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Digestible energy of crude glycerol for pacu and silver catfish

Energia digestível do glicerol bruto para o pacu e o jundiá

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– NOTE –

ABSTRACT

*The increase in global biodiesel production is originating a glycerol surplus, which has no defined destination. An alternative to overcome this problem is its use as energy source in animal feeding. In Brazil, Pacu (**Piaractus mesopotamicus**) is one of the most farmed native fish species, whereas Silver catfish (**Rhamdia quelen**) is suitable for production in subtropical region. Considering little knowledge about crude glycerol utilization in feeds for Neotropical fish species, it was evaluated the apparent digestibility coefficients (ADCs) for energy of crude glycerol for **P. mesopotamicus** and **R. quelen**. The digestibility and digestible energy content of crude glycerol can be considered excellent even when compared to energy of common ingredients such as maize and wheat, presenting 0.97 and 0.89 of energy ADCs, and 15.2 and 13.95MJ kg^{-1} of digestible energy for Pacu and Silver catfish, respectively. In conclusion, crude glycerol is an energetic ingredient with good potential in Brazilian native fish diets.*

Key words: *byproduct, glycerin, non-protein energy, nutrition.*

RESUMO

*O aumento na produção mundial de biodiesel está gerando um excesso de glicerol, sem destinação definida. Uma alternativa para superar este problema é seu uso como fonte de energia na alimentação animal. No Brasil, o pacu (**Piaractus mesopotamicus**) é uma das espécies de peixes nativas mais cultivadas, enquanto que o jundiá (**Rhamdia quelen**) é apropriado para a produção na região subtropical. Considerando a falta de conhecimento sobre a utilização do glicerol bruto em rações para espécies de peixes Neotropicais, determinaram-se os coeficientes de digestibilidade aparente (CDAs) para a energia do glicerol bruto em **P. mesopotamicus** e **R. quelen**. A digestibilidade e o conteúdo de energia digestível do glicerol bruto podem ser considerados excelentes, mesmo quando comparados à energia de ingredientes comuns, como o milho e o trigo, apresentando para energia CDA de 0,97 e 0,89, e 15,2 e 13,95MJ kg^{-1} de energia digestível para o pacu e o jundiá, respectivamente. Por fim, o glicerol bruto é um ingrediente energético com bom potencial para dietas de peixes nativos do Brasil.*

Palavras-chave: *subproduto, glicerina, energia não-proteica, nutrição.*

South America has the richest ichthyofauna of all continents (SAINT-PAUL, 1986). Among these species, the Pacu ***Piaractus mesopotamicus*** (Holmberg) stands out for its easy adaptation to be farmed and to consume a diverse number of feedstuffs (ABIMORAD & CARNEIRO, 2004). On the other hand, Silver catfish ***Rhamdia quelen*** (Quoy & Gaimard) is an omnivorous fish with interest for aquaculture in Brazil, Argentina, and Uruguay (SALHI & BESSONART, 2012), because it withstands cold winters and presents fast growth rate in summer, characteristics that make it a suitable species for fish production in southern South America (PEREIRA et al., 2006).

Glycerol is the main byproduct generated in biodiesel production (DASARI et al., 2005), an alternative fuel obtained from renewable lipids such as those in vegetable oils or animal fat (LUCENA et al., 2008). It is estimated that by 2016 the world biodiesel market will achieve the quantity of 37 billion gallons, which means that more than 4 billion gallons of crude glycerol will be produced every year (KOŚMIDER et

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al., 2011). Such glycerol surplus will not only result in a further reduction in prices, but the disposal of these streams will become a major issue (MCCOY, 2006).

The development of new markets to absorb the crude glycerol production can reduce its accumulation, as well as establish a sustainable industrial chain for biofuels. Crude glycerol utilization in fish diets was reported only to Channel catfish (LI et al., 2010) and Nile tilapia (NEU et al., 2012a, 2013). There are no studies on the digestible energy of glycerol in Neotropical fish species, and little information published is restricted to Nile tilapia (MEURER et al., 2012; NEU et al., 2012b). The present study aimed to determine the apparent digestibility coefficients (ADCs) of crude glycerol energy for ***P. mesopotamicus*** and ***R. quelen***.

The experiment was performed at Aquatic Organisms Nutrition Laboratory of Universidade Federal do Paraná, Setor Palotina, Paraná State, Brazil. Crude glycerol was provided by BSBIOS Indústria e Comércio de Biodiesel Sul Brasil S/A, Passo Fundo, Rio Grande do Sul State, Brazil. Due to its high hygroscopic degree, crude glycerol was dried in a ventilated drying oven at 55ºC for 24h before ration manufacture. ADCs for energy were measured indirectly using 0.1% of chromic oxide (Cr_2O_3) as an inert marker. The reference and test diets were formulated and pelletized based on vegetable food (Table 1).

The fish were housed in one cage (100L) per species. For each species, a polyethylene circular tank (1,000L) was utilized as feeding tank and a cylinder-conical tank (150L) as a faecal collecting tank. Feeding and feces collection tanks were aerated continuously (>5mg L^{-1}) and temperature was maintained by thermostatic heaters at 28±1.5°C.

Table 1 - Composition of experimental feeds (g kg^{-1}).

Ingredient	Reference diet	Test diet
Soybean meal	661.6	463.1
Maize	290.7	203.5
Soybean oil	11.1	7.8
Dicalcic phosphate	18.4	18.4
Calcitic lime	2.2	2.2
Mineral and vitamin supplement[1]	10.0	10.0
Salt	5.0	5.0
Cr_2O_3	1.0	1.0
Glycerol	-	289.0

[1]Warranty levels per product kilogram: Vit. A, 1,200,000UI, Vit. D3, 200,000UI, Vit. E, 12,000mg, Vit. K3, 2,400mg, Vit. B1, 4,800mg, Vit. B2, 4,800mg, Vit. B6, 4,000mg, Vit. B12, 4,800mg, Folic acid, 1,200mg, Pantotenate Ca, 12,000mg, Vit. C, 48,000mg, Biotin, 48mg, Coline, 65,000mg, Niacin, 24,000mg, Fe, 10,000mg, Cu, 6,000mg, Mn, 4,000mg, Zn, 6,000mg, I, 20mg, Co, 2mg, Se, 20mg.

Fish juveniles (Pacu, 129.06±29.27g, 18.46±1.52cm, n=25; Silver catfish, 69.06±12.77g, 19.79±1.14cm, n=30) were submitted to an adaptation period (5 days) to the experimental conditions and diets. Thereafter, fish were kept in cages at feeding tanks from 07:30 to 18:00h, fed once in the morning (at 11:00 hours) and from 16:30 to 17:40h, until apparent satiation. After 20min of last feeding, the fish were transferred to cylinder-conical tanks, where they remained until 07:30h of the following morning, when these came back again to feeding tanks. The techniques used for the faecal collection and processing were the same as adapted by Meurer et al. (2012).

Gross energy content was measured by combustion in an adiabatic bomb calorimeter (Parr Instruments, Moline, IL, USA, model Parr 6200), and chromic oxide was determined using a process involving perchloric and nitric acid digestion followed by atomic absorption spectrometric determination (KIMURA & MILLER, 1957). The crude glycerol energy ADCs values were calculated according to NRC (2011).

Crude glycerol presented 15.67MJ kg^{-1} of gross energy, 93.24% of dry matter, and 6.06% of ash. Energy ADCs were 0.97 and 0.89, and digestible energy were 15.2 and 13.95MJ kg^{-1}, for Pacu and Silver catfish, respectively.

ADCs results and digestible energy content to crude glycerol determined in this study were higher than those described to Nile tilapia by MEURER et al. (2012) (0.89 and 13.09MJ kg^{-1}) and NEU et al. (2012b) (0.81 and 10.91MJ kg^{-1} to semi-purified mixture glycerol, 0.58 and 12.78MJ kg^{-1} to crude vegetable oil glycerol, and 0.47 and 7.33MJ kg^{-1} to semi-purified vegetable glycerol, respectively).

Compared to the ADCs and digestible energy values from other energy ingredients for Pacu, glycerol was higher than wheat meal (0.81 and 13.84MJ kg^{-1}, respectively), maize (0.87 and 14.48MJ kg^{-1}), and sorghum (0.93 and 14.51MJ kg^{-1}), and lower than rice meal (0.93 and 17.60MJ kg^{-1}) (ABIMORAD & CARNEIRO, 2004). FERNANDES et al. (2004) observed lower values for digestible energy in maize (14.02MJ kg^{-1}) and wheat bran (7.46MJ kg^{-1}) for ***Piaractus brachypomus*** (Cuvier).

When it comes to Silver catfish, these values were higher than those reported by OLIVEIRA FILHO & FRACALOSSI (2006) for maize (0.59 and 9.62MJ kg^{-1}) and broken rice (0.64 and 10.28 MJ kg^{-1}). Regarding another Neotropical catfish species, TEIXEIRA et al. (2010) described ADCs values of gross energy for maize (0.62), rice bran (0.66), broken rice (0.46), and sorghum (0.47) for sorubim (***Pseudoplatystoma*** sp.). Moreover, GONÇALVES & CARNEIRO (2003) observed values of 0.64 for maize, 0.48 for sorghum, 0.51 for rice bran, and 0.47 for broken rice in spotted sorubim ***P. corruscans*** (Spix & Agassiz) diets, and SILVA et al. (2013) reported for striped sorubim (***P. reticulatum*** Eigenmann & Eigenmann) ADC values of 0.43 for maize.

All these values were lower than those of gross energy ADCs of crude glycerol determined in this study for silver catfish, probably due to their different chemical compositions. The above mentioned ingredients have a lot of starch in its composition, which is not well utilized by fish, especially carnivorous species, characteristic related to the utilization of carbohydrates (SHIAU, 1997) or glucose intolerance (MOON, 2001) in fish.

The good energy digestibility determined for glycerol as well as the amount of digestible energy can be related to the ease in which this nutrient is digested, absorbed and used by both species. According to LIN (1977), glycerol is absorbed in the intestine, enters into the bloodstream and subsequently is used by liver and tissues for glucose synthesis by gluconeogenesis or energy production by glycolysis and citric acid cycle.

These results show the possibility of crude glycerol to be used as energy source in Pacu and Silver catfish diets. The current increase in biofuel production originates a large surplus of crude glycerol and its use in feed formulation could reduce costs and improve profits of both productive chains. Therefore, additional experiments must be performed to evaluate crude glycerol replacing other energy sources in fish diets, to evaluate its productive performance, feed efficiency and body composition in different phases of growth.

Crude glycerol derived from the biodiesel production is an energy source with good potential for omnivorous fish species, presenting ADC of 0.97 and 0.89, and digestible energy content of 15.2 and 13.95MJ kg^{-1} as fed basis for Pacu and Silver catfish, respectively.

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ETHICS COMITTE AND BIOSECURITY

This study was approved by Ethical Committee on Animal Experimentation of the Universidade Federal do Paraná (Protocol n.14/2011 - CEUA Campus Palotina).

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