https://doi.org/10.21708/avb.2023.17.1.11410

Sensory evaluation of pacific white shrimp fed with different levels of soy protein concentrate in replacement of fish meal

Avaliação sensorial de camarões-branco-do-pacífico alimentados com diferentes níveis de concentrado protéico de soja em substituição da farinha de peixe

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ABSTRACT: The aim of this study was to evaluate the sensory quality of Pacific white shrimp (*L. vannamei*) fed diets in which fish meal was replaced by soy protein concentrate. Four diets were evaluated, with different levels of replacement (33%, 66% and 100%) of fish meal by soy protein concentrate. In the sensory analysis, 50 tasters evaluated using the ordering preference test and 50 tasters evaluated the acceptability of the shrimp. The inclusion of vegetable protein source in the shrimp diet showed no difference in the discriminatory and preference ordering test and did not change the evaluated sensory attributes, which makes the product attractive to the consumer, due to the fact of consuming a product without presenting alterations in the taste.

KEY WORDS: Acceptability; Consumer market; Biofloc; Aquaculture; *Litopenaeus vanammei.*

RESUMO: O objetivo deste estudo foi avaliar a qualidade sensorial do camarão-branco-do-pacífico (*L. vannamei*) alimentados com dietas em que houve substituição da farinha de peixe por concentrado proteico de soja. Quatro dietas foram avaliadas, com diferentes níveis de substituição (33%, 66% e 100%) da farinha de peixe pelo concentrado proteico de soja. Na análise sensorial, 30 provadores avaliaram por meio do teste de ordenação de preferência e 50 provadores avaliaram a aceitabilidade dos camarões. A inclusão da fonte proteica vegetal na dieta dos camarões não apresentou diferença no teste discriminatório e de ordenação de preferência e não alterou os atributos sensoriais avaliados, o que torna o produto atrativo para o consumidor, pelo fato de consumir um produto sem apresentar alterações no paladar.

PALAVRAS-CHAVE: aceitabilidade; mercado consumidor; biofloco; aquicultura, *Litopenaeus vanammei*.

INTRODUCTION

Aquaculture is an activity in full expansion, with this, the use of protein sources of plant origin has become the focus of studies to replace animal protein, especially fish meal. Plant-derived proteins have an acceptable protein level, adequate amino acid content, easy commercialization, less fluctuation in quality, in addition to being considered a renewable ingredient (Sookying; Davis; Silva, 2013). And among plant ingredients, soy protein concentrate (CPS) proves to be promising, as it has a better amino acid profile and digestibility (energy and protein) than other derivatives.

The total or partial replacement of some ingredient in the fish feed can directly interfere with the quality of the final product, which refers to the characteristics that make food acceptable to consumers and can be determined by several aspects: hygiene, value nutritional value, freshness, ease of use by the consumer, its intrinsic properties (sensory) and availability (Nunes et al., 2007; Amaral and Freitas, 2013). It is worth noting that the sensory analysis evaluates the acceptability of the product, as it is not advisable to change the formulation of the feed and compromise and/or reduce acceptance among consumers.

In a recent study, JATOBÁ et al. (2017) evaluated the effect of different levels of replacement of fish meal by soy protein concentrate on the water quality and zootechnical performance of Pacific white shrimp (*Litopenaeus vannamei*) reared in a biofloc system, demonstrating the technical feasibility of using this method. ingredient, however, it was not evaluated

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Received: 08/10/2022. Accepted: 11/03/2022

whether the substitution compromises its acceptance. Thus, to complement the previous study (JATOBÁ et al., 2017), the objective was to evaluate the sensory quality of Pacific white shrimp (*L. vannamei*) fed diets containing different levels of replacement of fish meal by concentrate soy protein.

MATERIAL AND METHODS

The shrimp used in this study were supplied by Genearch Ltda. (Rio Grande do Norte, Brazil) and obtained from the reproduction of a notifiable Specific Pathogen Free (SPF) strain (WSSV - *White Spot Sydrome Virus*, IHHNV - *Infectious Hypodermal and Hematopoietic Necrosis Virus*, TSV - *Taura Syndrome Virus*, IMNV - *Infectious Myonecrosis Virus* and YHV - *Yellow Head Virus*), by the International Organization of Epizootiases (OIE). The juvenile marine shrimps at the beginning of the experiment had an average weight of 3.96g and at the end of 14.20g, they were cultivated for a period of 40 days, under a super-intensive biofloc BFT system, in twelve experimental units of polyethylene of 800 L, kept with constant aeration and 800W heater, to maintain the temperature at 29°±0.5 (Jatobá et al. 2017).

Four different isocaloric diets were formulated (Table 1) with different levels of soy protein concentrate (SPC) as a substitute for fish meal (0, 33, 66 and 100% replacement). The diets were produced in the xxx (xxx) of xxx (xxx), (JATOBA et al., 2017), were formulated with 300-330 g kg^{-1} of crude protein (JATOBÁ et al., 2014) and similar amounts of lipids (61 – 66 g kg^{-1}) of marine origin (fish oil and fat contained in fish meal), aiming to provide a similar composition of fatty acids.

The experimental units were distributed among four treatments - A: 0%, B: 33%, C: 66% and D: 100% replacement of fish meal by CPS - completely at random, in triplicate. In each tank, 200 shrimp were stocked, maintaining an initial density of 250 shrimp m^{-3}. Shrimp were fed four times a day (8:00 am, 11:00 am, 2:00 pm, and 5:00 pm) with a monitoring program to confirm intake, as described by Jatobá et al. (2014).

At the end of the experiment, harvesting took place, where the shrimp were placed in empty boxes for the disinfection bath, through immersion in clean water, containing 5 ppm of chlorine, for 3 minutes. For the slaughter procedure, ice was used in a 2:1 ratio (ice/shrimp) for 20 minutes.

Sensory analysis

Sensory analysis was carried out at the Laboratory of Analysis Laboratory of Analysis (LABCAL), of the Department of Food Science and Technology (CAL), of the Federal University of Santa Catarina. Sensory analysis tests were carried out according to the methods described by MEILGAARD, CIVILLE; CARR (2007) to evaluate the ordering of preference and acceptability of the four shrimp samples (A, B, C and D) fed different diets (Table 1), the evaluators were in places suitable for carrying out sensory analysis, where it was carried out individually.

Table 1. Formulation of experimental diets for marine shrimp (*L. vannamei*) reared in a super-intensive biofloc system with different levels of replacement of fish meal by soy protein concentrate.

Replacement level	Ingredient (g.kg^{-1})			
	0%	33%	66%	100%
Fish Meal (590 g.kg^{-1} PB)	209	132	60	0,0
[1] Soy Protein Concentrate	0	65	120	172
Soybean Meal (450 g.kg^{-1} PB)	350	350	350	350
Rice Grits	80	80	80	80
Flour	250	250	250	250
Soy Lecithin	15	15	15	15
Fish Oil	06	13	20	25
Soy Oil	20	20	20	20
Potassium Chloride	15	14	10	9
Sodium Chloride	14	15	15	15
Magnesium Sulfate	08	08	08	08
Vitamin-C	03	03	03	03
Kaolin	8	13	27	31
Monocalcium Phosphate	7	7	7	7
[2] Vitamin-Mineral Premix	15	15	15	15

[1] Centesimal composition, 63,07% crude protein, 1,38% of ethereal extract, 4,66% crude fiber, 6,79% moisture and volatiles, 6.32% mineral material, 17.78% non-nitrogen extract, 1.38% acid hydrolysis extract, 4.426,0 cal.g^{-1}; [1] Aminogram Aspartic Acid 6.67%; B.C. Glutamic 10.03%; Serine 2.65%; Glycine 1.90%; Histidine 1.68%; Arginine 3.69%; Threonine 1.74%; Proline 2.73%; Tyrosine 1.69%; Valine 2.73%; Methionine 0.71%; Methionine + Cystine 1.37%; Isoleucine 2.82%; Leucine 4.99%; Phenylalanine 3.04%; and Lysine. 3.92%. [2] Guarantee levels per kilogram of product: vit. A – 10,000,000 IU; vit. D3 – 2,000,000 IU; vit. E – 30,000 IU; vit. B1 – 2.0g; vit. B6 – 4.0g; pantothenic acid - 12.0 g; biotin – 0.10 g; vit. K3 - 3.0g; folic acid – 1.0 g; nicotinic acid - 50.0 g; vit. B12 – 15,000 mcg; If – 0, 25 g; and Vehicle q.s.p – 1,000 g. Source: Jatobá et al. (2017)

For sensory analyses, the shrimp were stored on ice 2:1, then cooked in boiling water, and about 12g per sample were presented to consumers still warm (35°C) and salt added, (100 g shrimp: 0.1 g grams of NaCl) served in disposable plates, coded in random numbers. Water was served between samples to clean the palate.

Preference sorting

The analyzes were carried out shortly after the preparation of the shrimp, with 30 volunteer judges (not trained and usual consumers of shrimp) 4 samples of shrimp were offered at the same time, fed with different diets in which the tasters were asked to order the samples according to with your preference (least liked to the one you liked the most).

Acceptability

The acceptability test was carried out shortly after the preparation of the shrimp, using a hedonic scale of 9 established points, with the extremes of "I liked it very much" (9) and "I disliked it very much" (1). Both tests were applied to 50 volunteer, untrained judges, regular consumers of shrimp. Attributes of color, aroma, appearance, consistency, flavor, and overall impression of the shrimp were evaluated.

Statistical analysis

The preference ordering results were analyzed using the Friedman test using the Newell and MacFarlane Table, according to MEILGAARD, CIVILLE; CARR (2007). The acceptability results were submitted to analysis of variance, and comparison of means, by Tukey's test at the 5% level (ZAR, 2010).

RESULTS AND DISCUSSION

Sensory analysis

From the data obtained in the ordering tests of preference and acceptability of the four shrimp samples (A, B, C and D) fed with rations of different concentrations of CPS, it is assumed that, the replacement of fish meal by protein concentrate of soy, did not interfere with the acceptability of the Pacific white shrimp, for the sensory parameters (Table 3).

Preference sorting

To carry out the statistical analysis of the preference ranking tests, a critical value of 26 was obtained, according to the Newell and MacFarlane Table (MEILGAARD; CIVILLE; CARR, 2007) for 4 samples and 30 judges. For each response obtained, values from 1 to 4 were assigned to the samples, with 1 being the least preferred and 4 being the most preferred. Each sample had its values summed and the difference between the totals was considered significant at the 5% level only when ≥ 26, in which the samples with the highest total values were the most preferred.

However, no significant difference ($p \geq 0.05$) was observed in preference between shrimp submitted to different diets (Table 2). According to REBOUÇAS et al. (2017) the difference between the acceptance of shrimp by judges is related to personal preferences and different perceptions, when no taster knows what treatments will be applied during sensory analysis.

Acceptability

The acceptability result of the shrimp samples is shown in Table 3. The result of the sensory evaluation for the attribute "color" did not differ significantly ($p \geq 0.05$) between the shrimp samples.

The aroma and appearance of the tested shrimp did not differ ($p \geq 0.05$), receiving grades equivalent to "I liked it a lot", around 8 points. ERICKSON et al. (2006) observed that appearance, color, and aroma are the main attributes that influence the acceptability of cooked shrimp.

Table 3. Mean values for acceptability* of four shrimp samples

Shrimp Samples	0%	33%	66%	100%
Color	8,6^a	8,5^a	8,6^a	8,6^a
Aroma	8,4^a	8,4^a	8,0^a	8,4^a
Appearance	8,5^a	8,6^a	8,3^a	8,5^a
Consistency	8,5^a	8,6^a	8,2^a	8,4^a
Flavor	8,6^a	8,4^a	8,0^a	8,2^a
Overall impression	8,6^a	8,6^a	8,4^a	8,3^a

Mean determination values of 50 judges. *Acceptability (9-point hedonic scale: 1 = dislike very much, 5 = indifferent, 9 = like very much). Mean values in the same line, followed by different letters, are significantly different ($p \leq 0.05$), according to the Tukey test.

Table 2. Distribution of scores (%) according to consumer preference (n=30) in relation to shrimp samples.

Score	0%	33%	66%	100%
1	13 (43,3%)	5 (16,7%)	8 (26,7%)	4 (13,3%)
2	8 (13,3%)	16 (26,7%)	26 (43,3%)	10 (16,7%)
3	27 (30,0%)	18 (20,0%)	9 (10,0%)	36 (40,0%)
4	16 (13,4%)	44 (36,6%)	24 (20,0%)	36 (30,0%)

Values in the same line with different letters are significantly different ($p < 0.05$). 1: least preferred sample; 2: least preferred intermediate; 3: most preferred intermediate; 4: most preferred sample. Sum of each sample = (1 x no. scores 1) + (2 x no. scores 2) + (3 x no. scores 3) + (4 x no. scores 4).

The consistency and flavor of the shrimps also did not show variation ($p \geq 0.05$) in the acceptance between the shrimps fed with different concentrations of feed receiving grades that corresponded to "I liked it a lot" and "I liked it very much".

The grades received by the products ranged from 8.5 to 8.6, which ranges from "I liked it a lot" to "I liked it very much". Interesting fact, since color is a sensory attribute readily available to the consumer, being one of the first criteria at the time of purchase (TUME et al., 2009), indicating that feeding with different levels of CPS instead of fish meal does not change the color of the prawns. In agreement with the present study, in breast meat from chickens fed with different levels of sorghum replacing corn, they did not influence ($p>0.05$) the sensorial characteristics, including the color of the breast meat (GARCIA et al., 2005). BERGAMIN et al. (2010) evaluated the sensory quality of Hungarian carp fillet fed diets in which pork meal was replaced by soy and canola meal, and the color and flavor of the fillets were not affected by the inclusion of vegetable protein sources.

The overall impression of shrimp treated with different diets obtained a score of 8.3 to 8.6, therefore, all shrimp samples obtained an average acceptance in the range of 8.0 on the hedonic scale, which corresponds to "I liked it very much", and, in all evaluated attributes, the samples presented acceptability scores higher than the minimum acceptable, which is 5 ("indifferent") in the hedonic scale. Thus, feeding shrimp with different levels of CPS did not interfere with the sensory parameters and acceptability of the shrimp, and could use up to 100% replacement of fish meal with CPS, however, in the previous study carried out by JATOBÁ et al. (2017) the substitution that presented the best average final weight and weekly gain was the replacement of 33% of fish meal by CPS in the cultivation of *L. vannamei* in a biofloc system without harming the zootechnical indices of the cultivation. Therefore, the results obtained in the present study led us to conclude that the best percentage of replacement of fish meal by CPS should be defined based on zootechnical and/or economic variables, since there were no changes in the sensory characteristics of shrimp fed with diets containing CPS.

CONCLUSIONS

The replacement of fish meal by CPS did not change the sensory tests applied to samples of Pacific white shrimp (*L. vannamei*) cultivated in a biofloc system.

ACKNOWLEDGEMENTS

The authors of this study recognize the financial support of the National Council for Scientific and Technological Development (CNPq) in the form of a scholarship offered for the development of the project; Financier of Studies and Projects (FINEP), to support the project "Nutritional Bases for the Development of Diets for the Cultivation of *Litopenaeus vannamei* Shrimp in Intensive Regime with Microbial Flakes and Minimum Water Change – FINEP/RECARCINA- 2010-2012"; and IMCOPA, NICOLUZZI and GUABI, for financing and supplying ingredients for the production of diets and technical support from Karine Goulart de Oliveia, Lucas Gomes Mendes, Efrayn Wilker de Souza Cândia. Felipe Vieira, Walter Seiffer and José Mouriño who received research productivity grants from CNPQ (process number 309868/2014-9, 302792/2012-0, 2014-6 respectively).

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