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A Comparative Study of Physico-Chemical, Proximate Composition and Microbiological Muscle Properties, in Two Species Shrimps of the Pacific Tropical Coast

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ABSTRACT

Physicochemical, proximate composition and microbiological analysis of white shrimp (*Litopenaeus vannamei*) and blue shrimp (*L. stylirostris*) tissues were compared. The wild shrimp were collected off the coasts of Sinaloa, México (in front Navachiste Bay, Guasave) and of Nayarit (in front Boca de Cuautla-Novilleros, Tecuala), Mexico. The results of our study suggested that meats of white and blue shrimp are a good source of protein and lipids. The blue shrimp tend to have better protein content than white shrimp, and white shrimp tend to have better lipid content than blue shrimp.

Keywords: protein; lipid; faecal coliform; l. vannamei; *Litopenaeus stylirostris*.

I. INTRODUCTION

Shrimp is one of the world’s most popular shellfish (Turan et al., 2011). In Mexico the most important Pacific shrimp species are blue shrimp *Litopenaeus stylirostris* (Stimpson, 1874), white shrimp *Litopenaeus vannamei* (Boone, 1931), brown shrimp *Farfantepenaeus californiensis* (Holmes, 1900), and crystal red shrimp *Farfantepenaeus brevirostris* (Kingsley, 1978), which account 70% of domestic production of shrimp caught (García-Juárez et al., 2009).

Shrimp meat is an excellent source of protein (Cao et al., 2009; Oksuz et al., 2009; Rødde et al., 2008). Its meat is low in fat, especially saturated fatty acids; contain high amounts unsaturated fatty acids (HUFA) such as eicosapentaenoic (20:5n3, EPA) and docosahexaenoic (22:6n3, DHA) acids (Puga-López et al., 2013), are excellent sources of essential amino acids, and a good source of iron, zinc, copper, calcium and vitamin B12 (Roy et al., 2009). Nevertheless, the compositions can vary with the feed sources. Additionally, proximate compositions, fatty acid profiles, cholesterol contents and total carotenoid contents (Turan et al., 2011) of shrimps change seasonally. Both white shrimp and blue shrimp have been accepted by consumers mainly the large sizes > 35 g. However, little information regarding the physicochemical, proximate composition and microbiological muscle properties of both shrimps has been reported. The main goal of this investigation was compare the properties of muscle of the white and blue shrimps in Sinaloa and Nayarit states, Mexico.

II. MATERIAL AND METHODS

A. *Sample preparations*

White shrimp and blue shrimp were collected on the coast of Sinaloa, in front Navachiste Bay, Guasave (25°19´37.36” N; 108°46´24.63” W) and Nayarit, in front Boca de Cuautla-Novilleros, Tecuala (22º15´33.08” N; 105°45´48.98” W), Mexico and sampled by capturing shrimp trawls known as "changos" on boats with outboard motor at depths between 10 and 20 m. Total length (from tip of the rostrum to the tip of the telson along the mid-dorsal line) and weight of each shrimp were measured. After collection, each sample was placed in an air-tight polyethylene bag and immersed in plenty of crushed ice until being transported to the laboratory (Laboratorio de Calidad de Agua y Alimentos del Centro Regional de Investigación Pesquera de Mazatlán, Sinaloa, México). The muscle, hepatopancreas and shell were separated, respectively, were sampled shrimp and the others were kept in a freezer at -18 °C. The shrimps were deveined and the edible portions were ground to obtain uniformity. All peeled shrimp were composited, homogenized, and analysed. All analysis (physicochemical, proximate composition and microbiological), were determined in triplicate.

B. Physicochemical Analysis

The pH was determined in shrimp muscle using about 5 to 10 g of sample homogenized in distilled water. After 5 minutes at room temperature using a previously calibrated potentiometer reading was taken performed in triplicate. The % of chloride (NaCl) was obtained using 10 g of sample, 0.1 N solution of silver nitrate, HNO_3 and titrated with 0.1 M solution of ammonium thiocyanate. TVB-N (total volatile basic nitrogen) was determined by distillation technique Macro-Kjeldahl Method. Using 10 g of shrimp muscle placed in a blender to homogenize. Analyses were performed in triplicate.

C. Proximate Composition

Shrimp muscle were analysed for moisture and ash contents were determined as described by Latimer (2012), and protein content was determined by the Kjeldahl method. These analyses were performed in triplicate. Crude lipid content was performed by acid digestion prior to petroleum ether extraction (b.p. 40–60 ºC) in a Soxtec system (Latimer, 2012). The values were expressed as % (wet weight basis).

D. Microbiological Analysis

Microbiological analysis was from each processing techniques performed according to the standard procedure for the enumeration and identification of microorganisms (Cain et al., 2012). The most probable number (MPN)s technique was used to determine the level of faecal coliforms. The samples were homogenized in a blender using sterile physiological saline (0.85% NaCl solution). Total coliform (TC) bacteria were assayed by the membrane filtration technique with m-Endo agar (Difco) and incubated for 24 h at 35°C. The standard M 7h FC membrane filtration method (1) was used to recover faecal coliforms (FC) at 41.5°C. Peptone (0.1%) was used for all serial dilutions. All assays were done according to APHA (2012).

E. Statistical Analysis

Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Tukey's multiple range test (Montgomeru, 2008). Statistical analyses were performed using the Statistical Package for Social Science (SPSS 11.0 for windows, SPSS Inc., ChicagoIL).

III. RESULTS

A. Physico-chemical Analysis

PH, % of chloride and TVB-N concentrations of shrimp are shown in Table 1. In general there were no differences in the pH and TVB-N parameters in white and blue shrimp, only a significant (*P*<0,05) higher concentration of chlorides on white shrimp. The results of pH in the fresh muscle of all shrimp were measured above 7.0.

B. Proximate Composition

The results of proximate composition are presented in Table 2. Shrimps had suitable moisture contents (72.95 to 73.91%). Protein was found as the major constituent, indicating that shrimp muscle can be a good source of amino acids. No significant difference (*P*< 0,05) between the two species. Nevertheless, protein levels showed a tendency to increase with blue shrimp. It was found that white shrimp had significant (*P*<0,05) higher concentrations of lipid that blue shrimp. The Sinaloa shrimp had significant higher concentrations of ash than those obtained in the Nayarit state.

TABLE I. PH, % CHLORINE AND TOTAL VOLATILE BASES NITROGEN (TBV-N) COMPOSITION OF WHITE SHRIMP (*L. VANNAMEI*) AND BLUE SHRIMP (*L. STYLIROSTRIS*) MUSCLE. MEANS FOLLOWED BY DIFFERENT LETTERS SHOW STATISTICAL DIFFERENCES.

Parameter/ Source	WS	WN	SS	SN
pH	7.23±0.24	7.25±0.21	7.31±0.16	7.22±0.19
Chlorides	0.72±0.02a	0.73±0.02a	0.66±0.03b	0.66±0.05b
TVB-N	34.85±1.66	33.79±2.03	35.75±2.13	34.44±1.97

Volatile bases total nitrogen; WS = Sinaloa white shrimp; WN = Nayarit white shrimp; SS = Sinaloa blue shrimp; SN = Nayarit blue shrimp. Units: TBV-N, mg $100g^{-1}$; Chlorides, %.

TABLE II. PROXIMATE COMPOSITION (G $100G^{-1}$) MEAT WHITE SHRIMP (*L. VANNAMEI*) AND BLUE SHIRIMP (*L. STYLIROSTRIS*).

Parameter/ Source	WS	WN	SS	SN
Moisture	73.91±1.06a	73.63±0.86a	72.95±0.88a	73.77±0.80a
Protein	20.04±0.93a	20.10±0.52a	20.47±0.61a	20.46±0.48a
Crude lipid	1.27±0.16a	1.42±0.17a	1.03±0.15b	0.95±0.13b
Ash	2.26±1.66a	2.10±1.05b	2.30±0.71a	2.18±0.69b

WS = Sinaloa white shrimp; WN = Nayarit white shrimp; SS = Sinaloa blue shrimp; SN = Nayarit blue shrimp.

C. Microbiological analysis

Faecal coliforms were detectable in white and blue shrimps and their counts ranged from <3 to 86·MPN g^{-1} (Fig. 1). Faecal coliform observed in different samples of Sinaloa state shrimp were between <3 to 10 MPN g^{-1}, while in Nayarit State shrimp the count of all the samples were <3 to 86 MPN g^{-1}. In about 40% of all samples was determined at a concentration of <3 MPN g^{-1}. The sanitary conditions of white and blue shrimp are best in the Sinaloa State.

IV. DISCUSSION

The determination of TVB-N in shrimp and fresh produce is used as an indicator of freshness and is a measure commonly used in trade (Cadun et al., 2008)[l]. This determination quantifies the nitrogenous bases, trimethylamine, dimethylamine and ammonia produced during spoilage of shrimp (Ali, 2011). In this experiment the nitrogenous bases of the thawed shrimp head were of 17.76 mgN $100g^{-1}$ fresh head, concentration near the content of the anchovy (14 mgN $100g^{-1}$) maintained at 20-28 °C for 12 hours before process meal. In anchovy meal with a greater than 30 mg TVB-N $100g^{-1}$ in raw fish, the deterioration of the raw material has a significant negative effect on consumption and growth of shrimp (Tsironi et al., 2009). Biochemical alterations increase the pH of shrimp muscle even under freezing conditions resulting in decreased product quality over time. This increment of pH value can be attributed to compounds accumulated from endogenous and microbial enzymatic reactions Seabra et al., 2011). The results of pH in the fresh shrimp muscle were measured above 7.0, this agrees with the findings by Reddy et al. (2012), Seabra et al. (2011) and Tsironi et al. (2009).

Greater ash content was noticeable in this work than in shrimp from the farms in Songkhla and Suratthani provinces (Rødde et al., 2008). The Sinaloa shrimp had significant (P<0,05) higher concentrations of ash than those obtained in the Nayarit state, these results may be attributed to the high ash content of the diet, the high levels of chitin found in crustaceans consumed by the shrimp (Fall et al., 2012; Khanafari et al., 2008). Proximate compositions (protein and fat) of the edible part of shrimp are slightly different from that found by Rødde et al. (2008) for these species. Proximate compositions in shrimp muscles are ruled by many factors, including species, growth stage, feed and season (Turan et al., 2011). However, that results indicated no significant difference (P<0,05) were observed in terms species and origin of samples. In our study, the proximate contents found for *L. vannamei* and *L. stylirostris* were within the range of other shrimp species (Oksuz et al., 2009; Puga-López et al., 2013; Turan et al., 2011).

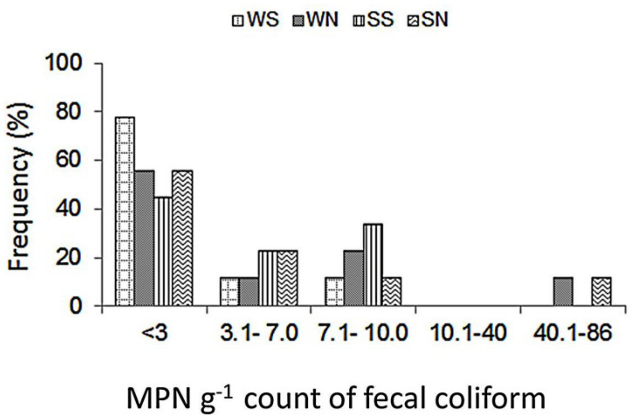

Figure1. Faecal coliform frequency from white and blue shrimp muscle samples (WS = Sinaloa white shrimp; WN = Nayarit white shrimp; SS = Sinaloa blue shrimp; SN = Nayarit blue shrimp).

Faecal coliform are considered to be present, especially in the gut and feces of warm-blooded animals. Because the origins of faecal coliforms are more specific than the origins of the total coliform group, coliforms are considered a more accurate indication of animal or human waste than the total coliforms. The presence of faecal coliform is not permitted in the shrimp samples in Japan, USA and other European countries (Azzam et al., 2010).

The sanitary conditions of white and blue shrimp are best in the Sinaloa State. Faecal coliform contents in shrimps vary depending on the sanitary and hygienic conditions of the landing centers or farm (Ali et al., 2012; Hossain et al., 2010) reported that the incidence of total coliforms in cultured *P. indicus* was 230 g, while Ali et al. (2012) reported a total coliform count of >240 MPN g^{-1} in tropical shrimps. Ali et al. (2012) reported faecal coliform counts of 11 to 240 MPN g^{-1}, 2 to >2400 MPN g^{-1} and 0 to 1600 MPN g^{-1}, respectively in freshly caught penaeid shrimps. As the microbiological condition of the shrimp studied this far below those reported for other species.

V. CONCLUSIONS

The results of our study suggested that muscle of white and blue shrimp are a good source of protein and lipids. The differences in physicochemical compositions and microbiological properties between groups might be associated with the origin and handling. Blue shrimp tend to have better protein content than white shrimp, and white shrimp tend to have better lipid content than blue shrimp.

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