# Feasibility Study for Machine Processing Croakers into Fillets and for Forming the Fillets into Larger Portions.

A Fishery Resource Grants Sponsored Project
Virginia Sea Grant

Done in conjunction with Wanchese Fish Company
Hampton, VA

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September, 2001

## SUMMARY

The purpose of this project was to discover ways to economically process croakers into forms the market would more readily accept. Several manufacturing companies' processing machines were investigated. Two manufacturing companies' processing machines were brought to Hampton for testing. No company makes machinery specifically designed to process croaker. Small croaker fillets were also bound into larger fillets successfully. Processing machines were identified that will work and were purchased. The machinery is currently being successfully used to produce croaker fillets for both the frozen and fresh market. However, the machines are still being modified to improve the quality of the cut. While croaker fillets were successfully bound into larger pieces, further work needs to be done before that process is commercially viable. Only $869.90 of the allocated $19,500 was spent on this project.

## PROJECT RESULTS

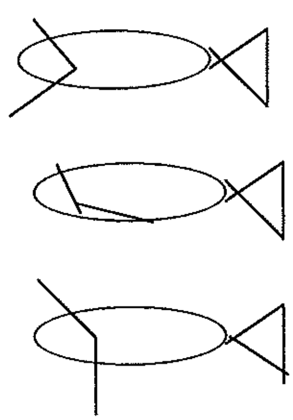
### EQUIPMENT REVIEW

Equipment, from Baader North American Corp. and Pisces Industries, to head and fillet croaker was examined.

In March of 2000 a trip was taken to the Pisces factory in Gladstone on the Upper Peninsula of Michigan. Large and small croakers, medium trout and medium blue fish were taken for testing at the Pisces plant.

The fish were first headed on the Pisces HSV-25. This heading machine has two spinning knives that could be adjusted for maximum yield depending on the type of fish in question. The holding mechanism carries the fish head into the mechanism in such a way that a slight concave cut is made in back of the gill plate, thus slightly increasing the yield. The spinning blades that take the head off can be set at different angles in order to maximize yield.

Examples of how the blades can be set are as follows:



The heading machine appeared simple to operate with appropriate safety guards and lockout devices. When guards or covers were lifted power to the operating parts of the machine was cut off. The safety lockout could not be easily overcome with the lid up. To keep the machines adjusted didn't appear to require a high degree of mechanical skill and it was easy to clean. Its disadvantage was that carrier mechanisms had to be accurately hand loaded. It was important to get the fish placed in the mechanism properly; otherwise yield was lower than necessary. Fish coming out of the header also had to be picked up and placed by hand into the filleting machine.

The Pisces filleting machine was the FR-200. The machine produced smooth cuts that were equal to or better than hand cut in appearance. Adjusted correctly, the machine slices up over the belly bones leaving boneless belly flap. The few pin bones that run along the mid-line of the croaker are not removed. Getting the fish body oriented correctly as they are loaded into the belt is important. Incorrect orientation results in fish getting filleted on the wrong side of the backbone. However, correct orientation was fairly easy to do.

This machine was also easy to adjust and maintain. A person of ordinary mechanical skills should be able to keep it running.

Matt Wastell, a Pisces vice president, said motor belts could be purchased in auto parts stores and most of the other parts that wear out could be purchased at Graingers. The main belt which transported the fish was a custom made belt. However, it was heavy and looked like it would last a long time.

Yields on the tested fish were as follows:

- Small Croakers 32.5%
- Large Croakers 33%
- Trout 57%

Wastell said the machines were capable of handling 60 fish per minute but in a production environment that level of throughput could not be maintained.

He said some companies could process only about 40 fish per minute, but good operators could do 50 fish per minute. Using Wastell's average figures, the following pounds of fillet per hour could be obtained:

| Fish | Per Min | Wt. Of Fish | Yield | Fillet Wt/Hr |
|---|---|---|---|---|
| Sm Croaker | 40 | 0.5 | 0.33 | 396 |
| Lg Croaker | 40 | 1.0 | 0.325 | 780 |
| Med Trout | 40 | 1.5 | 0.57 | 2,052 |

The machines that were used for these tests were brand new and headed to a production facility in Greece. The two new machines were priced at a total of $81,235. The factory also reconditions used machines and sells them. Pictures of the Pisces machines and the croakers cut at the factory follow in Figure 1.

Subsequent to the trip to the Pisces factory, 200 pounds of small croaker were sent to a red perch processing facility in Canada. The facility there used a Baader 153 machine. A Baader factory representative, Holger Jordan, supervised the croaker filleting there. The principle investigator did not go to Canada and no sea grant funds were spent on this part of the project. Jordan sent videotape showing the Baader 153 cutting the Virginia croaker. Pictures of the croaker fillets are in Figure 2.

Jordan froze some of the fillets and shipped them back to Virginia. The fillets were well cut and smooth. Jordan had the fish cut three ways. Some with the belly nape entirely on, some with the belly bone sliced off and some with the belly entirely removed. As is characteristic with Baader machines, the 153 could apparently be adjusted to cut the fillet almost any way you want. The cost of this flexibility, however, is that it takes a skilled mechanic to keep the machine in adjustment.

Yields, as reported from Jordan, were as follows:

| Fish | Per Min | Wt. Of Fish | Yield | Fillet Wt/Hr |
|---|---|---|---|---|
| Belly on | 70 | 0.64 | 30.00% | 806 |
| Belly trimmed | 70 | 0.59 | 29.05% | 720 |
| Belly off | 70 | 0.57 | 26.22% | 630 |

Like the Pisces, the Baader also had to be hand loaded but the carrier mechanism was simpler than with the Pisces machine. It was extremely easy to get the fish oriented correctly. However, the 153 cut the head with a single knife, which perhaps explains why the yields were slightly lower than with competing Pisces machines.

The 153 would require at least one less person to operate than the Pisces machine. With the 153 once croaker is loaded into the machine, the fillets come out the other end. With the Pisces machines it takes an additional person to transfer the fish from the header to the filleting machine.

The 153 appears to be a more sophisticated machine capable of doing more things with less labor than the Pisces machines. However, to keep it adjusted appears to require a higher degree of skill and new Pisces machines are only about one-third the cost of a factory reconditioned Baader 153. Baader priced the reconditioned machine at $250,000. As reported earlier, the combined price of two Pisces machines was $81,235.

Because of the cost issue Wanchese Fish rejected the 153. Sam Daniels, the manager of Wanchese's Hampton operations, located a used Baader fillet machine, which was not factory reconditioned. The machine was brought to the Hampton facility. The west coast firm selling the machine provided a technician to make it run. However, the technician was unable to adjust the machine to produce fillets judged to be of adequate quality. The machine was sent back. The West Coast company had no connection with Baader. The frozen croaker fillets that Baader itself produced were of high quality.

## INITIAL PRODUCT RESULTS

Subsequently Daniels made the decision to bring Pisces reconditioned machines to Hampton for trial. An older FR-200, which fillets the fish, was brought in, as was an HS-20 header as opposed to the HSV-25 that the principle investigator had seen at the Pisces factory. The HS-20 had just one header blade like the Baader 153. This meant it could do only a straight cut and not a v-cut like earlier diagrams showed the HSV-25 able to do. Management felt better yield could be obtained with the V-cut so the HS-20 was sent back and an additional cutter head was added to it. The machines have now been purchased.

Fillets from these machines are now being sold in both the fresh and frozen markets. Management is not totally satisfied with the machine performance. Another set of circular blades was added to the FR-200 to trim the belly of the fillet. If this will improve performance has not yet been determined.

The FR-200 and HS-20 with a second blade are being used nearly every day to cut up to 1,300 pounds of fillet a day. Sales, while good, have not been spectacular. Apparently one of the factors limiting sales is the pinbones, which are still in the fillet.

In practice, so far, the machines are producing fillets at far below their theoretical ability. At best they are averaging about 200 pounds of fillet an hour, but that number is improving as workers gain experience. The machines have a theoretical capability of 9,500 pounds of fillet per day if one pound fish are being used at a 33% yield. Probably a realistic target rate of 3,000 pounds could be set. To do that a number of bottlenecks in the current system would have to be removed.

Workers were told to put fish through the FR-200, rapidly for one minute. With those instructions, 32 fish were filleted in one minute. If that 32 fish rate could be maintained for an eight-hour production schedule, then about 5,000 pounds per day could be produced. Four of the 32 fish were miscut because they were not loaded into the belt correctly.

Yields are improving as workers gain experience. Yields have moved from 27 per cent to as high 34 per cent when they are cutting firm, high quality fish.

The filleting machine works best on higher quality fish. Soft fish lead to miscuts and poor belly cuts. Right now only gill net fish are being utilized. Whether trawl caught fish could be utilized in this program hasn't been determined.

Machine costs per pound of fillet, of course, are entirely dependent on production assumptions and opportunity cost of capital, etc. Using assumptions of 2,000 pounds per day for 150 days a year and capital costs of $81,250 produce machine production costs of

$.04. The spreadsheet used to develop these numbers is in Figure 3. Assumptions, of course, can be varied. Generally accepted time value of money concepts are incorporated into the spreadsheet.

Machine Costs for Croaker Fillet.

| MACHINE COSTS | |
|---|---|
| Total Capital Costs | $81,250 |
| Useful Life (Years) | 10 |
| Opportunity Cost of Capital | 0.08 |
| Salvage Value | $10,000 |
| Annual Maintenance | $1,000 |
| Days used a year | 150 |
| **Daily Cost** | $80.98 |
| **Machine Cost Per Pound Fillet** | $0.040 |
| | |
| **Pounds Fillet Per Day** | 2000 |

This table does not adequately capture the start-up costs of a totally new operation. The costs of scaling machines and other ancillary equipment are not included in the machine costs, as the assumption is that some of the equipment for the operation is already owned.

As one would suspect, machine costs per pound are most sensitive to the number of days the machine is worked and the number of pounds put through it. Both relationships are linear. For instance, if the machine is used for only 100 days machine costs per pound rise to $0.061, but at 250 days per year costs drop to $0.024 cents per pound, when fillet production is being held constant at 2,000 lbs. Similarly doubling the throughput on fillets halves the cost per pound. Maintenance costs are assumed to be unvarying.

Fish costs and labor costs will vary from fish house to fish house. But regardless, machine costs will be the least important of the three, assuming an adequate time period for amortization. Machine costs are not nearly so dear as labor costs. However, machines demand tribute even if the croaker aren't around. Labor, on the other hand, can be shed if the croaker dry up. Thus, anyone making such investment, needs to estimate how long the current plentitude of croakers will last.

The next stage of the project, forming bigger fillets out of smaller fillets has not been commercialized yet.

Robert Fisher and the principal investigator did demonstrate conclusively that the croaker fillets could be bound together using Fibrimex, a plasma binder developed in the Netherlands and currently being produced in Canada (R.A. Fisher).* A number of seafood companies are using this binder. It has been used in the red meat industry since 1991.

They were less successful using ACTIVA, a sodium caseinate-transglutaminase binder. However, this binder is used successfully in the seafood industry. Both investigators feel

ACTIVA can be made to bind croaker fillets successfully with a little more work.

On November 1, 2000, Robert Fisher coated two sets of croaker fillets with two concentrations of Fibrimex. The first concentration was at one pound of Fibrimex to 20 pounds of fish, the second was at a 1:15 concentration. Fillets were also coated with ACTIVA.

These binders were applied with a paintbrush to the fillets. The fillets were then laid together. Both skin on and skinless fillets were formed together. Since we had no compression forms in the shape of a fillet, we free formed them. Various configurations were tried. Pictures of the various forms tried are enclosed.

The painted fillets were then placed in refrigeration and allowed to set-up overnight. The next morning the fillets were packaged for freezing. After freezing they were placed in a storage freezer for two months. At the end of December 2000 all the fillets were slacked out to see how well they stayed together.

The fillets bound with both concentrations of Fibrimex adhered to each other well. At both concentrations the raw croaker flesh actually tore rather than separating smoothly. (See pictures). The adhesion of bound flesh edges was actually stronger than the internal adhesion of the croaker flesh. Shear tests were not done on the fillets. Subjectively it appeared that the 6.3% (1:15) solution bound only very little better than the 4.8%(1:20) solution. Since adhesion was strong with both concentrations, it would appear that the next step would be to try even lower concentrations.

The ACTIVA bound fillets did not adhere at all. When the slacked small fillets within the larger formed fillet were pulled upon they separated smoothly along the cut edges of the flesh. (See pictures). Possibly the ACTIVA was not applied correctly or maybe it was oxidized and had lost its binding capacity.

The Fibrimex fillets were cooked on December 28. Some of the fillets were dipped in an egg wash and coated with House Autrey breader and deep-fried. Other fillets were broiled with a lemon/butter reduction. A very ad hoc fish-house taste panel decided the both the fried and broiled fillets tasted good. Surprisingly they gave a slight nod to the broiled fillets saying they tasted slightly less "ticky." Croaker, depending on what they are feeding on, sometimes have a slight iodine taste. More research work will have to be done in order to make the binding of fillets commercially successful. Molds will need to be developed to better form the fillets. But it is clear that binding can be successfully done. Further work also needs to be done on breading of these fillets to see what kind of value added products can be produced.

Before further binding tests and breading trials could be done, the principal investigator left the employ of the Hampton company. Under those circumstances, it was decided to terminate further value-added demonstration research and write a final report .

*(R.A.. Fisher, <u>Seafood Restructuring Using Cold Set-Binding Technology</u>, Virginia Sea Grant Marine Resource Advisory No. 70.)