

## Scientific Paper

Utilization of shrimp (*Litopenaeus vannamei*) waste meal in heifers

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**Abstract**

The objective of this trial was to determine the effect of the utilization of 30 % shrimp (*Litopenaeus vannamei*) waste meal on some productive and reproductive indicators of grazing heifers, in Culiacán –Sinaloa, Mexico–. Between February and August, 2016, a trial was conducted with 12 Swiss Brown heifers, of 10-14 months of age, distributed in a completely randomized design with two treatments of six animals each: control treatment: 3 kg of supplement, which contained 100 % concentrate feed; experimental treatment: 3 kg of supplement which contained 70 % concentrate feed and 30 % shrimp waste meal. The remainder of the diet consisted in grazing and grass hay. The daily weight gain was favorable and significant with the presence of the shrimp waste meal (0,520 vs. 0,410 kg/animal/day); while the reproductive response was shown in the percentages of pregnant heifers at the end of the test (83 % in the experimental treatment vs. 50 % in the control). It was proven that the inclusion of 30 % shrimp waste meal allowed higher daily weight gain, as well as a decrease of some indicators of caloric stress, such as the pH of urine and feces, in addition to the rectum temperature; this permitted pregnancies in a shorter time period, essential aspect for cattle husbandry in Sinaloa.

Keywords: weight gain, reproduction, supplements

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**Introduction**

An adequate nutritional management constitutes a key point for maintaining the productivity of an animal husbandry system, because it influences the zootechnical indexes, specially the reproductive ones. For such reasons, concentrate feed<sup>1</sup> is one of the most widely used feedstuffs by animal husbandry farmers of the Sinaloa region for the supplementation of cattle in all its stages; nevertheless, due to its high cost in the market—more than 350 dollars per ton, according to SNIIM (2018)—it is necessary to search for new supplementation alternatives, because the region, and Mexico in general, shows low weight gain and low pregnancy percentage, which affects animal husbandry (Vélez-Terranova *et al.*, 2014).

Mexico is among the first places in shrimp production in Latin America, because in 2016 it produced 211 096 t (SAGARPA, 2016); and the species blue shrimp (*Litopenaeus stylirostris*), white shrimp (*Litopenaeus vannamei*) and brown shrimp (*Farfantepenaeus californiensis*) were the most captured ones in the Pacific (INAPESCA, 2016).

Sinaloa produced a total of 99 015 t of shrimp, for which it is estimated that up to 30 000 t of wastes are generated (SIAP, 2016). This is an ecological problem in the capture zones, because these wastes are deposited in the open air, where they undergo decomposition. If they are not utilized, they become pollutants; in the high sea, where the capture occurs, as well as on land, within shrimp farms; or failing that, in municipal garbage dumps, beaches, forests or sinks where they are thrown (INEGI, 2015).

It has been proven by Salas-Durán *et al.* (2015), Chacón-Villalobos *et al.* (2016) and Cayambe-Paguay (2016) that shrimp can be used in feeding animal species, such as laying hens, fattening fowls and Guinea pigs, among others. However, in the bovine species and in ruminants in general it has been little studied, which could be beneficial due to the high crude protein of the shrimp waste meal (> 46 %), probably because of its habitat type and feeding; and because, unlike terrestrial animals, it uses protein as primary energy source, instead of carbohydrates (Carranco *et al.*, 2003).

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<sup>1</sup> Good-quality concentrate feed produced by the company Forrajes El Barrio S. A. de C. V. Culiacán, Sinaloa, Mexico.  
<http://forrajeselbarrio.com.mx/>

The shrimp waste meal is an excellent source of minerals, chitin, cholesterol, phospholipids and fatty acids (Colindres-García *et al.*, 2015); and comes from the shell, tail, cephalothorax and residual meat which is not adequate to produce food for human beings (Cahú *et al.*, 2012). These wastes contain mainly protein (45 %), minerals (35 %), chitin (14-30 %) and carotenoid pigments; and are a rich source of tastes and enzymes (Sowmya *et al.*, 2011).

The objective of this study was to determine the effect of using 30 % of shrimp (*L. vannamei*) waste meal on some productive and reproductive indicators of grazing heifers, in Culiacán.

## Materials and Methods

**Location.** The study was conducted in the period from February to October, 2016, in Culiacán–Sinaloa, Mexico–, located in the coordinates 24° 48' 15" North latitude and 107° 25' 52" West longitude, at an altitude of 54 m.a.s.l. and with subtropical climate. The bromatology of the meal was analyzed in the Laboratories of the School of Agronomy; while the biological essay of the heifers was carried out in the zootechnical area, both belonging to the Autonomous University of Sinaloa (AUS), located on the km 17.5, Culiacán-El Dorado road.

**Feeding and animals.** Twelve Swiss Brown heifers were used, between 12 and 14 months old and with an initial weight of  $193 \pm 3$  kg of live weight, which were placed in individual pens to be offered the supplement and afterwards taken out to graze [*Sorghum sudanense* (Piper) Stapf] in a 9-ha area, during seven hours; afterwards they were protected in collective pens, where they were supplied hay bales of grasses similar to those of the grazing area.

**Treatments and experimental design.** Two treatments were evaluated in a completely randomized design: control treatment: 3 kg of supplement that contained 100 % concentrate feed (forraje El Barrio), experimental treatment: 3 kg of supplement which contained 70 % concentrate feed (forraje El Barrio) and 30 % shrimp waste meal. The remaining diet consisted in grazing and grass hay. The supplement levels were those used in the region for that animal category. The experimental period lasted 240 days.

**Experimental procedure.** The fresh matter of the shrimp waste for elaborating the meal was of industrial origin, and came from the seafood and freezing company Los Arcos. The processing for

the elaboration of the shrimp waste meal was carried out in the UAS, in the zootechnical area of the School of Agronomy.

The raw material, as it was from shrimps processed on the same day of collection, had an optimum status before starting the process and did not show companion fauna. The process of collection and transportation towards the zootechnical area was done as fast as possible, to guarantee at all times the integrity of the material. It was constituted, essentially, by cephalothorax of the species *L. vannamei*.

The material was dried under sunlight during 24-48 hours, and every 12 h it was turned to guarantee more adequate drying; when it was completely dry, it was collected and put in sacks and plastic bags of approximately 50 kg. Then it was ground with an automatic grinder to 5 mm, and samples were obtained from ten different sacks for performing the bromatological analysis; afterwards, the concentrate was substituted in a ratio 70:30 % of shrimp waste meal.

The crude protein (CP), crude fiber (CF), dry matter (DM), organic matter (OM) and ash (ash) were determined according to AOAC (2005), and the lipids, by the Soxhlet method (table 1).

Table 1. Physical and chemical characterization of the shrimp waste meal (%).

Indicator	Mean	Standard deviation
Dry matter	96,9	0,05
Humidity	3,2	0,05
Crude fiber	10,5	0,12
Cell count	78,3	0,60
Organic matter	77,7	0,20
Ash	22,3	0,20
Hemicellulose	1,1	0,01
Protein	47,0	1,15
Lipids	3,8	0,10
Chitin	6,0	0,20

**Measurements.** The variables were: body weight, daily weight gain, pH of the urine and feces, temperature of the feces and urine, and rectum temperature, which were measured every 15 days. The reproductive performance was controlled through the visual observation of estrus in the morning and in the late afternoon. When it was detected, the aimed mating took place as soon as possible.

**Statistical analysis.** For the statistical processing of the data, normality was proven through the Kolmogorov-Smirnov test and variance homogeneity, by Levene's test. All the variables fulfilled the assumptions. The data were processed through the statistical package INFOSTAT (Di Rienzo *et al.*, 2012).

## Results and Discussion

Table 2 shows the weight gain in the heifers fed shrimp waste meal (0,540 kg/animal/day); in the control heifers (0,410 kg/animal/day) the gain was lower, with significant differences ( $p < 0,05$ ). This could have been due to the increase of the nutrients contributed by the shrimp waste meal, for example, protein.

Such results differ from the ones found by Mora-Luna *et al.* (2014), who did not find significant difference in the daily weight gain when they supplemented with corn meal, hydrolyzed feather meal and soybean meal, in Brahman heifers. However, Obispo *et al.* (2002) reported live weight gains of 0,411 kg in Holstein heifers which received a supplement of similar composition, with addition of

250 g of fish meal. This could have been due to the fact that the supplements with higher palatability have better acceptance by the heifers, because they favor higher intake (Gutiérrez-Borroto *et al.*, 2018).

The daily weight gain in this study (0,520 kg) can be considered adequate, because González-Stagnaro *et al.* (2007) suggested gains higher than 0,450 kg/animal/day for the heifers to show excellent body condition, good development of the reproductive organ and a quick start of the ovarian activity, with adequate fertility.

The decrease of caloric stress indicators in the animals with supplement and inclusion of shrimp waste is shown in table 3. This could be associated to a decrease in metabolic heat, probably due to a high passage rate of the shrimp waste meal because of its particle size, and/or to a high rate of degradability in rumen of the experimental animals, which can modify the pH of the urine as well as the feces (Cordero *et al.*, 2018).

There was a better reproductive performance, finding pregnancies in a lower period of time (table 4); this coincides with the report by Perdomo-Calderón *et al.* (2017) regarding the

Table 2. Daily weight gain of heifers, with or without shrimp waste.

Treatment	Initial weight, kg	Final weight, kg	Daily gain, kg
Control	193	291	0,410
Experimental	196	321	0,520
SE $\pm$	18	7,2*	0,14*

\* $p < 0,05$

Table 3. Physiological indicators in the studied heifers, with regards to their internal medium.

Treatment	Temperature in the feces, °C	Temperature in the urine, °C	pH feces	pH urine	Rectum temperature, °C
Control	31,4	36,5	6,6	6,9	38,5
Experimental	30,3	35,2	6,8	7,1	38,1
SE $\pm$	0,21*	0,30*	0,05*	0,10	0,10*

\* $p < 0,05$

Table 4. Reproductive performance of the heifers.

Treatment	Puberty-first mating and/or mounting, days	Puberty-pregnancy, days	Matings per pregnancy	No. of pregnant heifers 8 months after the beginning
Control	61	179	1,8	3
Experimental	55	156	1,4	5
SE $\pm$	-	6*	0,1*	-

\* $p < 0,05$

fact that a weight gain in heifers from 300 to 600 g/day guarantees good reproduction and higher pregnancy percentage, and equally influences the stress attenuation. The reproductive performance of cows depends, necessarily, on the nutritional status and the environment that surrounds them. A reduction in puberty was reached for the first service of 6 days and from puberty to pregnancy of 23 days less, which could be due to the higher protein contributions and to the minerals of the shrimp waste meal, such as Ca, P, Mn, Cu, Zn, because the mineral deficit delays growth and the start of the reproductive age (Ruiz-Sánchez, 2016).

## Conclusions

The inclusion of 30 % shrimp waste meal in the diets of heifers allowed higher daily weight gain, as well as a decrease of some caloric stress indicators, such as pH of the urine and feces and rectum temperature, which allowed pregnancies in shorter time periods, essential aspect for animal husbandry in Sinaloa.

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