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MICROBIAL AND NUTRITIONAL ATTRIBUTES

OF SOFT CRABS

INTRODUCTION

Soft-shelled blue crabs (post molt hard blue crab - Callinectes sapidus, continue to be sought as a special, high priced culinary delight. Based on current costs per pound (≥ $8.00/lb. retail) the soft crab remains one of the highest priced seafood selections. Although consumption figures are not available, recent increases in domestic production and prices suggest consumer demand continues to exceed supply. In Florida alone, there was essentially no production prior to 1978; whereas, the 1983 production was in excess of 50,000 pounds with a dockside value above $70,000 dollars (Andree, 1985). In light of these developments more information is needed regarding the handling and storage of the product, and to explain their relative dietary contribution. Common retail practice is to store pre-wrapped soft crabs either frozen (0° F; -18° C) or fresh (40° F; 4.2° C). Based on commercial experience, the frozen shelflife for properly packaged soft crabs can exceed 12 months. However, there are no reports on the recommended refrigerated shelflife. Likewise, there is no formal published data on the nutritional constituents of soft crabs. This report addresses these issues.

METHODS

Soft crabs were obtained from a commercial shedding facility in Cedar Key, Florida. This operation used common procedures for holding pre-molt hard blue crabs in flow-through water systems. The water used was drawn from the adjacent brackish waters which have been monitored to meet water quality standards sufficient for harvest of shellfish (FL Dept. of Natural Resources, Dept. Rules, Chapter 16B-28; median fecal coliform Most Probable Number (MPN) of water shall not exceed 14/100 ml and not more than 10% of the samples shall exceed 43/100 ml.) Crab samples were taken during spring (May) and fall (October).

The post molt samples were immediately wrapped in plastic film and held on ice prior to initiating analyses. Microbial analyses began within 24 hours (0 day) after shedding. Nutritional analyses were performed on spring samples pre-frozen on zero (0) day. All analyses used the entire edible portion (whole crab dressed or cleaned with gills, apron, eyes and mouth parts removed). The crabs were cleaned just prior to analyses.

Microbial analyses included aerobic plate counts (APC) with incubation at 25° C. Fecal coliforms and Vibrio parahaemolyticus were tested by methods outlined in the Food and Drug Administration's "Bacteriological Analytical Manual," (FDA, 1978). All analyses were conducted in duplicate per sampling day (0, 2, 4, 6 and 8 days storage).

Nutritional analyses included proximate composition (AOAC, 1980), minerals (Na, K, Ca, P, Mg, Zn, Fe, Cu, Mn, Cd, and Hg) and fatty acids. Gall et al. (1983) should be referenced for more specific methodology. Mineral analyses employed an atomic absorption spectrophotometer (Perkens-Elmer Corp., Model PE503 and 5000). Ashed samples were dissolved in a final concentration of 0.2N hydrochloric acid. Phosphorus was assayed colorimetrically using tartrate-molybdate-ascorbic acid reagent, and Mercury was determined by the Perkens-Elmer Mercury Analysis System.

Fatty acids were determined by methyl ester preparations (McCreary, et al., 1978) separated by gas-liquid chromatography (Hewlett Packard Model 5840-A gas chromatograph) equipped with a Hewlett Packard Model 7671-A automatic sampler and 6 ft., 4 mm i.d. columns packed with 10% Silar 10 C - Applied Science Labs. Acids were identified by comparison with retention times for pure fatty acid methyl ester references (Nu Chek Prep, Inc.)

RESULTS AND DISCUSSION

High microbial counts coupled with adverse product evaluations indicate soft crabs have a relatively short refrigerated shelflife (Table 1). After six days storage below 35° F (1.7° C) or on ice, the average microorganisms per gram (APC, 25° C) ranged from 0.2 to 1.2 x 10^8 . The crabs had become flaccid, exuding excess weepage with obvious slime and objectionable odors. The raw product was judged unacceptable on the sixth day of refrigeration. This result is expected realizing the vulnerable nature of the initial crab tissues infilterated with a high moisture content resulting from the natural, untreated water supply and no subsequent washing. Attempts to treat the water supply to better facilitate crab survival and lower initial microbial counts would not necessarily assure an extended shelflife. The soft, moist condition of the crab tissues is apparently a suitable media for prolific bacterial growth. The low counts for fecal coliforms is a favorable reflection of the water quality and attest to the use of water monitoring by standard conditions.

The detection in the crabs of the potential pathogen, Vibrio parahaemolyticus is common for seafoods from similar areas and should not pose a health threat unless careless handling affords a chance for cross-contamination with cooked, or ready-to-eat items. Retailers should be warned of the consequences and exercise care in handling and storage, i.e., do not store raw soft crabs near or with cooked crabs or with other ready-to-eat seafoods, and never reuse soft crab packaging or containers to hold cooked items. Note that parahaemolyticus did decrease during refrigerated storage.

The high moisture content contributing to the bacterial growth was evident in the proximate analyses (Table 2). Typically, raw blue crab meat has a moisture and protein content of approximately 80 and 16 percent, respectively (Sidwell, 1981). The protein content in immediately post-molt blue crabs is lower due to the lower proportion of muscle tissues. The

protein loss is balanced by an increase in water content, which is actively taken in to expand the new molt. There is also more ash content resulting from the higher proportion of tissue destined to be shell. Notice that lipids are not significantly different.

The mineral composition is likewise a reflection of the higher proportion of shell material and the metabolic state immediately post-molt (Table 3). The sodium (Na), Calcium (Ca) and phosphorus (P) content in the soft crabs was substantially higher than that reported for raw hard crab muscle tissue (Sidwell, 1981). These concentrations reflect the osmotic state of the crab and the high calcium content can be explained as a necessary constituent for shell formation and hardening. The microminerals are similar to previous reports except for the lower concentrations of zinc (Zn) and copper (Cu). These minor minerals are primarily associated with muscle growth and function, thus they should be initially low due to the lower proportion of protein found in soft crabs. There was no detection of mercury (Hg) or cadmium (Cd) with detection methods limited to 0.01 ug/ml.

The fatty acid profile is similar as for most lean varities of seafoods (< 2% lipid) with a high concentration of polyunsaturated acids (Table 4). The monosaturates and polyunsaturates constituted 21.48% and 33.26% of the total fatty acids, respectively. In comparing the polyunsaturates to saturates ratio for soft crabs (PUFA/SAT - 1.48) the soft crabs appear more saturated than raw hard crab meat (1.34; Sidwell, 1981) and pasteurized crab meat (1.32; Gruger, et al. 1964). Apparently, the post-molt condition does not significantly influence the total fat content, but does alter the fat composition (compare tables 1 and 4).

These basic nutritional constituents in raw soft crabs would be altered by cooking as reported for other seafoods (Mai et al., 1978; Gall et al., 1983). If breaded and fried, the customary method for preparation, the soft crab moisture content should decrease causing a slight increase in protein content. These changes would not represent a major alteration in the nutritional value. The addition of calories from breading and absorbed frying oil would cause the most significant changes. The fat content and composition per serving would increase and change to reflect the character of the frying oil. Likewise, the breading formulation could dominate the mineral composition, particularily sodium content. Fried soft crabs would represent a seafood with relatively high salt content. Based on the raw composition, 486 mg Na/100 g crab (Table 4), plus additions from breading and cooking dehydration, a fried soft crab could provide in excess of 130 mg sodium per 4 ounce serving. In general, fried soft crabs should be considered a typical lean variety of fried seafood with a higher than average amount of sodium. Persons on a low-sodium restricted diet may consider alternative non-fried recipes and/or consumption in moderation.

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Table 1. Aerobic plate counts (APC, 25°C - microorganisms (g), fecal coliforms (FC - MPN/g) and Vibrio parahaemolyticus (VP - positive samples/3 samples tested) for whole, raw soft crabs stored on ice in refrigeration (35°F; 1.7°C).

Storage (Days)	Spring (May) APC	FC	VP	Fall (Oct.) APC	FC	VP
0	2.5×10^6	< 2	3/3	2.0×10^5	< 2	2/3
2	9.7×10^6	< 2	2/3			
4	4.6×10^7	< 2	0/3	1.4×10^6	< 2	
6	1.2×10^8	< 2	2/3	2.2×10^7	< 2	
8	2.3×10^8	< 2	0/3			

Table 2. Proximate composition (%) for whole, raw blue crabs.

	Soft Blue Crab[1]	Hard Blue Crab[2]
Moisture	84.68 ± 0.25	80.3 (77.4 - 86.7)[3]
Protein	10.91 ± 0.53	15.9 (8.6 - 19.8)
Fat	1.40 ± 0.06	1.3 (0.4 - 2.2)
Ash	2.84 ± 0.10	1.9 (1.3 - 2.7)
Total	99.83	

[1]Each soft crab mean value and standard deviation (±) represents eight replicates where one replicate is for one whole crab blended for analysis.

[2]Source: Sidwell, 1981.

[3]Range.

Table 3. Mineral analysis for whole, raw blue crabs.

Minerals	Soft Blue Crab[1]	Hard Blue Crab[2]
	---------- mg/100g ----------	
NA	486.4 ± 23.57	337
K	249.71 ± 6.89	244 (188 - 299)[3]
Ca	422.35 ± 47.79	115 (60 - 277)
P	309.14 ± 52.46	174 (38 - 272)
Mg	64.53 ± 3.55	32 (12 - 47)
	---------- mg/100g ----------	
Fe	22. 0 ± 1.0	23.17 (2 - 54)
Cu	4.28 ± 0.55	9.36 (1.3 - 19.0)
Zn	18. 8 ± 0.8	40.24 (34 - 46)
Mn	6.00 ± 0.78	
Cd	[4]N.D.	
Hg	N.D.	

[1]Each soft crab mean value and standard deviation (±) represents eight replicates where one replicate is for one whole crab blended for analysis.

[2]Source: Sidwell, 1981.

[3]Range.

[4]Not detected.

Table 4. Fatty acid profile (% composition of total fatty acids) for whole, raw soft blue crab.

Fatty Acid	Percent[1]
14:0	3.99 ± 0.48
14:1 ω 9 + 15:0	3.21 ± 0.50
16:0	18.75 ± 0.90
16:1 ω 9	8.59 ± 0.39
17:0	3.62 ± 0.37
18:0	8.54 ± 0.61
18:1 ω 9	9.68 ± 0.69
19:0	0.53 ± 0.30
18:2 ω 6	1.62 ± 0.73
20:0	0.99 ± 0.40
20:1 ω 9 + 18:3 ω 3	5.39 ± 0.80
20:2 ω 6	1.60 ± 0.39
22:0	0.54 ± 0.24
20:3 ω 6	0.30 ± 0.14
20:4 ω 6	5.43 ± 0.23
22:2 ω 6	2.14 ± 0.14
20:5 ω 3	7.35 ± 0.31
22:3 ω 6	0.27 ± 0.19
22:4 ω 6	1.25 ± 0.36
22:5 ω 3	1.18 ± 0.07
22:6 ω 3	6.76 ± 0.47
Others	8.31 ± 0.82
Total	100.04

[1]Each mean value and standard deviation (±) represents eight replications were one replicate is one crab blended for analysis.