Recent Advances In Shrimp Technology

JOHN A. HOLSTON
Bureau of Commercial Fisheries, Washington, D. C.

Abstract

About 90 per cent of the breaded shrimp in the United States is produced under the continuous inspection of the Department of the Interior. Inspectors are stationed in 14 plants producing breaded shrimp. Although final inspection is made on the frozen product, the inspector must check on the quality of the incoming shrimp and other raw materials to insure the proper use of the Grade A label. The freshness of the shrimp is determined organoleptically at the present time. Our technologists are studying the chemical characteristics of shrimp spoilage with hopes of devising simple objective means of evaluating freshness. At present, the Nessler's test and the newly developed Picric Acid Turbidity Test appear promising.

Factors Affecting Yield of Meat From The Blue Crab [1]

C. F. DUNKER, D. H. B. ULMER, JR., AND G. W. WHARTON[2]

Summary

Steam-boiling crabs at 212°F. for 15 minutes, in contrast to steaming at 15 pounds per square inch (p.s.i.) (250°F.) for ten minutes, resulted in an increase of crabmeat, such that a monetary savings of over one dollar per barrel (100 lbs.) live crabs can be realized.

One hundred pounds of picked meat will consist of approximately 53 per cent regular white, 25 per cent of backfin lump, and 22 per cent of claw meat.

Chesapeake Bay crabs in Maryland showed highest yields of crabmeat in summer, followed in decreasing order by spring, fall and winter crabs.

When steaming crabs at 15 p.s.i. (250°F.), in general, a ten minute cook produced more picked meat than did either shorter or longer cooks.

Choptank River crabs, mainly male crabs, gave higher yield than did Chesapeake Bay female crabs.

Cooking crabs ten-fifteen minutes at 212°-227°F. resulted in maximum crabmeat yield; but with temperatures of 239°-250°F. maximum yield occurred at five-ten minutes, with marked reduction in yield at fifteen minutes.

Study made of two methods of post-cook handling: namely deback and refrigerate before picking versus whole crabs held at room temperature, showed a tendency for the former method to result in higher yields.

Introduction

If a processor is producing crabmeat of the highest quality, with good storage characteristics, he will surely be interested in any factors which might increase his yield. With this thought in mind, the following research results are pointed out. Yield of picked crabmeat is affected one way or another by such factors

[1]Contribution from the University of Maryland Seafood Processing Laboratory, Crisfield, Maryland. This is a revised version of the paper read at the Institute and was presented at the Fourth Atlantic Fisheries Technological Conference, Halifax, N.S., March 7, 1960.
[2]C. F. Dunker, Director, and D. H. B. Ulmer, Jr., Research Associate of the University of Maryland Seafood Processing Laboratory. G. W. Wharton, Professor and Head, Department of Zoology, University of Maryland.

as: method of cooking, time of year, length of cook, source of crabs, temperature of cook, and post-cook handling methods.

Method of Cooking

A series of twelve plant runs were carried out, comparing steam-boiling against pressure-steaming. In steam-boiling, high pressure steam at 50-60 p.s.i. entered the bottom of an open retort through a spreader, causing the water in the retort to boil turbulently at 212°F. While the crabs were being steam-boiled for fifteen minutes, the water was continuously recharged with sterile water from the steam condensate, and simultaneously the foam and detrita, caused by boiling the crabs, were carried away by overflowing the retort lip into a collar and drain, attached to the top rim of the retort. Pressure-steaming the crabs was carried out by placing the crabs into an empty retort and cooking a 15 p.s.i. (250°F.) for ten minutes. Condensed steam was removed continuously by bleeding through the bottom of the retort.

TABLE 1

METHOD OF COOKING CRABS IN RELATION TO YIELD

Test	*Method*	*Live crabs* (lbs.)	*Yield (lbs. per batch)* Reg.	Lump	Claw	Total	*Yield* (%)
1	A	402	36.8	22.0	13.4	72.2	18.0
	B	402	40.0	23.0	17.0	80.0	19.9
2	A	467	40.0	21.8	16.6	78.4	16.8
	B	467	46.0	21.5	19.8	87.3	18.7
3	A	425	38.9	22.0	15.8	76.7	18.0
	B	425	43.8	17.7	17.6	79.1	18.7
4	A	407	35.9	21.5	15.3	72.7	17.9
	B	407	38.4	19.1	17.9	75.4	18.5
5	A	356	32.5	17.0	13.4	62.9	17.7
	B	356	36.7	17.4	17.5	71.6	20.1
6	A	362	32.0	13.4	8.2	53.6	14.8
	B	362	34.4	10.3	8.2	52.9	14.6
7	A	296	27.6	13.3	11.0	51.9	17.5
	B	296	28.8	13.3	13.1	55.2	18.6
8	A	439	28.8	14.0	10.5	53.3	12.1
	B	438	34.0	11.0	11.9	56.9	13.0
9	A	249	26.4	10.0	8.0	44.4	17.8
	B	249	28.1	9.5	10.6	48.2	19.4
10	A	380	34.1	16.4	12.9	63.4	16.7
	B	380	37.6	14.5	15.0	67.1	17.7
11	A	325	32.3	18.5	14.3	65.1	20.0
	B	325	33.5	16.5	16.1	66.1	20.3
12	A	300	27.3	13.5	9.9	50.7	16.9
	B	300	31.4	14.8	13.5	59.7	19.9
Total	A	4408	393	203	150	745	
	B	4407	433	189	178	799	
Average (12)			8.9%	4.6%	3.4%		16.9
			9.8%	4.3%	4.0%		18.2
B over A (%): lbs. per 100 lbs. crabs							1.3
lbs. per 100 lbs. picked meat							7.7

A - steamed 10 minutes at 15 p.s.i. (250°F.)
B - steam-boiled at 212°F. 15 minutes in tapwater

Results are summarized in Table 1. Pressure-steaming resulted in a recovery of 16.9 per cent total meat, based on 100 pounds of live crabs. Steam-boiling resulted in 18.2 per cent pounds total meat, which gave steam-boiling an advantage of 1.3 pounds of meat per 100 pounds of live crabs. Steam-boiling resulted in 7.7 pounds more meat per 100 pounds of picked meat than did pressure-steaming, an advantage which results in a monetary saving of about $1.25 per 100 pounds of live crabs.

Pilot plant tests were made, comparing the yield from forty batches of crabs steam-boiled at 212°F. for ten minutes, with forty batches of crabs pressure-boiled for ten minutes at 250°F. (15 p.s.i.). Each batch consisted of 100 pounds of crabs.

The results as shown in Table 2, indicate that the yield of crabmeat from the steam-boiled crabs was 17.6 pounds per 100 pounds of live crabs versus 15.9 pounds for pressure-steaming. The advantage for steam-boiling over steaming was 1.7 pounds of meat per 100 pounds of crabs. This would result in an extra monetary advantage of almost $1.50 per 100 pounds (barrel) of live crabs.

TABLE 2

YIELD, IN RELATION TO METHOD OF COOKING

	(%) lbs. crabmeat per 100 lbs. crabs	
	Range	*Average (40)*
Steam-boiled at 212°F.	15.5-19.3	17.6
Steamed at 250°F.	14.2-17.6	15.9

Yield of Various Types of Meat

Whether steam-boiling crabs at 212°F., or steaming at 250°F., the percentage of the various types of meat is similar. One hundred pounds of picked meat will consist of approximately 53 per cent regular white, 25 per cent of backfin lump, and 22 per cent claw meat. Table 3 shows the percentage yields of various types of meat.

TABLE 3

PER CENT DIFFERENT TYPES OF MEAT

	total	*regular*	*lump*	*claw*
Steam-boiled	100	53	24	23
Pressure-steamed	100	52	27	21
Average of 24 cooks	100	53	25	22

Seasonal Yield of Crabmeat

Table 4 shows the effect of seasons on yield (Littleford 1957). All of the crabs were obtained from the same source. Highest yields were during summer, followed by spring, fall and winter. Differences are not significant between summer and spring crabs, but are significantly lower during fall and winter.

The crabs were obtained at different times of the year and grouped into seasonal categories as follows: winter crabs, dredge crabs obtained from February 2 through March 15; spring crabs, May 9 through June 15; summer crabs, August 6 through September 13; and fall crabs, October 8 through November

5. Thirty cooks were made in each group, ten each at five, ten and fifteen minute cooking time at 250°F.

TABLE 4
SEASONAL YIELD OF CRABMEAT

Season	*lbs. meat/100 lbs. crabs**
Winter	14.9
Spring	16.5
Summer	16.9
Fall	15.8

*Average of ten cooks, at 250°F. for 10 minutes

Effect of Length of Cook

Crabs were steamed at 250°F. (15 p.s.i.): for five, ten, and fifteen minutes in one set of tests, Table 5; and for eight, twelve, and twenty minutes in another series of tests as shown in Table 6. Optimum length of time for steaming crabs at 250°F., seems to be from eight-ten minutes. Shorter or longer cooking time resulted in lower yields. Apparently five minutes is too short to allow proper weakening of the bond between the muscles and the skeleton, and as a result the crabs are undercooked and difficult to pick. Crabs that are overcooked, cooked too long, have meat that is dried out and also difficult to pick.

TABLE 5
EFFECT OF LENGTH OF COOK AT 250°F. ON YIELD

Sample	*Duration of Cook*		
	5 mins.	*10 mins.*	*15 mins.*
A	14.4*	14.9	13.5
B	15.9	16.5	14.7
C	14.7	16.9	14.5
D	15.0	15.8	14.3
Average of 40 cooks	15.0	16.0	14.2

*All figures represent: lbs. crabmeat/100 lbs. crabs

TABLE 6
EFFECT OF LENGTH OF COOK AT 250°F. ON YIELD

Sample	*Duration of Cook*		
	8 mins.	*12 mins.*	*20 mins.*
E	15.0*	13.5	13.2
F	15.9	15.1	14.6
Average of 24 cooks	15.5	14.3	13.9

*All figures represent: lbs. meat/100 lbs. crabs

Comparison of Crabs from two Locations

During the summer of 1957, female crabs captured in crab pots from Chesapeake Bay near Crisfield were compared with male crabs caught on trot

lines in the Choptank River. The crabs were cooked at 15 p.s.i. (250°F.) for eight, twelve and twenty minutes. Thirty-six cooks were made, (twelve for each cook time), on each set of crabs from the two different sources. (Table 7).

TABLE 7

PER CENT YIELD PER 100 LBS. LIVE CRABS

Area	*Cooking Time in Minutes at 250°F.* 8 min.	12 min.	20 min.	*Mean Yield*
Chesapeake Bay	15.0	13.5	13.2	13.9
Choptank River	15.9	15.1	14.6	15.2

The difference in mean yield of 1.3 per cent between crabs from the two sources is statistically significant. Despite this difference, the relative effect of cooking time on yield for each set of crabs was similar; the eight minute cooking time giving a significantly higher yield than the twenty minute. This demonstrates that differences in cooking yield occur between crabs from different localities. However, the relative effects of yield, of modifications in cooking time, are similar for both sets of crabs.

On the basis of the data on crabs obtained during different seasons of the year, and crabs obtained from different localities, it is concluded that although yields vary from place to place and season to season, cooking modifications affect all of the crabs in the same way. Studies on the effects of various cooking methods in crabs from one area can be applied to crabs from other areas.

Effect of Cooking Temperature

A study of the effect of different cooking temperatures on yield was undertaken, using tapwater at 212°F., 3 per cent brine at 213°F., 227°F., 239°F. and 250°F. (Table 8). The crabs boiled at 212°F. in tapwater showed significantly higher yields of picked meat than did the other four methods of cooking.

TABLE 8

YIELD, AS AFFECTED BY TEMPERATURE OF COOK

Treatment	*lbs. meat/100 lbs. crabs*
212°F., tapwater	14.9
213°F., brine 3%	14.3
227°F., 5 p.s.i.	14.1
239°F., 10 p.s.i.	13.6
250°F., 15 p.s.i.	13.4

Average of 30 cooks, each treatment

Table 9 shows the temperature-time relationship in crab cooking. Each temperature and treatment approaches an optimum time period. At lower temperatures 212°-227°F. cooking time, as long as fifteen minutes, does not critically affect yield. Brine-cooking seems to be the exception, since fifteen minute cooks reduced yield markedly over ten minute cooks. An explanation possibly is that sodium chloride leaching of soluble proteins may have occurred. At higher temperatures 239-250°F., ten minutes seems near maximum time limit over which time drastic yield losses occur.

TABLE 9

PER CENT YIELD AS AFFECTED BY COOK TREATMENT

Time Min.	*Boiling*		*Steam Temperatures*		
	Water	*Brine*	*227°F. (5 p.s.i.)*	*239°F. (10 p.s.i.)*	*250°F. (15 p.s.i.)*
5	14.2	13.8	13.9	14.3	14.7
10	15.2	15.0	14.1	13.9	14.4
15	15.3	14.2	14.4	12.7	11.2

Post-Cook Handling

Post-cook handling is important in yield, since, as the crab cools, it also dries and congeals. The meat in a freshly cooked warm crab is more likely to break into small flakes than is the meat in a cooled crab that has been allowed to dry out overnight. Table 10 summarizes an experiment involving 150 cooks, 30 for each method of post-cook handling. The following yields, expressed in per cent, were obtained: Deback refrigerate overnight 14.3, deback pick immediately 14.3, hold overnight at room temperature 14.1, refrigerate overnight 14.0, and pick immediately 13.7. When these results were studied it was found that the demonstrated differences were not statistically significant, that is, that the observed differences could have been caused by chance rather than by the differences that were being studied.

Table 11 shows the result of a pilot plant study, each treatment representing twenty cooks. Debacking and refrigerating crabs showed yields significantly higher, than did holding whole crabs overnight at room temperature before picking the meat.

TABLE 10

YIELD, IN RELATION TO POST-COOK HANDLING

Storage time and temperature	*lbs. meat/100 lbs. crabs*
Room temperature, overnight	14.1
Refrigerator, overnight	14.0
Pick immediately (hot)	13.7
Deback, pick immediately	14.3
Deback, refrigerate overnight	14.3

Average of 30 cooks, each treatment

TABLE 11

POST-COOK HANDLING IN RELATION TO YIELD

Treatment	*lbs. meat/100 lbs. crabs*
Steam-boiled: (10 mins. 212°F.)	
Whole crab, room temp., overnight	17.1
Debacked, refrigerated overnight	18.0
Pressure-steamed: (10 mins. 250°F.)	
Whole crab, room temp., overnight	15.3
Debacked, refrigerated overnight	16.5

Average of 20 cooks, each treatment

Conclusion

Maximum yield of crabmeat as shown by this investigation would likely be obtained under the following optimum conditions: Choptank River male crabs, obtained in summer, steam-boiled fifteen minutes at 212°F. in tapwater, debacked, chilled overnight at 38°F.

Acknowledgment

This research was carried out under the United States Bureau of Commercial Fisheries Contract #14-19-008-9323 (April 1957-October 1959).

REFERENCES

LITTLEFORD, ROBERT A.

1957. Retort cooking of blue crabs. Bull. No. 1, University of Maryland, Seafood Processing Laboratory, Crisfield, Maryland.

North Atlantic Tuna Explorations

JAMES L. SQUIRE, JR.

Bureau of Commercial Fisheries, Gloucester, Mass.

This presentation was a verbal commentary on a moving picture. This 16 mm. color film may be obtained on loan from the Bureau of Commercial Fisheries, State Fish Pier, Gloucester, Massachusetts.