

BONE DETECTION IN FISH BY X-RAY EXAMINATION

Part 2 - Fluoroscopic Examination of Frozen Fried Fish Sticks

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ABSTRACT

WITH THE USE OF A MEDICAL DIAGNOSTIC X-RAY FLUOROSCOPE, 98.5 PERCENT OF THE BONES CONTAINED IN SEVERAL THOUSAND FROZEN FRIED FISH STICKS WERE DETECTED DURING A TEST OF THE METHOD. USE OF THE FLUOROSCOPE FOR THE PURPOSE OF BONE DETECTION DID NOT REQUIRE COOKING AND DESTRUCTION OF THE FISH STICKS, WHICH WOULD BE NECESSARY IN MANUAL-VISUAL INSPECTION. THIS FLUOROSCOPIC X-RAY METHOD IS SUITABLE FOR ROUTINE QUALITY-CONTROL IN COMMERCIAL PLANTS AND FOR USE IN DETECTING BONES IN THE GRADING OF FROZEN FRIED FISH STICKS.

INTRODUCTION

A quick and accurate method for the detection of bones in fishery products has been sought since the U. S. Fish and Wildlife Service, with the cooperation of the fishing industry, developed the voluntary United States Standards for Grades of Frozen Fried Fish Sticks (Federal Register, July 21, 1956^{1/}). Frascatore and Holston (1955) employed photographic X-ray examination for the detection of bones in fish blocks and fillets. Although that method proved to be accurate, it was time-consuming and expensive. Fluoroscopic X-ray examination for bone detection in fishery products was suggested as being a quicker and a more practical means of solving this problem.

This paper reports the preliminary experiments employing the suggested fluoroscopic X-ray technique. The immediate purpose of this test is to develop a routine quality-control measure in commercial plants and for grading procedures in the application of the voluntary United States Standards for fishery products. The ultimate purpose, however, is to acquire information that will aid in the development of a routine continuous method of bone detection in fishery products as they are being processed commercially.



FIG. 1 - DETERMINING THE "BONE-CONTENT" OF FISH STICKS, BLOCKS, OR FILLETS BY USE OF X-RAY FLUOROSCOPY. THE OPERATOR IS ADJUSTING THE X-RAY CONTROL PANEL.

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^{1/}ALSO COMMERCIAL FISHERIES REVIEW, AUGUST 1956, P. 78.

The fluoroscopic equipment available for these studies at the Bureau of Commercial Fisheries Technological Laboratory at East Boston was not designed for industrial use but rather for routine medical diagnostic examinations. It has an operating range of 2.5 to 15.0 milliamperes and 30 to 85 kilovolts.

The image produced on the fluoroscopic screen (Dupont-Patterson CB-2) is influenced by various factors. The sharpness of the image, for example, is dependent on the size of the focal point (that point where the cathode rays strike the anode to produce X-rays). If this point is large or if the tungsten anode overheats, expanding the metal, the image may be distorted, causing it to be diffuse and vague.

Other difficulties are caused by the inability of the operator to see the bones on the fluoroscopic screen. The light emitted by the fluoroscope is dim, and as a result, the operator is quickly susceptible to eye fatigue.

OBJECTIVES

The objectives of the present study were as follows:

1. To determine the optimum conditions for use and operation of available X-ray fluoroscopic equipment.
2. To determine the reliability of the fluoroscopic method when applied to the detection of bones in frozen fried fish sticks.

EXPERIMENTAL

The first problem was to determine the optimum energy levels at which to view the test samples. Approximately 50 pounds of fresh haddock and scrod haddock fillets (each fillet contained at least one bone) were viewed on the fluoroscopic screen with the current ranging from 2.5 to 9.5 milliamperes and the potential ranging from 40 to 85 kilovolts. The clearest and sharpest image on the screen was obtained at a setting of 8 to 9 milliamperes and 70 to 75 kilovolts.

The continuous use of such high-energy levels for over 3 minutes would be detrimental to the X-ray tube, causing it to overheat. To solve this problem, the instrument was operated for 2 minutes and then turned off for an equal period. When this procedure was followed, the image produced on the screen was sharp and clear.

Before viewing the samples in the dark room, the operator must accustom his eyes to the very dim light emitted by the fluoroscope. This is accomplished by donning red plastic adaptation goggles at least 20 minutes before entering the darkroom. If this precautionary measure was not taken or was done improperly (that is, if the goggles were worn in sunlight or under bright artificial light), small bones in the fish sticks were apt to be missed. The goggles are removed before viewing the screen.

After viewing samples in the dim light of the X-ray room for approximately 30 minutes, the operator's eyes became tired. Therefore, any viewing beyond this length of time decreased the reliability of the observation. Accordingly, the 30-minute time limit for viewing was never exceeded.

To test the effectiveness of the method 3,301 frozen fried fish sticks were obtained from several commercial plants. The fish sticks were removed from the package prior to being fluoroscoped. The fish sticks that were shown to contain bones by this method were designated positive; those not showing the presence of bones were designated negative. The fish sticks were then placed on a cookie pan (the positive fish sticks were indicated) and cooked in an oven at 400° F. for 15 min-

utes. The cooked fish sticks were removed from the oven and allowed to cool. They were then crushed and shredded by hand to feel for bones to check the accuracy of the fluoroscopic examination.

Table 1 - Reliability of X-ray Fluoroscope in Detection of Bones in Frozen Fried Fish Sticks

Number of Fish Sticks ^{1/} Examined	Number of Bones Detected by Manual-Visual Inspection	Number of Bones Detected by Fluoroscopic Inspection	Number of Bones Missed in Fluoroscopic Inspection	Accuracy by Fluoroscopic ^{2/} Inspection
3,301	130	128	2	<u>Percent</u> 98.5

^{1/} ALL STICKS WERE FIRST EXAMINED BY A FLUOROSCOPE THEN COOKED AND EXAMINED BY MANUAL-VISUAL INSPECTION.
^{2/} PERCENTAGE OF ACCURACY CALCULATED AS FOLLOWS:

$$100 - \frac{\left[\text{NUMBER OF BONES DETECTED BY MANUAL-VISUAL INSPECTION} \right] - \left[\text{NUMBER OF BONES DETECTED BY FLUOROSCOPIC INSPECTION} \right]}{\left[\text{NUMBER OF BONES DETECTED BY MANUAL-VISUAL INSPECTION} \right]} \times 100 = \text{PERCENT ACCURACY}$$

The results of this study (table 1) indicated that the X-ray fluoroscope, when operated under the conditions stated, will detect 98.5 percent of the bones present in frozen fried fish sticks.

CONCLUSION AND RECOMMENDATION

An accuracy of 98.5 percent in the detection of bones in frozen fried fish sticks was obtained using a diagnostic-type fluoroscopic X-ray unit.

The detection of bones in frozen fried fish sticks by fluoroscopic X-ray examination can be applied to routine quality-control. This method can also be used by the Federal Inspection Service for grading frozen fried fish sticks. Whether this method can be applied to continuous plant inspection has yet to be determined. Further tests should be conducted to determine the feasibility of detecting bones in frozen fishery products on a continuous inspection basis using industrial-type fluoroscopic X-ray units.

LITERATURE CITED

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