Chemical Composition of Seafood Breading and Batter Mixes[1]

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ABSTRACT

Twenty-four seafood breading and batter mixes were analyzed by proximate analysis to establish value-added protein guidelines for use in food service and school lunch programs. Protein levels were similar for 17 breading samples; values ranged from 9.10 to 12.80%. All batter mixes except one contained less protein than the breadings, ranging from 2.90 to 15.75%. Fat content varied from 0.20 to 5.30% and moisture content from 8.30 to 11.35%. Carbohydrate values for all breadings and batters ranged from 70 to 79%; crude fiber averaged 0.3%, and ash ranged from 1.00 to 8.05%. Specific amino acid contents were similar for all breading and batter mixes. Chemical scores determined that lysine was the primary limiting amino acid in 16 breading and batter samples and the second limiting amino acid in four samples. These scores were used to compare amino acid contents of various proteins with the reference pattern of the Food and Agriculture Organization, meeting the requirements of young children. Total sulfur-containing amino acids were limiting in six samples, and valine and isoleucine were the limiting amino acid in one sample each.

In the last 30 years, commercial production of battered and/or breaded food items has grown tremendously due to increased commercialization of frozen and fast foods produced to meet the demands of food service programs (including school lunch programs) as well as individual consumers. The United States is the world's largest market for battered and breaded seafood; many consumers only eat seafood prepared in this manner. The growing number of commercially packaged battered and/or breaded frozen seafood products offers a wide variety that would otherwise be strictly limited by the availability and expense of fresh seafood.

The menus for school lunch programs require nutritionally balanced yet inexpensive foods. Batters and breadings on seafood products such as shrimp, crab, fish patties, or fish sticks offer food service managers a tasty variety of inexpensive protein, with the added value of cereal protein, fiber, calcium, starch, and fat. Between 1962 and 1980, the total weight of batters and breadings used in the preparation of frozen seafoods grew 400% (Suderman 1983). In 1980, 56.4% of all batters and breadings produced for frozen products was used on seafood (Suderman 1983).

Seafood batters generally consist of a liquid mixture of water, flour, starch, salt, and spices, to which leavening may be added. The seafood is dipped in the batter before cooking. Seafood breadings are dry coarse mixtures applied to moistened or battered seafood and consist of flour, starch, and seasoning, with optional dry milk solids, whey, or yeast extracts. Types of breading include those made from wheat breads and ground or broken into the desired particle size; the cracker-meal type, widely used on seafoods, which is manufactured by baking the dough rapidly in a continuous, short-time process directly from flour to the finished product; and others, which consist mainly of corn flour. Protein levels of cracker breadings, ranging from 9.1 to 12.2% (average, 10.6%), exhibited a somewhat greater variability than those of BRD samples. Manufacturers vary the formulations of breadings to satisfy individual flavor requirements. Breaded fish or other seafoods, and seafoods cooked in a batter, provide nutrition and flavor attributes not found in the seafood alone.

The use of seafood breadings and batter is widespread, but few compositional studies have been reported (Suderman 1983). Proximate analysis of seafood batters and breadings has received little attention from food scientists or experts in nutrition labeling. The objective of the present study was to establish proximate analysis profiles and amino acid composition of various commercial types of seafood breadings and batters to assist food service managers (especially in hospital and nursing homes), school lunch nutrition advisors, and others interested in nutrition information and labeling. The proximate analysis and amino acid composition of several commercially available breading and batter mixes were studied.

MATERIALS AND METHODS

Twenty-four samples of breading and batter mixes were supplied by Modern Maid Products, Inc., Garden City, NY; Golden Dipt Co., Millstadt, IL; and Newly Wed Foods, Inc., Chicago, IL. All materials were production-line samples intended for use on frozen shrimp and fish-fillet products.

Chemical Analyses

The contents of the breadings and batters (crude protein, fat, and fiber; moisture; and ash) were determined using AOAC approved methods (AOAC 1984). Reported results are the mean values of duplicate assays. Total carbohydrates by difference (Pomeranz 1987) were calculated for each sample.

Amino Acid Analysis

Amino acid analysis was conducted by heating the samples in 6*N* hydrochloric acid under a vacuum for 24 hr at 110°C. The samples were then filtered and the HCL removed on a rotary evaporator. The amino acids were analyzed with a Beckman model 116 amino acid analyzer according to the manufacturer's directions. Cysteine-cystine and tryptophan were determined using a standard microbiological assay (Difco Laboratories, Detroit, MI).

TABLE I
Reference Egg Protein[a]

Amino Acid	Amino Acids (g/100 g of protein)
Isoleucine	6.6
Leucine	8.8
Lysine	6.4
Aromatic amino acids	
Phenylalanine	5.8
Tyrosine	4.2
Sulfur-containing amino acids	
Cysteine-cystine	2.4
Methionine	3.1
Threonine	5.1
Tryptophan	1.6
Valine	7.3
Total essential amino acids	51.3

[a]Food and Agriculture Organization 1965.

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Calculation of Amino Acid Scores

Protein quality, or value of a food protein, depends on the kinds and amounts of amino acids it contains. Proteins from plants generally contain less essential amino acids than do proteins from animal sources. Protein scores are used to determine the value of a particular protein source and identify limiting or deficient amino acids (Fennema 1985). Protein scores were calculated using the essential amino acid reference pattern for hen's egg (FAO 1965) (Table I), which was chosen to satisfy the requirements of the young child.

RESULTS AND DISCUSSION

For ease of analysis and interpretation, the samples were grouped as batters (BAT) and as breadings made from bread (BRD), cracker meal (CRK), and other materials (OTH), principally corn flour. Variations in all proximate analyses were attributed to the different formulations of various mixes. Specific formulations were not available to the researchers.

Proximate Analysis

Crude protein levels of the BRD samples were very similar, ranging from 10.10 to 12.80% (average, 11.01%) (Table II). Crude fat levels ranged from 0.2 to 3.3%, while crude fiber levels were quite similar in all samples, ranging from 0.15 to 0.40% (Table II). Moisture levels varied from 9.00 to 11.25%. Ash levels exhibited greater variability, ranging from 1.00 to 8.05%. Dry-milk solids, whey, or yeast extracts are generally added to CRK breadings to aid browning reactions and enhance flavor. The fat levels of the CRK breadings ranged from 0.50 to 3.85%, and fiber levels varied from 0.15 to 0.30%. Moisture ranged from 8.85 to 10.70%. The ash level again was the most variable, ranging from 1.35 to 7.55%.

The protein levels of breadings from OTH sources showed little variability, ranging from 10.45 to 11.30% (average, 10.90%). Fat varied from 0.25 to 1.10%, while the levels of crude fiber ranged from 0.25 to 0.35%. Moisture levels varied from 8.3 to 9.8%; ash, from 3.30 to 5.65%.

The protein levels of seafood batters, ranging from 2.90 to 15.75% (average, 7.60%), showed greater variability than did the protein levels of the breadings. This average is much lower than the average protein levels of the breadings tested (10.90%). The values and ranges of BAT for fat, fiber, moisture, and ash were similar to those of the breadings (Table II).

Carbohydrates

Total carbohydrates were calculated by percent difference from other proximate analyses. Carbohydrate in BRD breadings (not shown) ranged from 70.35 to 78.20% and was slightly lower in CRK breadings, ranging from 69.1 to 75.0%. BAT mixes had the greatest range of percent carbohydrate (from 62.40 to 85.05%).

Amino Acid Scores

The essential amino acids of the breading and batter mixes were compared with the pattern for hen's egg (FAO 1965) (Table I). The amino acid content of the breading and batter mixes was very similar in all samples. Selected amino acid scores for relative biological protein quality of the samples and potentially limiting amino acids are listed in Table III. Lysine was the limiting amino acid in six of the nine BRD samples; the total sulfur-containing amino acids were limiting in two samples, and valine was limiting in the remaining sample. Lysine was the second limiting amino acid in samples 2 and 7 and was the limiting amino acid in the majority of the breading samples. Amino acid scores of CRK breadings showed that lysine was limiting in two samples; total sulfur-containing amino acids, cystine and methionine were also limiting in two samples. Isoleucine was limiting in sample 14. In three samples, the score for lysine was over 100, perhaps due to the addition of nonfat dry milk solids, whey, or yeast extracts to the mixes (exact formulations for the breadings were not provided by the manufacturers). Lysine was limiting in all three OTH breadings, which were composed primarily of corn flour.

BAT scores were similar to those of the breading samples. Lysine and sulfur-containing amino acids were limiting in five and two samples, respectively (Table III).

TABLE II
Proximate Composition (%) of Seafood Breading and Batter Mixes[a]

Sample	Crude Protein[b]	Crude Fat	Crude Fiber	Moisture	Crude Ash
Breadings made from bread					
1	10.40	3.30	0.20	10.35	4.25
2	11.55	0.85	0.40	10.25	3.30
3	12.80	0.85	0.20	11.25	1.40
4	10.60	0.20	0.30	9.40	1.30
5	11.95	0.35	0.35	9.75	1.00
6	10.85	0.80	0.35	10.60	5.30
7	10.10	2.35	0.15	9.00	8.05
8	10.60	0.80	0.30	9.55	5.44
9	11.30	1.25	0.15	10.55	1.60
Breadings made from cracker meal					
10	12.20	0.50	0.30	9.45	1.60
11	10.40	2.35	0.30	10.70	7.15
12	9.55	2.25	0.30	8.85	7.55
13	9.10	3.85	0.15	10.35	1.35
14	11.55	1.60	0.15	9.35	4.75
Breadings made from other materials, mainly cornmeal					
15	10.80	0.25	0.25	9.80	5.65
16	11.3	1.10	0.35	8.50	3.30
17	10.45	0.90	0.25	8.30	4.85
Batters					
18	7.00	1.20	0.20	11.35	5.40
19	15.75	5.30	0.75	10.10	5.70
20	7.45	2.00	0.25	11.05	4.75
21	8.30	1.20	0.30	9.00	7.20
22	2.90	0.20	0.20	9.00	7.20
23	7.35	1.75	0.30	9.25	6.30
24	4.25	1.30	0.30	8.65	1.75

[a] Mean of two determinations. Statistical comparisons were not considered due to unknown formula variations.
[b] Nitrogen × 6.25.

TABLE III
Selected Amino Acid Chemical Scores of Seafood Breading and Batter Mixes (g/100 g of protein)

Sample	Total Sulfur-containing Amino Acids	Lysine	Threonine	Valine	Isoleucine	Limiting Amino Acids
Breading made from breads						
1	64.6	40.4	100.00	97.6	100.00	Lys
2	62.9	64.5	91.3	83.1	90.6	Met + Cys
3	59.0	57.8	89.0	92.3	78.7	Lys
4	92.9	100.00	100.00	89.4	95.2	Val
5	92.1	66.0	100.00	76.5	83.6	Lys
6	72.2	67.3	100.00	100.0	81.2	Lys
7	45.9	50.9	100.00	92.1	77.2	Met + Cys
8	67.8	60.9	100.00	100.0	87.0	Lys
9	76.3	62.6	95.6	100.0	73.2	Lys
Breading made from cracker meal						
10	58.30	100.00	85.41	70.84	69.70	Met + Cys
11	81.90	63.22	73.74	96.98	81.51	Lys
12	77.61	65.06	100.00	100.00	70.16	Lys
13	65.49	100.00	92.05	79.76	100.00	Met + Cys
14	77.39	100.00	70.93	100.00	61.54	Ile
Other Breadings						
15	68.84	65.87	100.00	88.62	84.69	Lys
16	76.40	59.21	100.00	100.00	81.27	Lys
17	83.49	48.24	100.00	75.97	63.33	Lys
Batters						
18	76.96	54.09	92.05	81.10	92.85	Lys
19	73.60	74.36	100.00	100.00	97.05	Met + Cys
20	100.00	47.60	89.03	75.76	62.70	Lys
21	100.00	56.09	76.16	93.68	71.02	Lys
22	46.18	50.00	89.84	70.13	100.00	Met + Cys
23	83.21	57.37	99.40	100.00	79.41	Lys
24	77.31	61.78	100.00	100.00	70.32	Lys

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