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Short communication

Feed digestibility and productive performance of bullfrogs raised in cages and fed in different periods and high frequency

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ABSTRACT

Three feeding frequencies (24, 48 and 96 meals/day) and three feeding periods (daytime, nighttime and daytime/nighttime) were evaluated in this experiment. Bullfrogs (*Lithobates catesbeianus*), with average weight of 78.6 ± 15.7 g, were distributed in 36 pens at a density of 88 frogs/m^2. The pens, made of polypropylene and screened floor, were installed inside cages, linearly distributed in a 2000 m^2 pond with 5% water renewal. The frogs were fed daily by automatic feeders with extruded commercial feed for carnivore fish. The experiment lasted 90 days, corresponding to the autumn and winter seasons. Feeding frequency and period interacted on the frogs' average weight (AW) values. At the end of the experiment, in the daytime and daytime/nighttime periods, there was no difference of the AW values between the evaluated feeding frequencies; however, in the nighttime period, the frogs' AW was greater for the frequency of 48 meals/day. Separately, the feeding frequency and period influenced the result of apparent feed conversion ratio (FCR) which was better with the frequency of 96 meals/day with average value of 2.13, and average value of 2.23 at nighttime. There was no difference between the treatments regarding the coefficient of apparent digestibility of dry matter, crude protein and crude energy. The coefficients of apparent availability of calcium and phosphorus were higher with the feeding frequency of 48 meals/day, regardless of the feeding period. The results showed that bullfrogs can be fed at daytime as well as at nighttime and that the highest feeding frequencies improved FCR in the production of this species. For bullfrog rearing in cages, it is recommended feeding frequency of 96 meals/day at daytime and daytime/nighttime periods and 48 meals/day at nighttime.

1. Introduction

Feeding is the most costly item in frog production, representing up to 50% of the total costs (Lima and Agostinho, 1992), and its inadequate use can compromise the quality of the production water. In frog rearing, regardless of the production system, it is still common to provide feeding just a few times a day and in large quantities; this compromises the animals' performance and the sustainability of the activity because, in this kind of feed management, there are feed leftovers which increase the production costs and worsen the water quality. The utilization of good feed management practices can solve these deficiencies in frog rearing and guarantee the production success.

Feeding automation is a practice that positively helps feed management because it allows feeding with high frequency, that is, smaller portions of feed more times during the daytime, besides allowing nighttime feeding and efficiently controlling the quantity of provided ration (Agostinho et al., 2010). Knowing the most appropriate feeding period and feeding frequency is important to determine the best strategy of feed management in order to more appropriate use of the ration and achieve the best production efficiency without wasting ration. The utilization of high feeding frequencies provides good growth and feed conversion ratio in bullfrog production (Castro et al., 2012, Oliveira et al., 2009), and studies also reported the efficiency in fish production (Sousa et al., 2012; Zhou et al., 2003).

Frog rearing in cages has been little studied; however, this new rearing system provides the appropriate environment to growth of frogs (Sousa et al., 2010) because it has continuous water renewal which keeps the

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water quality within the cages similar to the water around it (Cyrino and Conte, 2000). According to Hipólito (2004), water quality is extremely important for bullfrog production.

The aim of this study was to evaluate the effect of different feeding periods and frequencies on the feed digestibility and productive performance of bullfrogs in cages.

2. Material and methods

A total of 36 pens measuring 0.70 × 0.70 × 0.15 m with polypropylene side walls and lid and a screened metal floor covered with PVC (polyvinyl chloride) were utilized in this experiment to rearing frogs. The pens were installed inside 36 1 × 1 × 1 m (1 m^3) cages made of a 12 mm metal screen covered with PVC, linearly distributed in a 2000 m^2 pond with maximum depth of three meters and water renewal at 5%. The pens were fixed to the side walls of the cages so that the water level inside each pen was 8 cm. All polypropylene pens had a shelter made of wood and PVC to protection and so that the frogs could control body temperature by staying in the dry part of the shelter or in the water.

Thirty Nile tilapia fry (*Oreochromis niloticus*), approximate average weight of 17 g, were distributed in each cage to eat the frog feed leftovers in order to reduce the bullfrog production impact on the aquatic environment.

An automatic feeder (Agostinho et al., 2010) with PLC (programmable logical controller) was installed in every polypropylene pen. The controller determined the functioning time, feeding time and feeding frequency of the automatic feeders according to the experimental treatments, and they daily corrected the amount of provided ration based on the frogs' weight gain which was estimated by the expected feed conversion ratio as found in the literature. The rearing system of frogs in cages with automatic feeders and the polypropylene pens installed inside the cages are shown in Fig. 1.

Bullfrogs (*Lithobates catesbeianus*) with initial body weight of 78.6 ± 15.7 g were distributed in 36 polypropylene pens at a density of 88 frogs/m^2 (43 frogs/pen). The experiment had a completely random design and the treatments were distributed in a factorial scheme with three frequencies (24, 48 and 96 meals/day), three periods (daytime, nighttime and daytime/nighttime) and four replications per treatment. The frogs were fed daily by automatic feeders (Agostinho et al., 2010) with commercial extruded feed for carnivore fish consisting of 40% crude protein, 8% lipid, 10% moisture, 6% crude fiber, 1.6% calcium and 0.8% phosphorus, according to the manufacturer, with feeding rate of 3% of live weight. The amount of provided feed was corrected daily by PLC based on the frogs' daily weight gain estimated by the expected feed conversion ratio of 1.5 (Oliveira et al., 2009). All the frogs in each experimental unit were individually weighed at 30, 60 and 90 days of the experiment. The experiment was carried out in the autumn and winter seasons.

The frogs' productive performance was evaluated through the following indexes: average weight (AW) at 30, 60 and 90 days of the experiment, total weight (TW), average weight gain (AWG), daily weight gain (DWG), apparent feed conversion ratio (FCR), uniformity (U) and survival rate (SR). An adapted equation proposed by Furuya et al. (1998) was utilized to determine the frogs' uniformity:

$$U(\%)=(N \pm 20/Nt) \times 100 \tag{1}$$

where: $U =$ uniformity; $Nt =$ total number of frogs in each experimental unity and $N \pm 20 =$ number of frogs with ±20% total weight around the average experimental unit.

At the end of the experiment, feces were collected from a sample of ten frogs in each experimental unit to analyze apparent digestibility of crude protein (CP), dry matter (DM), crude energy (CE) and apparent availability of calcium (Ca) and phosphorus (P). The feces were directly collected from the frogs' cloaca with a plastic pipette, by gently pressing their abdominal region (Castro et al., 2012). Silica (SiO_2), naturally present in rations, was utilized as an intern marker.

Feces and feed samples were dehydrated in forced air recirculation stove at 55 ºC for 48 hours and ground until particle sizes were smaller than 60 μm. A 50 mg sample added by 10 mL of deionized water was submitted to three cycles of 20-second 136-watt ultrasonic agitation to extract silicon (Si). The obtained extracts were separated from the solids by filtration. The determination of Si in these extracts was measured in a spectrophotometer, Thermo Spectronic, model Genesis 6, by the method of silicomolybdic anhydride.

For Ca and P mineralization, a 100 mg sample was submitted to microwave oven digestion utilizing 5 mL of nitric acid and 3 mL hydrogen peroxide. P was determined in a spectrophotometer, Thermo Spectronic, model Genesis 6, utilizing the method of molybdenum blue with antimony as catalyzer. To determine Ca, a SHIMADZU AA-6800 flame

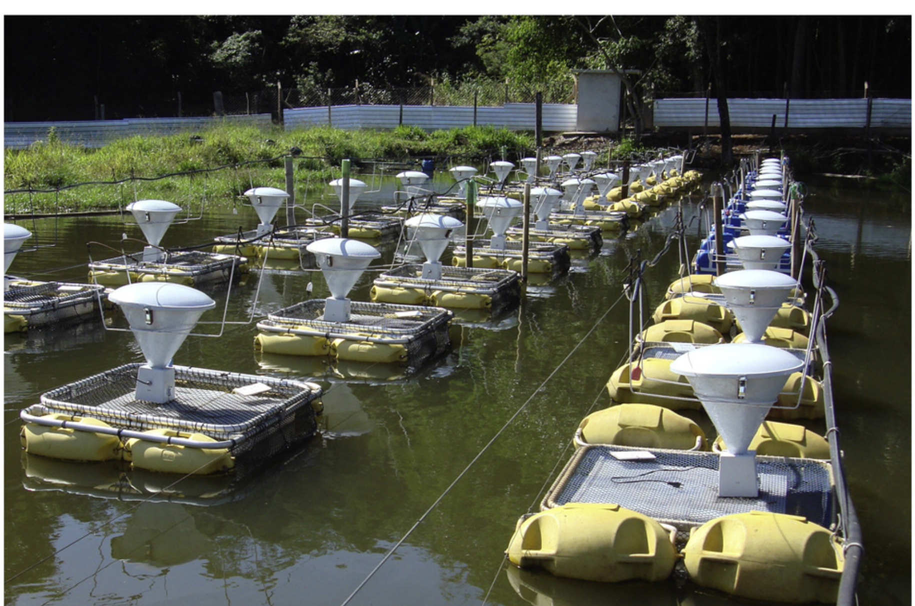

Fig. 1. Polypropylene pens, with automatic feeders, installed inside cages that were linearly distributed in a pond.