COMMERCIAL FISHERIES REVIEW

February 1957 Washington 25, D.C. Vol. 19, No. 2

SOME FACTORS AFFECTING "SAWDUST" LOSSES DURING THE CUTTING OF FISH STICKS

By F. J. Cocca*

ABSTRACT

Much fish is lost as "sawdust" in the cutting of fish sticks (a three-step operation). As the result of a study to reduce this loss by making the bandsaw blade more efficient, an "ideal" blade was designed. The loss of sawdust with this blade was significantly less than that with the blades that are regularly used. The data obtained in this study show the great importance of using a slicing operation rather than a sawing operation in the third step.

INTRODUCTION

Fish sticks are cut from frozen blocks of boneless and skinless fillets that have been compressed and frozen into a uniform rectangular shape. Although the sizes and shapes of the many fish blocks on the market vary considerably, the dimensions are such that, ordinarily, each properly-prepared block will produce a definite number of uniform sticks with a minumum amount of the block being lost as scrap. Even with perfect blocks, however, there is a considerable loss of "sawdust" when cutting the fish sticks. This loss ranges from 7 to 12 percent of the weight of the block.

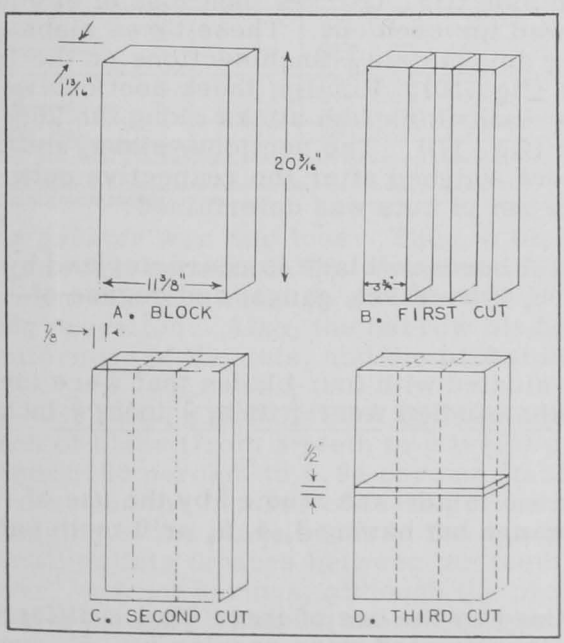

Fig. 1 - Steps in cutting fish sticks from fish blocks.

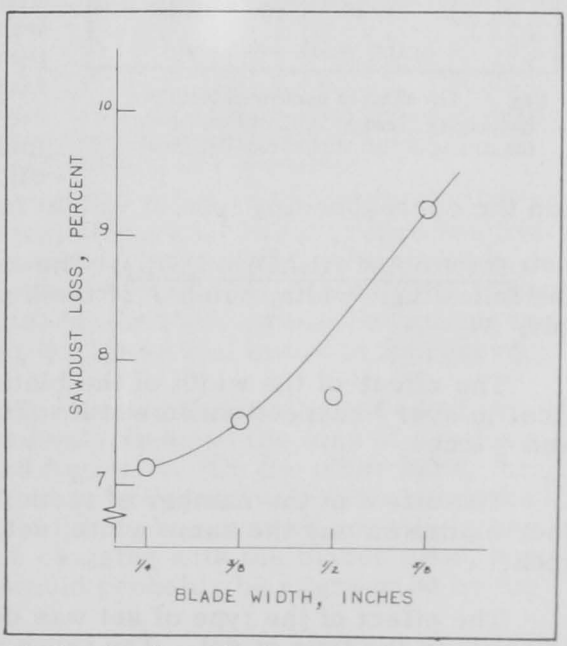

Fig. 2 - The effect of bandsaw widths on sawdust loss during the cutting of fish sticks from fish blocks.

Because the sawdust is not used in preparing fish sticks or for preparing other human food, it represents a considerable loss to the industry. The significance of this loss can be realized when the total importation of fish blocks is considered.

* Laboratory Aid, Fishery Technological Laboratory, Branch of Commercial Fisheries, U. S. Fish and Wildlife Service, East Boston, 28, Mass.

In 1955 a total of 48.2 million pounds of frozen fish blocks were imported into this country (domestic fish block production is not included in these figures). Assuming that sawing is the only method of cutting used and that the average loss of sawdust is 10 percent of the weight of the block, this loss would amount to 4.8 million pounds of fish fillets.

Fish sticks are cut from frozen fish-fillet blocks by two methods: (1) by the use of a group of bandsaws and (2) by the use of a combination of bandsaws and of guillotine cutting knives. The bandsaw blades that are used vary considerably in type and size.

Observations of commercial fish-stick cutting operations indicated that the characteristics of the bandsaw blade affected the amount of sawdust that was lost. A series of tests therefore was carried out at the Service's Fishery Technological Laboratory in East Boston to determine the effect of the type of blade on the loss of sawdust in the bandsaw cutting operations. The variables that were studied are the following: (1) width of blade, (2) number of teeth per inch, (3) type of set, (4) gauge (thickness), and (5) degree of set.

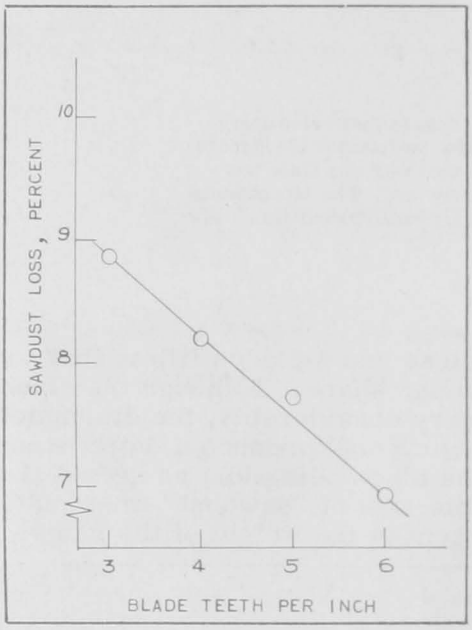

Fig. 3 - The effect of number of teeth per inch of saw blade on sawdust loss during the cutting of fish sticks from fish blocks.

EXPERIMENTAL PROCEDURE

CUTTING OF BLOCKS: The fish blocks used in this study were $20\frac{3}{16}$ inches in depth (fig. 1A). This block produced 216 whole fish sticks, each of which were $3\frac{3}{4}$ inches in length, $\frac{7}{8}$ inch in width, and $\frac{1}{2}$ inch in thickness.

In the production of the fish sticks, the blocks first were cut into three $3\frac{3}{4}$-inch sections on the $11\frac{3}{8}$-inch side (fig. 1B)--$\frac{1}{16}$ inch loss of sawdust was allowed for each cut. These three slabs then were cut into six $\frac{7}{8}$-inch sections on the $1\frac{13}{16}$-inch side (fig. 1C). Finally, these sections were cut into $\frac{1}{2}$-inch-thick fish sticks along the $20\frac{3}{16}$-inch side (fig. 1D). The sections, slabs, and fish sticks were weighed after the respective cuts and the corresponding loss of weight for each set of cuts was determined.

BANDSAW BLADES USED: The individual bandsaw blade is characterized by the following: width, number of teeth per inch, type of set, gauge, and degree of set.

The effect of the width of the blade was studied with four blades that were identical in every respect but in width. The widths studied were $\frac{1}{4}$ inch, $\frac{3}{8}$ inch, $\frac{1}{2}$ inch, and $\frac{5}{8}$ inch.

The effect of the number of teeth per inch of blade was studied by the use of four blades having the same width, set, and gauge but having 3, 4, 5, or 6 teeth per inch.

The effect of the type of set was determined by the use of three blades differing only in the type of set. The types of set investigated were regular set, [1/] every-tooth set, [2/] and no set. In all of the experiments in which the teeth were set, the

1/ A repeating series in which one tooth is bent to the right of the body of the blade, the next tooth is bent to the left, and the third tooth is not bent (fig. 6).

2/ A repeating series in which one tooth is bent to the right and the next is bent to the left.

bandsaws were set 0.007 inch on each side, making a total degree of set of 0.014 inch and, because the blades had a gauge of 0.025 inch, an "effective thickness" 3/ of 0.039 inch.

The effect of the gauge of the blade on the loss of sawdust was studied by the use of four bandsaw blades that differed only in thickness. The gauges studied were 0.020 inch, 0.025 inch, 0.028 inch, and 0.032 inch.

The effect of the degree of set was studied by the use of three bandsaw blades differing only in the degree of set. All of the blades had the same gauge of 0.025 inch. The blades had a total set of 0.006, 0.014, or 0.022 inch and thus an "effective thickness" of 0.031, 0.039, or 0.047 inch, respectively.

Because the bandsaw is a sensitive tool, the manufacturer had difficulty in making the bandsaw blades to the exact specifications. Consequently, unavoidable variation introduced a slight uncertainty in the results. Nevertheless, the data give a good indication of the general variations in the loss of sawdust that may be expected with each kind of blade.

DISCUSSION OF RESULTS

EFFECT OF WIDTH: The effect of the width of the blade in causing loss of sawdust is shown in table 1 and figure 2. Within the range used, the wider the blade

Table 1 - Effect of the Characteristics of the Bandsaw Blade on the Loss of Sawdust During the Cutting of Fish Sticks From Fillet Blocks

Blade Characteristics Under Test	Description of the Blades					Original Weight of Block	Cutting Losses 1/							
	Width	Teeth Per Inch	Type of Set 2/	Gauge	Effective Thickness 3/		First Cut		Second Cut		Third Cut		Total	
	Inch			Inch	Inch	Grams	Grams	Percent 4/	Grams	Percent 4/	Grams	Percent 4/	Grams	Percent 4/
Effect of width of blade	1/4	5	ETS	0.025	0.039	6232	31	0.50	107	1.72	307	4.92	445	7.14
	3/8	5	ETS	0.025	0.039	5932	32	0.54	112	1.89	302	5.10	446	7.52
	1/2	5	ETS	0.025	0.039	6096	33	0.54	117	1.92	321	5.27	471	7.73
	5/8	5	ETS	0.025	0.039	5822	38	0.66	144	2.48	358	6.14	540	9.28
Effect of number of teeth per inch of blade	1/2	3	ETS	0.025	0.039	6048	37	0.61	137	2.27	362	5.98	536	8.86
	1/2	4	ETS	0.025	0.039	5980	34	0.57	127	2.13	329	5.51	490	8.20
	1/2	5	ETS	0.025	0.039	6096	33	0.54	117	1.92	321	5.27	471	7.73
	1/2	6	ETS	0.025	0.039	5894	27	0.45	106	1.80	276	4.68	409	6.94
Effect of type of set 5/	1/2	4	ETS	0.025	0.039	5980	34	0.57	127	2.13	329	5.51	490	8.20
	1/2	4	REG	0.025	0.039	5979	35	0.58	134	2.25	323	5.40	492	8.23
Effect of gauge of blade	1/2	4	ETS	0.020	0.034	5858	32	0.55	112	1.91	283	4.85	427	7.30
	1/2	4	ETS	0.025	0.039	5980	34	0.57	127	2.13	329	5.51	490	8.20
	1/2	4	ETS	0.028	0.042	5881	36	0.62	141	2.39	347	5.89	524	8.91
	1/2	4	ETS	0.032	0.046	5866	42	0.72	155	2.64	389	6.62	586	9.98
Effect of degree of blade	1/2	4	ETS	0.025	0.031	5982	32	0.53	120	2.01	316	5.28	468	7.82
	1/2	4	ETS	0.025	0.039	5980	34	0.57	127	2.13	329	5.51	490	8.20
	1/2	4	ETS	0.025	0.047	6034	34	0.56	136	2.28	354	5.87	524	8.69
"Ideal" blade	3/8	6	REG	0.020	0.034	5948	26	0.44	103	1.74	254	4.27	383	6.44

1/ Averages of three replicate samples.
2/ ETS: Every tooth set; A repeating series in which one tooth is bent to the right and the next is bent to the left.
REG: Regular set; A repeating series in which one tooth is bent to the right, the next tooth is bent to the left and the third tooth is not bent.
3/ Effective thickness is the thickness of the blade plus the total set.
4/ Expressed as percent of the original block.
5/ A blade with no set was tested, but it proved completely unsatisfactory.

the greater was this loss. Thus, a blade of minimum width would reduce the loss of sawdust substantially. A practical limit, however, is placed on the possible decrease of width because a blade that is too narrow reduces the efficiency of the cutting operation. Also, the narrow blade ($\frac{1}{4}$ inch) bends under pressure causing nonuniformity of the cuts, and the probability that the blade will break is increased.

EFFECT OF NUMBER OF TEETH: An increase in the number of teeth per inch of blade (from 3 teeth to 6 teeth) progressively reduced the loss of sawdust from 8.86 percent to 6.94 percent (table 1 and figure 3). On the other hand, increases in the number of teeth per inch resulted in progressively increasing the clogging of the blade because the sawdust could not be removed efficiently by the small gullets (spaces between the teeth). The clogging with the blades used, however, was not serious, although the problem would probably be aggravated by the use of blades containing more teeth per inch.

EFFECT OF TYPE OF SET: The loss of sawdust that was incurred by a blade having a regular set was 8.23 percent, and the loss that was incurred by a blade

3/ "Effective thickness" is the thickness of the blade plus the total set.

having an every-tooth set was 8.20 percent. Theoretically, the loss of sawdust obtained from each blade should be the same because the gauge and "effective thickness" (a function of gauge and degree of set) on both blades was the same. In agreement with theory, the small difference (8.23 percent versus 8.20 percent) found in the experiment was not significant.

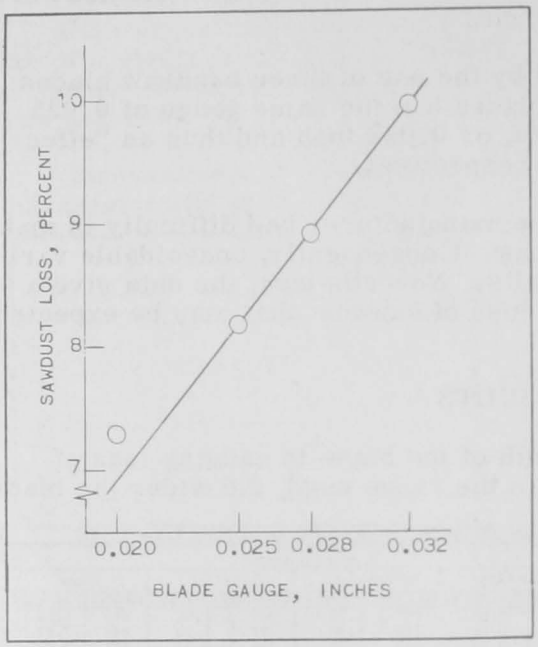

Fig. 4 - The effect of bandsaw gauge on sawdust loss during the cutting of fish sticks from fish blocks.

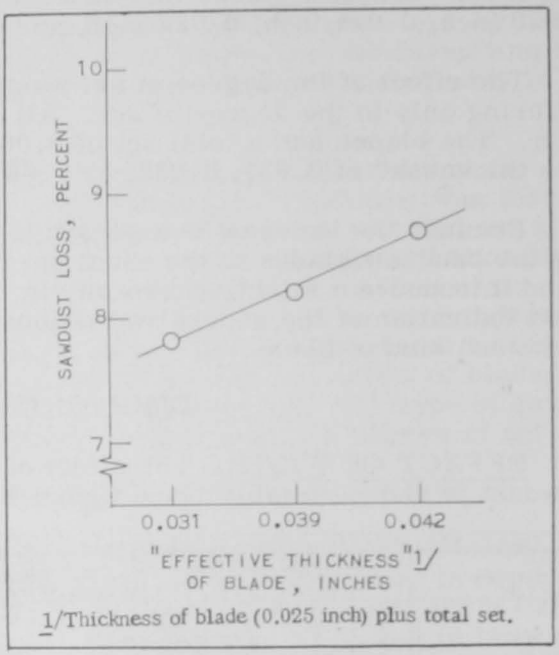

Fig. 5 - The effect of set of a bandsaw on dust during the cutting of fish sticks from fish blocks.

A bandsaw having no set was tested. The blade did not cut rapidly or satisfactorily. The sawdust formed became clogged between the blade and the surface of the meat; this clogging caused the blade to bend, resulting in a curved cut. A set in the blade is necessary, therefore, to prevent the accumulation of sawdust, to permit the blade to pass freely through the material being cut, and to prevent the cut from being curved.

EFFECT OF GAUGE OF BLADE: An increase in the thickness of the bandsaw blade from 0.020 inch to 0.032 inch caused a progressive increase of sawdust loss from 7.30 percent to 9.98 percent (table 1 and fig. 4). Using a blade of minimum thickness therefore would reduce the loss of sawdust.

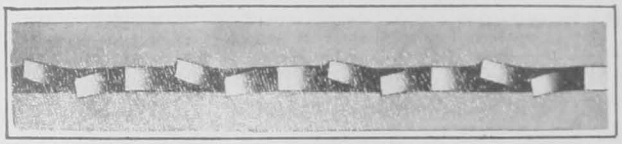

Fig. 6 - Regular set of bandsaw blade.

EFFECT OF DEGREE OF SET: An increase in total set (from 0.006 inch to 0.022 inch) caused a stepwise increase in the loss of sawdust from 7.82 percent to 8.69 percent (table 1 and fig. 5).

"IDEAL" SAW BLADE: After these factors had been considered, an "ideal" bandsaw blade was designed which was thought would decrease the loss of sawdust about as much as is possible. The blade that was chosen had the following characteristics: $\frac{3}{8}$ inch in width, 6 teeth per inch, regular set, 0.020-inch gauge, and 0.007-inch degree of set. The $\frac{3}{8}$-inch blade was chosen instead of a $\frac{1}{4}$-inch blade because the former held up much better under operating conditions than did the latter. The $\frac{3}{8}$-inch blade functioned about as well, however, as did a $\frac{1}{2}$-inch blade. A blade with 6 teeth per inch was selected despite the fact that a greater number

of teeth per inch tended to clog the blade with sawdust; however, given a regular set instead of an every-tooth set, the blade did remove the sawdust rapidly enough. Regular set was chosen because a blade with such a set cut more rapidly than did a blade with an every-tooth set. The 0.007-inch degree of set was selected instead of the 0.003-inch degree of set because it was believed that the latter did not have enough set to operate satisfactorily.

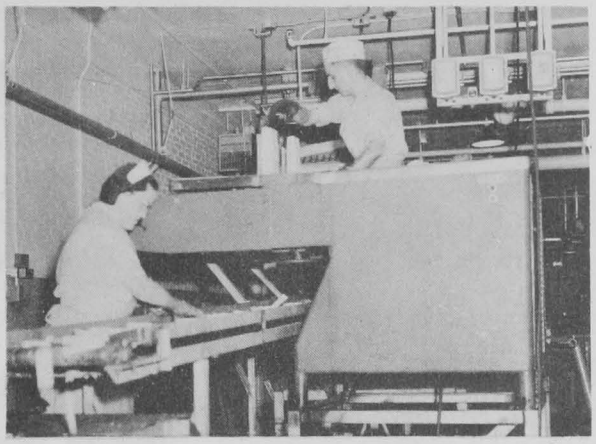

Fig. 7 - Frozen fish slabs fed into the guillotine cutter are sliced into individual fish sticks, which drop on to the conveyor belt for processing.

The 6.44-percent loss of sawdust incurred by the "ideal" blade (table 1) was 7.21 percent less than that incurred by the regularly-used blade having the least loss of sawdust and was 35.4 percent less than that incurred by the regularly-used blade having the most loss of sawdust.

EFFECT OF THE VARIOUS PHASES OF CUTTING: The relative importance of each cut, in terms of loss of fish for each of the various types of blades, may also be observed in table 1. The first cut (fig. 1B), which passed through a relatively small length-depth area of the block, in all cases caused a relatively small loss in weight (0.45 to 0.72 percent). The second cut (fig. 1C), which passed through the large length-width area, caused a noticeably greater loss in weight (1.72 to 2.64 percent). The third cut (fig. 1D), which passed through the relatively small-depth-width area, caused the greatest loss of all (4.68 to 6.62 percent) because of the large number of cuts made when each of the six slabs formed by the previous two cuts were sawed into thirty-six $\frac{1}{2}$-inch fish sticks (making 216 fish sticks in all). These data show the great importance of using a slicing or nonsawdust-forming cutting operation in the third step (fig. 7).

SUMMARY

Fish sticks are cut from frozen blocks of fillets in a three-step operation that results in the loss of 7 to 12 percent of the weight of the block as "sawdust." To help to minimize this loss, the Fishery Technological Laboratory at East Boston carried out a series of tests to determine the effect of the type of bandsaw blade on the loss of sawdust in the bandsaw cutting operations.

Increases in width, in thickness, and in degree of set of the bandsaw blades caused the amount of fish that was lost as sawdust to increase. An increase in the number of teeth per inch of blade caused the amount of fish that was lost as sawdust to decrease. The type of set--regular set or every-tooth set--had no effect on the amount of fish that was lost.

From these observations, an "ideal" bandsaw blade was designed to reduce the loss of sawdust to a minimum. The loss of sawdust incurred by this blade was 7.21 percent less than that with the regularly-used blade producing the least loss of sawdust and was 35.4 percent less than that with the regularly-used blade producing the most loss of sawdust.

In the study of the regularly-used bandsaw blades, it was found that about 0.6-percent sawdust was lost in the first step in the cutting operation, that about 2 percent was lost in the second step, and that about 6 percent was lost in the third step. These data show the great importance of using a slicing or nonsawdust-forming cutting operation in the third step.

LITERATURE CITED

Dassow, John A.; S. R. Pottinger, and John Holston
1956. Refrigeration of Fish. Part 4 - Preparation, Freezing, and Cold Storage of Fish, Shellfish, and Precooked Fishery Products. U. S. Fish and Wildlife Service, Washington 25, D. C. Fishery Leaflet 430, pp. 75-120.