Effect of Arterial Incisions on the Amount of Bleeding and Flesh Quality of Rainbow Trout

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ABSTRACT—Arteries of rainbow trout, Salmo gairdneri, *were severed at the isthmus, nape, and caudal peduncle, and blood loss was measured. The greatest amount of bleeding occurred with the caudal penduncle cut, resulting in a loss of blood weighing 2.29 percent of the total body weight. The effects of delayed bleeding and the use of an anticoagulant, also studied, were of no benefit. The quality of flesh, after being frozen up to 8 months, was superior for bled fish as evaluated by appearance, odor, and lipid stability.*

Introduction

Slaughter practices used in animal industries are not used in most fisheries. In the animal industry, the animals are maintained quiescent before slaughter, slaughtered, and bled immediately. In fisheries, struggling fish are sometimes stunned by a blow on the head or by electric shock to facilitate handling, but bleeding is rarely done. Most commonly, a landed fish is directly placed in the hold and processed later.

Adequate research has not been done to show the effect of bleeding and stunning on fish flesh quality although the literature indicates advantages from these practices. The removal of blood by making cuts or by evisceration has been noted as a means of accelerating death (Cobb, 1900; Jarvis, 1950) and retarding spoilage (Tower, 1901; Tressler, 1920; Jarvis, 1950; Anon., 1970; Boggess, et al., 1973). Bleeding of fish is required in some Norwegian fisheries to improve fish flesh quality (Fjortoft, 1969).

We initiated studies on the effect of techniques of stunning and bleeding on the quality of fish flesh at the National Marine Fisheries Service (NMFS) Laboratory, Seattle, Wash., in 1970. This paper describes effective and practical methods of bleeding fish. In addition, it presents preliminary information to show the improved quality of flesh of bled fish. Data are presented on the amount of blood bled from cuts made at three locations on cultured rainbow trout, *Salmo gairdneri,* and on the effects of an anticoagulant and delayed bleeding. The quality of flesh of bled and unbled fish was compared on the basis of appearance, odor, and TBA determinations (thiobarbituric acid) indicative of lipid stability.

Materials and Methods

Rainbow trout for the study were obtained from the Washington State Department of Game, Seward Park Hatchery, Seattle, Wash., and the NMFS Northwest and Alaska Fisheries Center, Seattle, Wash. Both stocks were just less than 2 years old at the time of testing; their total weight averaged 284 g (9.1 ounces) and ranged from 169 to 455 g (5.1-14.6 ounces). Fork length averaged 28.5 cm (11.2 inches) and ranged from 23 to 34 cm (9.1-13.4 inches). Trout were maintained at a temperature of about 10°C before use.

Main arteries of groups of unfed fish were severed at three loctions that could be cut efficiently. A cut at the isthmus severs the ventral aorta; at the nape, it severs the dorsal aorta and the spinal cord as well, thereby immobilizing the fish; and at the caudal peduncle, it excises the tail and severs the dorsal aorta. One cut at each location was made on each of 10 fish (5 from each hatchery).

The procedure was to net a fish from its holding tank before its daily feeding, maintain it out of water, blot water from it with paper towels, and at the end of 1 minute to make a cut for bleeding. Subjects were bled into individual plastic bags for 5 minutes. The weight of a bled fish and its blood were determined.

Blood that had been bled was washed off the trout with cold water, water was blotted off, and the fish were then weighted. The weight of the bled fish subtracted from the weight of the blood and fish combined provided the weight of blood lost.

Efficiency of delayed bleeding was examined. Twenty trout handled as in the previously described experiment were cut at the caudal peduncle except that the fish were maintained out of water for 20 minutes at 10°C before the cut was made. Combined total weights of fish and of blood bled of the 20 fish were determined.

An anticoagulant bath (3 percent sodium citrate solution) was used to determine if it facilitated bleeding. The procedure was as before for the caudal peduncle cut (immediately after a fish was removed from water) except that the peduncle was immersed in 100 ml of citrate solution immediately after the tail was excised. Total weight of fish and of blood bled of each of the 10 fish used for this

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part of the experiment were determined.

The effect of bleeding on the quality of the fish flesh was evaluated on the basis of its appearance, odor, and TBA determinations (Yu and Sinnhuber, 1957). Samples of fish flesh with skin intact were cut from each side of each fish, wrapped in vapor-barrier film, and stored at -18°C. Samples were thawed after 3 and 8 months and used for quality comparison. A part of each sample was skinned and minced. A part of each minced flesh was used for odor evaluation and the other part was mixed along with a similar weight of flesh from four other fish, similarly treated, for TBA analysis. Odor was rated on a scale of 1 to 5 where a rating of 5 was assigned to a normal fresh odor, and progressively lower ratings were given to samples having an increasingly more objectionable odor with a rating of 1 given to a sample having an extreme abnormal odor.

Amount of Bleeding by Procedure and Resulting Quality

Experiments indicated the relative efficiency of bleeding from cuts made at the three locations, the effect of delayed bleeding, the effect of an anticoagulant bath, and the improvement of fish flesh quality from bleeding.

The mean percentage of blood lost in total body weight from a cut at a given location was similar between the rainbow trout from the two hatcheries; however, this varied considerably with cut location (Table 1). A two-way analysis of variance test ($P = 0.05$) indicated the differences between the two stocks of fish was not significant ($F = 0.022$, 1, 29 d.f.), but differences between the cut locations were significant ($F = 20.128$, 2, 29 d.f.). The most effective cut was the peduncle incision that resulted in an average blood loss of 2.29 percent of the total body weight; the isthmus cut averaged 1.88 percent which was somewhat greater than the nape cut which averaged 1.67 percent. The 2.29 percent loss from the peduncle cut compares with 2.4 percent removed from rainbow trout with a syringe from the dorsal aorta at the peduncle by Smith (1966).

Delaying the caudal peduncle cut by 20 minutes after the fish is removed from water reduces bleeding efficiency. A delayed cut resulted in loss of 1.50 percent of total body weight in blood, whereas this averaged 2.29 percent for this cut made immediately after a fish was removed from the water.

The amount of blood bled was not significantly different between two groups of fish with excised tails where one group was held in an anticoagulant ($F = 1.207$, 1, 18 d.f.; Table 1).

Groups of bled and unbled fish, compared on the basis of appearance, odor, and TBA determinations, indicated that bleeding produced a superior food product. Flesh of bled fish was nearly free of blood, whereas that of the unbled trout was, without exception, discolored a pinkish to red with areas of hemorrhaging in some cases (Fig. 1). Odor tests showed the bled trout to be more acceptable; samples of unbled fish were slightly rancid after 3 months of storage while the bled sample did not show any rancidity until 8 months of storage (Table 2). The odor tests were confirmed by the TBA determinations; values were lower for the bled fish after 3 and 8 months with the TBA value similar between the bled fish after 8 months and the unbled trout after 3 months (Table 2).

Experiments of Boggess et al. (1973) on methods of stunning channel catfish, *Ictalurus punctatus,* confirm some of our findings. They determined that immobilization by CO_2 or bleeding (from peduncle and isthmus cuts) were superior methods because they produced flesh of better appearance and better aroma and flavor after 2 months of frozen storage

Table 1.—Amount of bleeding of rainbow trout from a cut made 1 minute after removal from the water at one of three different locations.

Location of cut	Hatchery of origin	No. of fish	Amount of bleeding (% of total weight) Range	SD	Mean
Isthmus	Seward	5	1.73-2.24	0.21	1.89
	Park	5	1.66-2.10	0.17	1.86
	NMFS	—			
		10	1.66-2.24	0.18	1.88
Nape	Seward	5	1.42-1.94	0.26	1.71
	Park	5	1.42-1.96	0.23	1.63
	NMFS	—			
		10	1.42-1.96	0.23	1.67
Caudal peduncle	Seward	5	2.00-2.57	0.23	2.25
	Park	5	2.02-2.66	0.23	2.33
	NMFS	—			
		10	2.00-2.66	0.22	2.29
Caudal peduncle (Immersed in anti-coagulant)	Seward Park	10	1.33-3.22	0.50	2.10

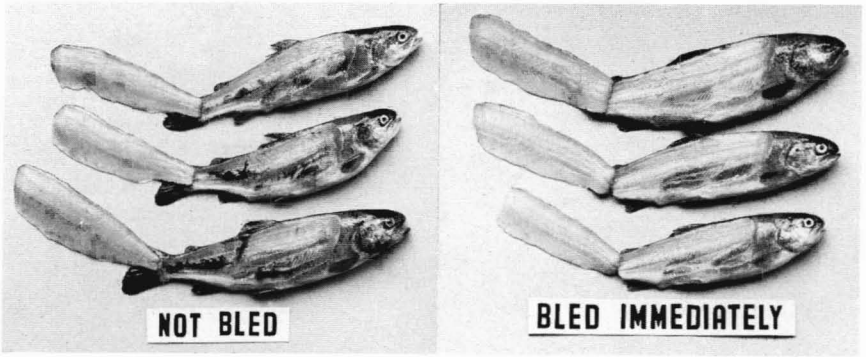

Figure 1.— Appearance of rainbow trout that have been split open to show the remaining blood present in fish that were not bled or bled immediately after they were removed from the water.

Table 2.—Odor and TBA values of raw flesh of samples of bled and unbled rainbow trout stored at -18°C.

Samples	3 months			8 months		
	Odor score[1]	TBA no.	Remarks	Odor score[1]	TBA no.	Remarks
Bled	3.6	1.8	Good quality	2.7	3.1	Slightly rancid
Unbled	2.6	3.2	Slightly rancid	0.6	4.3	Extremely rancid

[1] Rated on a scale of 1-5, where 5 = normal fresh odor; 4 = loss of normal odor; 3 = slight-to-moderate degree of abnormal odor; 2 = moderate-to-strong abnormal odor; 1 = extreme abnormal odor.

than electric or ice immobilization techniques.

Improvement of Product

The cut location affects the efficiency of bleeding with the result that bleeding improves the quality of stored trout flesh.

The two cut locations that should be considered are at the caudal peduncle and at the isthmus of rainbow trout. Greatest bleeding occurs from the caudal peduncle cut; if this results in an unsightly product, then the isthmus cut can be made with some loss in efficiency in bleeding. Based upon our results, the use of an anticoagulant is not recommended for increasing bleeding.

Smith (1966) suggested the blood of rainbow trout in the freshwater environment is 6.2 percent of the total weight of a fish. Assuming similar blood content for our experimental fish, the tail cut removed 37 percent of the blood. Our study shows that the removal of this quantity of blood effectively improves the appearance and reduces the rancidity of rainbow trout flesh that has been stored.

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