preservative a better chance to penetrate the skin. This may explain why dipped fish exhibited better color than did fish iced with a frozen solution of erythorbic acid.

CONCLUSIONS

6. CONCLUSIONS

1) The greatest source of loss of redfish pigment and scales occurred before this experiment began that is on board the vessel during the initial washing and handling. This fact refuted any further interpretation of the results other than some general observations. However, this conclusion is in itself valuable to Canadian wetfish trawler operators who must review their normal procedures. It is our recommendation that the use of water and rough handling methods be strictly minimized. It would appear that ice melt may contribute as much as washing to pigment loss and since this is inevitable on wetfish trawlers the only possible solution may be shorter trips with less ice useage or more practically, that this product be put up during the winter months.

2) Where reasonable comparisons could be made, the control sample (round, iced only) fared worse than other applied treatments.

3) The color-preserving effect of freezing-at-sea was possibly complicated by the use of dry ice.

4) Vitamin E, a fat soluble preservative was more effective at preserving color than erythorbic acid, a water soluble preservative but had some negative quality aspects.

5) There was no evidence that heading and gutting at the time of capture contributed to greater color preservation.

6) The overall assessment of color was complicated by possible areal color differences between redfish populations and within-sample variation of individual fish.

ACKNOWLEDGMENTS

7. ACKNOWLEDGEMENTS

Special mention is accorded to Mr. Stanton Guy, National Sea Products Ltd., whose personal interest in the subject helped initiate the work. I appreciate the cooperation of Messrs. P. Mathews and R. Bush, H.B. Nickerson Ltd., in making the vessel arrangements and providing technical field support. Ms. J. Dawson assisted in the data tabulation and analysis.

Mr. A. Woyewoda, Technical University of Nova Scotia, conducted the colorimeter and quality appraisals.

Messrs. Y. Santo and A. Matono, Nippan Suisan Kaisha Ltd., and Mr. J. Lindsay, National Sea Products Ltd. shared some of their own experience on the subject which helped enormously in the final interpretation of the results.

Dr. J. Wilmer and Mr. D. Lemon, D.F.O., kindly reviewed the first draft of the manuscript and made many useful suggestions which hopefully improved the final report.

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REFERENCES

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FIGURES

EXPERIMENTAL DESIGN AND FATE OF THE SAMPLES

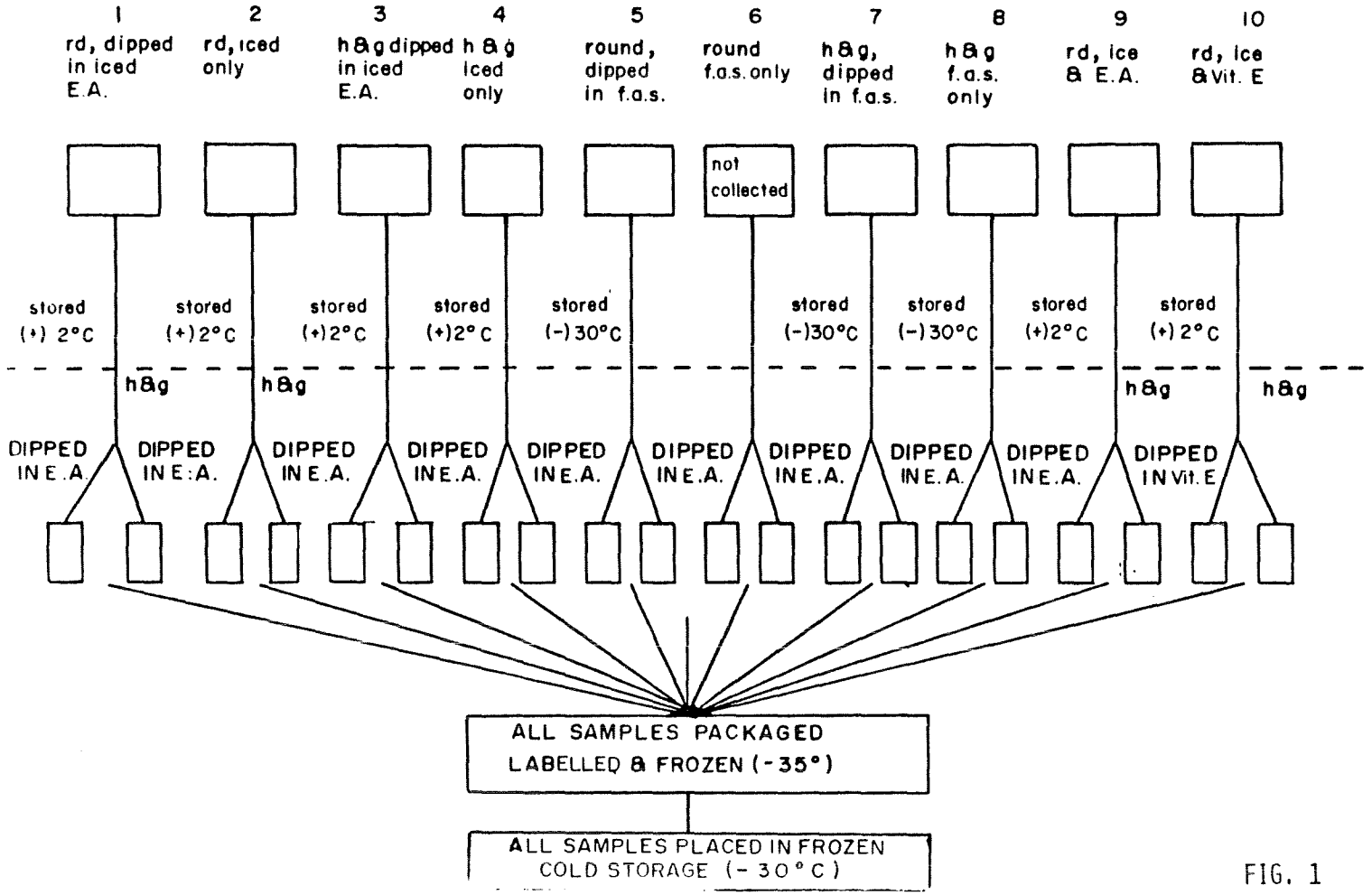
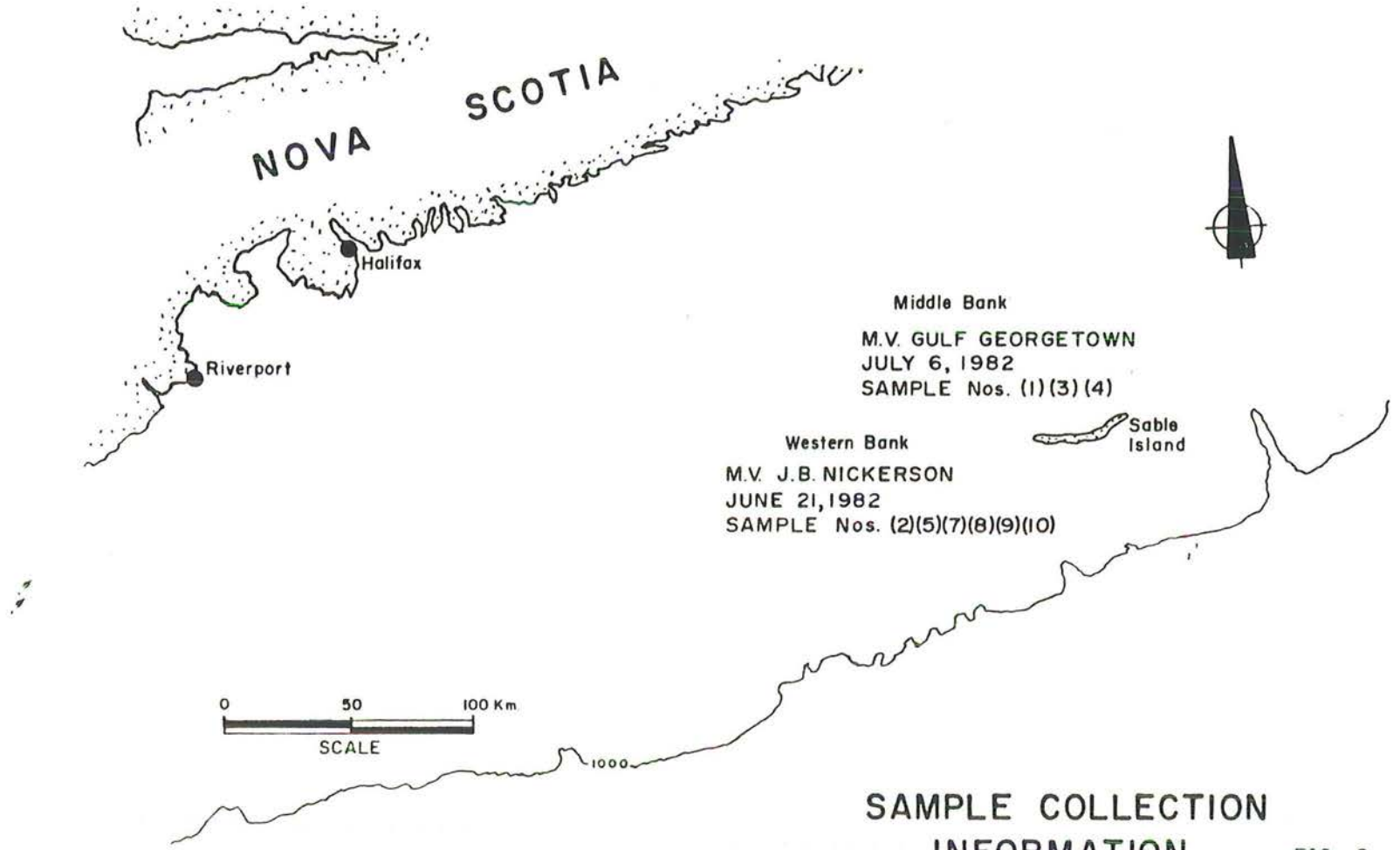
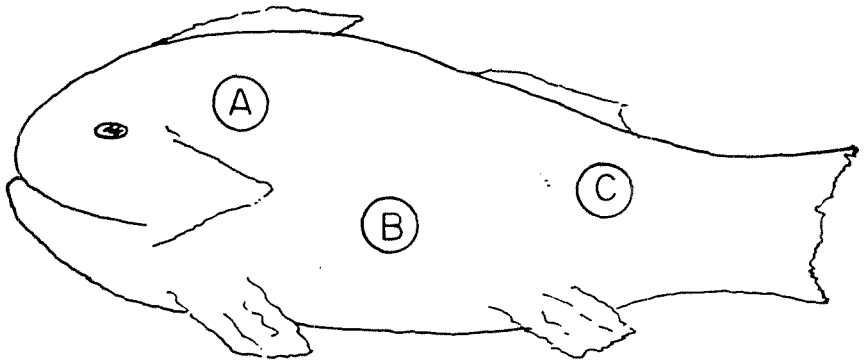


FIG. 1



SAMPLE COLLECTION INFORMATION

FIG. 2



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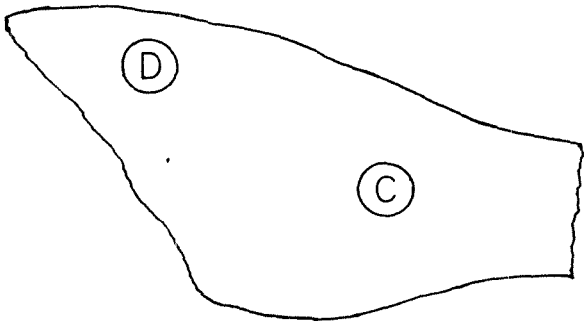
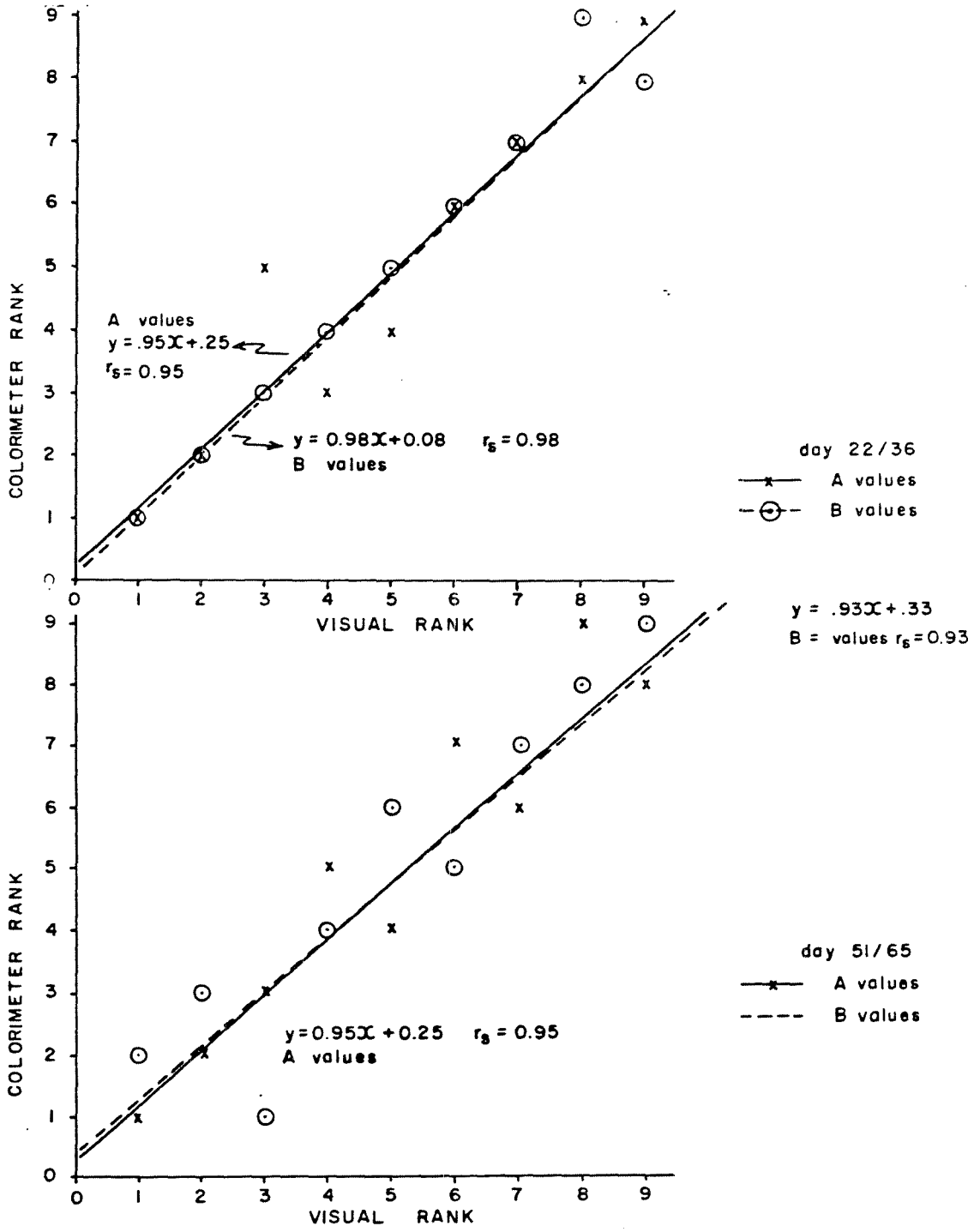


HEADED AND GUTTED

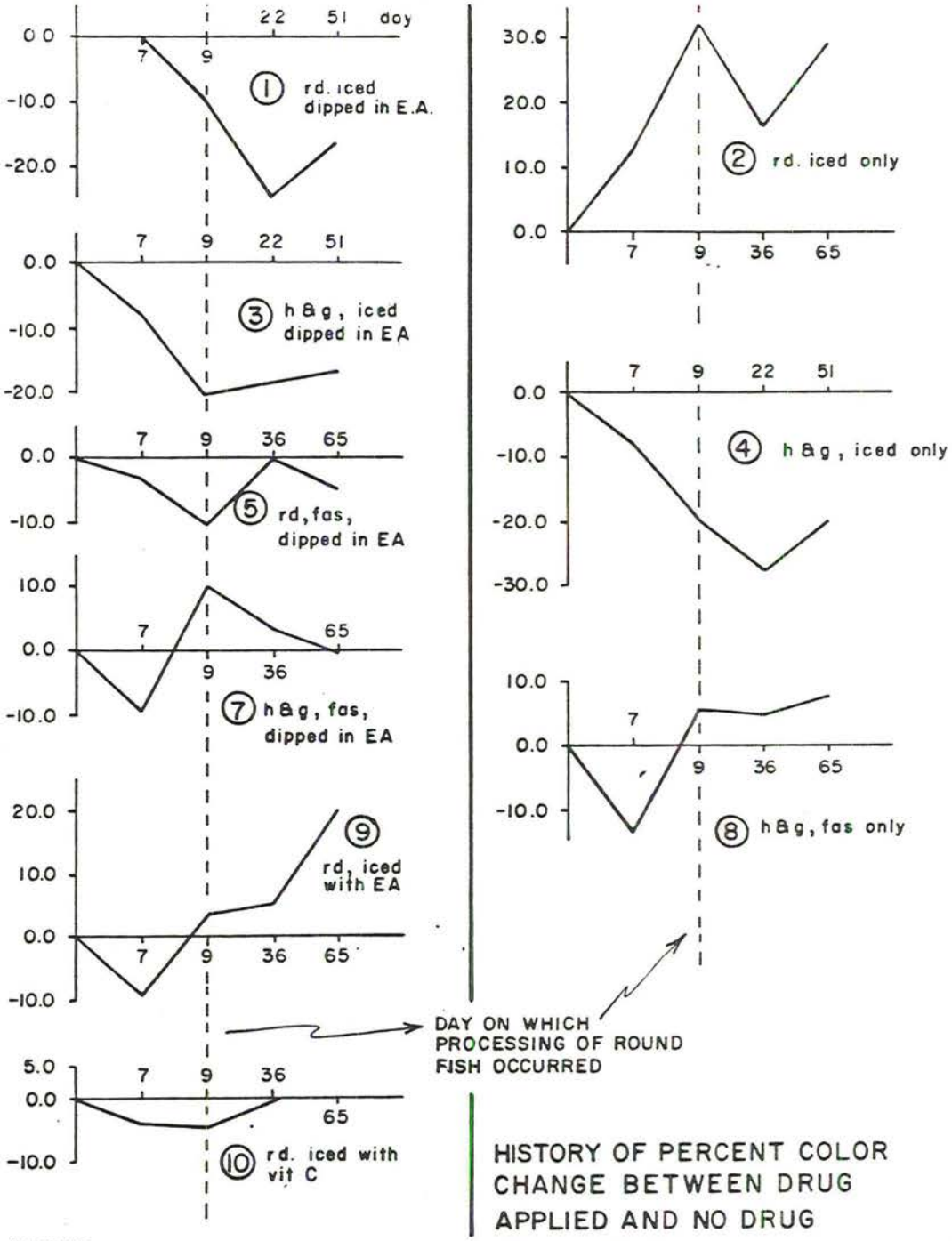
AREAS OF COLOR MEASUREMENT ON ROUND
AND EVISCERATED REDFISH

FIG. 3



RELATIONSHIP OF COLORIMETER RANK ON VISUAL RANK FOR A and B VALUES ON DAYS 22/36 and 51/65

FIG. 4



HISTORY OF PERCENT COLOR CHANGE BETWEEN DRUG APPLIED AND NO DRUG TREATMENTS

LEGEND:

x - SAMPLING DAYS

y - PERCENT CHANGE IN COLORIMETER VALUES ($\cot^{-1}\frac{a}{b}$)

FIG. 5

APPENDIX

B971 MK. #39

MINISTRY OF HEALTH AND WELFARE

1-2-2, Kasumigaseki, Chiyoda-ku, Tokyo

100 JAPAN

Cable Address: *KOSEISHO TOKYO*

C E R T I F I C A T E

This is to certify that the following substances are designated as food additives by Article 6, and their specifications and standards are established by Article 7, of the Food Sanition Law of No.233 of December 24, 1974, of Japan.

Commodity : Red Fish Antioxidant for Red Fish

Components of the commodity :

Sodium L-Ascorbate	15.0%
Sodium Erythorbate	10.0%
Sodium Hydrogen Pyrophosphate	7.0%
Sodium L-Glutamate	7.0%
Carboxymethyl Cellulose	5.0%
Sucrose Fatty Acid Ester	5.0%
Magnesium Sulfate	8.0%
Sodium Phosphate Dibasic	8.0%
Sodium DL-Malate	20.0%
D-Sorbitol	15.0%

Manufacturer :

Shimakyu Chemical Co.,Ltd.

2-13-59, Mikunihonmachi Yodogawa-Ku, Osaka, Japan

Exporter :-

Shimakyu Chemical Co.,Ltd.

2-13-59, Mikunihonmachi Yodogawa-Ku, Osaka, Japan

Dated JUL 16. 1980

M. Fujii

M. Fujii, Ph. D.
Chief, Food Chemistry Division,
Environmental Sanitation Bureau,

HURLEY FISHERIES CONSULTING
July/1983

DAY TWO PHOTOS


2 HR-2
Rd-ice
KODAK COLOR CONTROL PATCHES


3 HR-2
Ea. dip
hag
iced
KODAK COLOR CONTROL PATCHES


1 HR-2
Ea. dip
iced
KODAK COLOR CONTROL PATCHES


5 HR - 2
Rd EA
tas
KODAK COLOR CONTROL PATCHES


4 HR - 2
hdg
iced
KODAK COLOR CONTROL PATCHES


7 HR - 2
hdg EA
tas
KODAK COLOR CONTROL PATCHES


9 HR-2
Rd-ice
E.A.
KODAK COLOR CONTROL PATCHES


8HR-2
h+g tas.
KODAK COLOR CONTROL PATCHES


10HR-2
Rd-ice
Vit E
KODAK COLOR CONTROL PATCHES