OBSERVATIONS ON THE SPOILAGE OF CRABMEAT

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It is well known that fresh crabmeat is extremely perishable. Little has been published concerning its bacterial flora, and the casual agents of spoilage have not been identified. As a consequence, public health standards of bacterial quality are based on little exact data. In addition, information is lacking as to the numbers (ranges) of organisms that may be present in typically fresh meat, "flat" and "off" to foul meat, and its bearing on public health. Previous findings (2) indicated that typical fresh meat prevailed during the first 8 days storage. Crabmeat kept beyond that time lacked the strong "typical" flavor; a flatness became evident about that time though the meat was still quite edible. Patent spoilage occurred shortly after the "flat" stage, from 10 to 15 days after storage at 1-3°C.

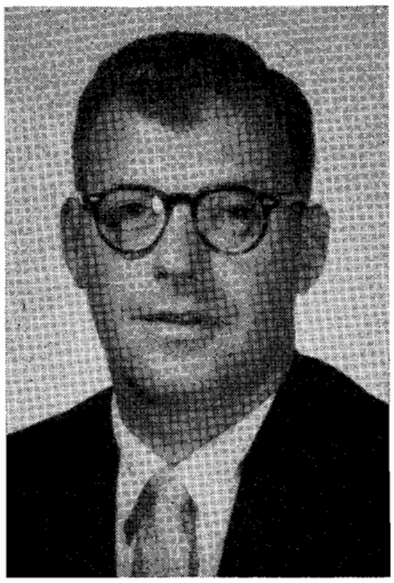
Fresh crabmeat is usually sold in three forms; "lump" (the muscles of the back fin or fifth pereiopod), "regular" (promotor muscles of the pereiopods), and "claw" (muscles of the chelipeds) which appears to be the order of desirability. Although official bacterial standards are the same for each of these types of crabmeat, little information is available about the rate and manner of their deterioration. In fact, crabmeat regulations do not mention types of meat. Tacit assumption considers all meats similar. The few published studies of crabmeat (1, 3, 4,) do not indicate the type of meat tested; one assumes that "regular" type meat, normally the most abundant, was used.

Another unproven but generally accepted notion is that the pH of a crabmeat extract or brei can indicate length of storage and progressive deterioration of the picked meat.

Past investigations in our laboratory indicated a distinguishable and repetitive pattern to crabmeat deterioration; moreover, each type of meat had a distinctly different initial pH, that became markedly irregular with increased storage. Because of this, a definite need for a comprehensive study of the pattern of crabmeat deterioration with each type of meat appeared evident. This would include pH measurements and the ranges of bacterial density in typical, *flat* and *off to foul meat*. The data reported here were obtained over a twelve month period and include only data obtained from a study of these two factors.

EXPERIMENTAL PROCEDURE

The meat for each test was obtained by retort steaming 200 pound-quantities of live Atlantic Blue Crabs (*Callinectes sapidus* Rathbun) for 10 minutes at 250°F (15psi). The crabs were allowed to cool overnight at (1-3°C. and then the meat was removed by professional pickers and packed in half-pound snap-lock crab cans.



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At intervals, cans were removed from storage (1-3°C) and the bacterial count, pH and organoleptic quality were determined. A 50-gm sample of meat from each can or a total of 50 gm from three cans (composite) was placed into a chilled food blendor containing 450 ml of sterile, chilled distilled water. After 3 minutes of blending, additional 10-fold serial dilutions were made. Triplicate 1-ml portions of the appropriate dilutions were plated in nutrient agar (BBL[1]) and incubated at 25°C (±5°C) for 72 hours. Bacterial plate counts were made at that time. Hydrogen-ion activity (pH) was determined electrometrically on samples of the original 1:10 dilution. Sensory evaluation was performed by the laboratory personnel.

[1]Baltimore Biological Laboratories, Baltimore, Md.

RESULTS AND DISCUSSION

The results of plate counts and pH determinations for "regular", "lump", and claw meat are contained in Tables 1, 2 and 3 respectively.[2]

In the case of all three meats there was little correlation between plate counts and pH. In January after the seventh day, regular meat showed sharply rising counts which were not accompanied by increases in pH, but rather, slight decreases. Similar patterns were obtained with lump and claw meats. The slowly rising or stationary counts during the first week of storage are of interest as they portray the growth pattern of psychrophilic-like organisms that grow well at refrigeration temperatures (1-3°C) after a period of adjustment. Unpublished data from our laboratory indicates these organisms to be directly related to spoilage.

The data for April was quite similar in that an erratic pattern of hydrogen-ion activity was obtained with the rising counts. All meat samples examined in June spoiled rapidly. The counts rose sharply in four days and continued upward at so rapid a rate that the samples were all putrid before the eighth day. The pH, on the other hand, either dropped or remained steady. This appeared to be a significant finding for it indicates the lack of correlation between progressing deterioration and pH.

In August the pattern of little correlation between pH and deterioration was again observed. Although a steady rise in pH was obtained in November, with regular meat, it did not occur with appreciable population increases; similarly with lump meat. Claw meat also showed an erratic pH pattern. The December samples likewise showed poor correlation between pH and deterioration.

Irregularity between pH and plate counts was the only constant characteristic indicated by the data obtained during the one year study. No pattern emerged that could be considered as a generalized or a representative version of pH changes with increased storage time. Furthermore, seasonal differences were not evident. During the year, the three types of meat exhibited wide ranges in pH, as seen in the Tables. The over-lapping is far too great to be of value in distinguishing types. In addition, the pH did not drop below 7.4 nor rise above 8.6 at any time. Thus, only 1.2 pH units represented the widest change in hydrogen-ion activity over about 20 days of storage during which time crabmeat progresses from a fresh to a foul, inedible condition. Table 4 indicates that changes in pH units within any type of meat are relatively

TABLE 1 — CHANGES IN BACTERIAL COUNTS AND pH OF REGULAR TYPE CRABMEAT DURING STORAGE AT 1-3°C.

	Bacterial count (in millions) and pH after periods of storage indicated															
	Initial		2 days		5 days		7 days		11 days		13 dayc		15 days		18 days	
Month	pH	TPC[a]	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC
January	7.75	.023	7.8	.020	7.9	.086	7.9	.080	7.7	21.8[s]	7.7	150[s]			7.5	4620[s]
April	7.95	.013	7.95	.041	8.25	.10	8.25	1.22			7.9	41[s]				
June	8.0	.70			7.9	8.1[s]	7.9									
August	8.0	.012			8.05	.018			8.1	.022	8.2	.93[p]	8.15	6.2[s]		
November	7.3	.005			7.9	.010	8.0	0.25	8.15	4.0[f]						1200[s]
December	7.85	.004			7.8	.010	8.05	.022	7.95	.06			7.85	1.5[f]		

[s]spoiled; [f]flat; [p]off; [a]TPC=Total Plate Count

TABLE 2 — CHANGES IN BACTERIAL COUNTS AND pH OF LUMP TYPE CRABMEAT DURING STORAGE AT 1-3°C.

	Bacterial count (in millions) and pH after periods of storage indicated															
	Initial		2 days		5 days		7 days		11 days		13 dayc		15 days		18 days	
Month	pH	TPC[a]	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC
January	7.45	.01	7.5	.01	7.6	.01	7.61	.04	7.5	6.0[p]	7.5	60.[s]			7.45	227.[s]
April	7.95	.009	7.7	.027	7.75	.039	7.82	.43			7.9	220.[s]	7.5		7.7	1107.[s]
June	7.6	.142			7.6	1.65[s]	7.9[s]									
August	7.8	.008			7.85	.011			7.8	.052[f]	7.9	2.97[p]	7.8	12.2[s]		
November	7.55	.006			7.7	.011	7.8	.036	7.8	1.46[f]						
December	7.55	.007			7.5	.01	7.7	.019	7.25	.98[f]			7.5	6.5[s]		

[s]spoiled; [f]flat; [p]off; [a]TPC=Total Plate Count

[2]It should be borne in mind that the crabmeat was processed under laboratory conditions which may not prevail in commercial plants .

TABLE 3 - CHANGES IN BACTERIAL COUNTS AND pH OF CLAW TYPE CRABMEAT DURING STORAGE AT 1-3°C.

	Bacterial count (in millions) and pH after periods of storage indicated															
	Initial		2 days		5 days		7 days		11 days		13 days		15 days		18 days	
Month	pH	TPC[a]	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC	pH	TPC
January	8.25	.01	8.3	.035	8.35	.027	8.50	.044	8.5	3.5[p]	8.45	60.[s]			8.5	76.[s]
April	8.45	.02	8.45	.097	8.5	.12	8.6	.54			8.3	41.[s]				
June	8.55	1.0			7.75	8.2[s]	7.7[s]									
August	8.35	.009			8.35	.013			8.35	.02	8.5	.58[p]	8.35	2.3[s]		
November	8.2	.008			8.3	.008	8.25	.017	7.8	1.83[p]					7.8	15.[s]
December	8.2	.01			8.25	.015	8.3	.025	8.2	3.0[f]			7.85	17.[s]		

[s]spoiled; [f]flat; [p]off; [a]TPC=Total Plate Count

slight from the time of typical freshness to the outset of patently spoiled meat.

An interesting point with respect to the individual types was evident from the pH data in Tables 1, 2 and 3. On a yearly basis, lump meat had the lowest pH, averaging 7.65. Regular meat had the middle position with an average pH of 7.8; claw meat was regularly higher than the other two with an average of 8.3

The pH data reported here are contrary to the findings noted in the few published reports on this subject. Harris (3) and Tobin and McCleskey (4) observed that the pH of fresh crabmeat was about 7.2 to 7.4 while spoiled meat had a pH of 8.0 to 8.5. Alford, Tobin and McCleskey (4) agreed with these figures but noted that although there was an increase in pH with an increase in bacterial numbers, "The bacterial count could not be predicted from the pH determination". Recently Dr. Eichii Tanakawa (Japan) stated (5) that he, too, found pH measurements useless as an index of freshness. He used meat from the Kegani or hairy crab, *Erimacrus eisenbeckii.*

Meat with the typical strong crabmeat odor and flavor had counts ranging from approximately 6 thousand to one-million per gm. For the most part, however, the counts are well below one-hundred thousand per gm. Flat meat had counts from about one-hundred thousand to four million per gm. Meat entering the off to foul stage had counts from one-hundred thousand to one billion but more usually one million to ten million per gm. This might be taken into consideration by public health agencies charged with establishing tolerances for intra-state and inter-state shipments. There is little value in establishing a low maximum number in such a highly variable product.

TABLE 4 - DIFFERENCE IN pH UNITS BETWEEN INITIALLY FRESH MEAT AND SPOILED MEAT.

	TYPE OF MEAT		
Period	Regular	Lump	Claw
January	+.05	+.1	+ .20
April	− .05	0	− .15
June	− .1	0	− 1.0
August	+.15	0	0
November	+.85	+.25	− .4
December	0	0	− .35

The over-lapping figures with their wide ranges suggest that some special factors may be operative; the type of bacteria rather than absolute numbers may be of greater significance. Certain specific genera may actually be the cause of progressive deterioration while others may be merely ancillary.

Factors other than bacteria may play a role in spoilage; this is a fertile area for study, although the temperature and time used to steam live crabs suggests that enzymes would not be active. Heat protective action exerted by proteins, fats, and other celloids may afford considerable protection to the enzymes present.

Another finding of possible use to agencies charged with routine analysis were the large differences in total counts obtained by the twenty-five degree incubation temperature for 3 days. This procedure rather than the 35-37°C temperature for 48 hours now recommended by most state agencies, results in counts higher by 10 to 1000 times. The "official" methods are probably sufficient for the detection of pathogens but are of considerably less value for obtaining a complete picture of plant sanitation and general bacterial quality of crabmeat.

From the data obtained, it appears that little value can be placed on pH measurements as a guide to length of storage or progressing spoilage. It was also found that the three commercial types of crabmeat lump, regular, and claw have similar spoilage characteristics, and should be considered similar in terms of public health standards.

ACKNOWLEDGEMENT

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AMENDMENT TO SANITARY STANDARDS FOR PUMPS FOR MILK AND MILK PRODUCTS SERIAL 0202

Formulated by
International Association of Milk and Food Sanitarians
U. S. Public Health Service
The Dairy Industry Committee

The "Sanitary Standards For Pumps For Milk And Milk Products, Amended April 30, 1952", Serial 0201, is further amended by adding paragraph (3) to section "A. MATERIALS", adding paragraphs (8) and (9) to "B. CONSTRUCTION", and adding footnotes 1, 2, and 3.

A. MATERIAL

(3) Pump impellers or rotors may be made of, or covered with, rubber or rubber-like materials provided such materials are non-toxic,[1] relatively non-absorbent,[2] relatively resistant to fat, resistant to normal cleaning and bactericidal solutions, and readily cleanable. Rubber or rubber-like materials used for pump impellers or rotors shall be of such composition as to retain their surface and conformation characteristics under conditions encountered in normal use and cleaning operations.

B. CONSTRUCTION

(8) The rubber or rubber-like coating of pump impellers or rotors shall be bonded in such manner that the bond is continuous and mechanically sound, and so that in normal service the rubber or rubber-like material does not separate from the base metal. The final bond shall conform in all respects to the criteria established in paragraph A(3).

(9) The surface of rubber or rubber-like covering of pump impellers or rotors shall be equal in cleanability to stainless steel with 120 grit finish properly applied.[3]

[1]Materials determined to be non-toxic under conditions of use, in accordance with procedures used by the Food and Drug Administration, may be considered as meeting this criteria.

[2]Moisture and fat absorption shall not exceed one percent absorption by weight as determined by standard ASTM test No. D-471 at 158°F. for seven days.

[3]Pending development of a standard procedure for measuring the cleanability of surfaces, conformance with this item may be judged by comparing the removal of standard soil from the rubber or rubber-like material and from the stainless steel having a 120 grit finish, when standardized cleaning procedures are used. A technique for such comparisons has been developed by Dr. O. W. Kaufman, Michigan State University.

(Effective date November 1, 1958)