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PROXIMATE BIOCHEMICAL COMPOSITION OF *PENAEUS VANNAMEI*: A REVIEW WITH COMPARATIVE ANALYSIS

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Abstract

Penaeus vannamei (Pacific whiteleg shrimp) is the most extensively cultured penaeid shrimp worldwide and a major contributor to global seafood supply. Knowledge of its proximate biochemical composition-moisture, crude protein, lipid, ash, and carbohydrate-is essential for evaluating nutritional quality, optimizing aquaculture feed formulations, and understanding the influence of culture practices and environmental factors on shrimp quality. This review synthesizes published literature on the proximate composition of *P. vannamei* and presents comparative tables highlighting variations reported across studies.

Keywords: *Penaeus vannamei*; Proximate Composition; Protein; Lipid; Ash; Aquaculture Nutrition.

Introduction

The Pacific whiteleg shrimp, *Penaeus vannamei* (Boone, 1931), currently dominates global shrimp aquaculture because of its rapid growth, tolerance to a wide range of salinities, high survival under intensive culture, and strong consumer acceptance [1,2]. Beyond production efficiency, the biochemical composition of shrimp meat determines its nutritional value and market quality. Proximate composition analysis-measurement of moisture, crude protein, crude lipid, ash, and carbohydrates-is widely used to assess shrimp nutritional quality for both human consumption and aquaculture research [3,4].

Several studies have reported the proximate composition of *P. vannamei* cultured under different environmental conditions, feeding regimes, and farming systems.However, reported values vary considerably due to differences in analytical methods, basis of expression (wet or dry weight), sample type (muscle vs whole body), and biological factors such as size and molt stage [5,6]. This review summarizes and compares available data to provide an integrated understanding of the proximate biochemical composition of *P. vannamei*.

Methods Commonly Used for Proximate Analysis

Most studies on *P. vannamei* employ standard analytical procedures recommended by the Association of Official Analytical Chemists (AOAC).Moisture content is determined by oven-drying at 105 °C to constant weight, crude protein by the Kjeldahl method (N × 6.25), crude lipid by Soxhlet or solvent extraction methods, and ash by incineration in a muffle furnace at 500–550 °C [3,7]. Carbohydrate content is generally calculated by difference rather than directly measured [8].

Proximate Biochemical Composition of *Penaeus vannamei*

1 Moisture

Moisture constitutes the largest fraction of shrimp muscle. Reported moisture content in *P. vannamei* muscle typically ranges from 72% to 78% on a wet weight basis [4,9]. Variations are influenced by shrimp size, muscle composition, and post-harvest handling [10].

2 Crude Protein

Protein is the most nutritionally significant component of shrimp meat. Muscle protein content of *P. vannamei* generally ranges from 18% to 24% on a wet weight basis, while dry weight values may exceed 60% [1,4,11]. High protein content underscores the importance of *P. vannamei* as a high-quality animal protein source for human diets.

3 Crude Lipid

Compared with finfish, shrimp are considered low-fat seafood. Reported lipid content of *P. vannamei* muscle is usually between 0.5% and 3.0% on a wet weight basis [9,12]. Higher lipid values have been reported in whole-body samples due to lipid storage in the hepatopancreas [6]. Lipid levels are strongly influenced by diet composition and culture system [13].

4 Ash

Ash content reflects total mineral matter. In *P. vannamei* muscle, ash content commonly ranges from 1.0% to 2.5% (wet basis) [4,10]. Whole shrimp samples, including shell, show higher ash values due to the presence of calcium-rich exoskeleton [14].

5 Carbohydrates

Carbohydrates represent a minor fraction of shrimp proximate composition and are mainly present as glycogen. Reported carbohydrate values are typically below 2% on a wet weight basis and vary with feeding status and physiological condition [8,15].

Comparative Studies on Proximate Composition

Table 01: Proximate composition of *Penaeus vannamei* muscle reported by different authors (wet weight basis).

Author	Culture system / Source	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Reference
Nunes et al. (2014)	Farmed, pond	74.6	21.3	1.2	1.5	[1]
Gunalan et al. (2015)	Farmed, India	76.8	20.1	0.9	1.4	[4]
Li et al. (2021)	Commercial samples	73.9	22.4	1.6	1.8	[9]
Manimehalai et al. (2021)	Brackish water culture	75.2	21.0	1.4	1.6	[10]
Liu et al. (2022)	Market samples	72.5	23.1	2.2	2.0	[11]

Table 02: Comparison of proximate composition of *P. vannamei* under different culture systems.

Culture system	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Reference
Earthen pond	74–77	20–22	0.8–1.5	1.3–1.7	[4,9]
Biofloc system	72–75	22–24	1.5–2.5	1.6–2.0	[13]
Recirculating aquaculture system	73–76	21–23	1.2–2.0	1.5–1.9	[6]

Table 03: Muscle versus whole-body proximate composition of *P. vannamei.*

Sample type	Moisture (%)	Protein (%)	Lipid (%)	Ash (%)	Reference
Muscle only	72–77	20–24	0.5–2.5	1.0–2.5	[4,9,11]
Whole body	68–74	16–20	2.5–6.0	3.0–6.5	[6,14]

Factors Affecting Proximate Composition

1 Diet and Nutrition

Dietary protein and lipid levels directly influence tissue composition. High-energy diets tend to increase lipid deposition, whereas balanced protein diets enhance muscle protein accretion [13,16].

2 Environmental Conditions

Salinity, temperature, and water quality affect metabolic activity and nutrient utilization in shrimp, leading to observable differences in proximate composition across farming regions [2,6].

3 Size, Age, and Molt Stage

Juveniles generally exhibit higher moisture and lower protein compared with adults. Molting and reproductive cycles also alter biochemical reserves, particularly lipid and glycogen [15].

Nutritional Significance

The high protein and low lipid content of *P. vannamei* make it a valuable seafood for human consumption. Shrimp protein contains essential amino acids in favorable proportions, while low fat levels appeal to health-conscious consumers [1,11]. From an aquaculture perspective, understanding body composition assists in designing efficient feeds and predicting growth performance [16].

Conclusions

The proximate biochemical composition of *Penaeus vannamei* is characterized by high moisture, high-quality protein, low lipid content, and moderate mineral levels. Although general compositional ranges are well established, significant variation exists among studies due to biological, environmental, and methodological factors.Comparative analysis highlights the influence of culture systems and sample type on reported values. Future research should emphasize standardized analytical protocols and integrated nutritional profiling to improve comparability across studies.

Conflict of Interest

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