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Effects of Boiled Jatrophacurcas Kernel Meal on Growth Performances of Clariasbatrachus Fingerlings

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Abstract

A feeding experiment was conducted under strictly laboratory conditions to investigate the effects of boiled Jatrophacurcas kernel meal (JCKM) on growth performances, feed utilization and protein efficiency of Clariasbatrachus fingerlings for 8 weeks. Fishes were fed twice daily at the rate of 5% of body weight. Percentage weight gain of fishes varied significantly among the experimental diets and the control diet. Specific growth rates were also significantly different among the control diet (0% JCKM) and diet 3 and 4 with 20% and 30% inclusion levels of JCKM respectively.Fishes fed with diet 4 exhibited best growth performances in comparision to other diets. It is suggested that Clariasbatrachus fingerlings could tolerate 30% inclusion level of JCKM in supplementary feeding trial.

Keywords: Jatrophacurcas, Clariasbatrachus, Kernel Meal, Growth.

Introduction

In tropical countries, intensive fish culture practices are facing a major threat from the high price of fish meal (FAO, 2012). Traditionally, fish meal has long been utilized as the choice of protein supplement in aquaculture practices, but non-availability, poor quality and higher cost of fish meal have restricted its use in recent years. Hence, alternative protein sources, both conventional and non-conventional, have been used to replace fish meal from fish diet (Makkar *et. al*.,1997; Becker and Makkar, 2008). A number of low-cost, plant protein ingredients have been tested experimentally, but not with much success except soybean meal. But increasing demand of soybean meal for human consumption and for other animal feed industries has elevated its price to a record level. In this context, search for some other alternative protein sources in fish feed supplements without reducing the nutritional quality has become inevitable (Madalla, 2008; FAO, 2012).

Jatrophacurcas L., a perennial, multipurpose plant of family Euphorbiaceae, is easily grown in tropics and sub-tropics. It is a seed-bearing plant and each ton of dry seed yields 200-300 litres of bio-diesel and nearly 700-800 Kg of kernel meal as by-product (Brodjonegoro *et.al*., 2005). The kernel cake obtained after oil extraction, contains about 56.4% crude protein which is higher than that of soybean meal (48%). Therefore, Jatrophacurcas kernel meal (JCKM) can effectively be used as a protein supplement for animals. The amino acid composition of this kernel meal is comparable with that of FAO reference protein for pre-school children except lysine. But JCKM can not be used as such due to the presence of a number of toxic and anti-nutritional compounds like lectin , anti-trypsin , saponin, phytate and phorbol esters(PEs) (Makkar *et. al*.,1998). Among these, PEs are considered to be the most toxic component of JCKM (Makkar and Becker, 1998).

Therefore, the potential of JCKM in aquaculture could only be tenable if it is detoxified by means of a low-cost detoxification technique. The detoxified JCKM has the potential to be a good competitor of soybean meal in animal feed market (Olvera-Novoa *et. al.,* 2002). But reports on performances of fishes fed with detoxified JCKM as a substitute of fish meal or soybean meal are very limited (Kumar *et. al*., 2008 ; Makkar and Becker,1999; Akintayo *et.al*.,2008; Workagegn *et. al*.,2013; Alatise et. al., 2014). In view of these, the present study has been focussed on utilization of boiled JCKM in the diet of a catfish, Clariasbatrachus fingerlings. The aim of the experiment is to evaluate the efficiency of boiled JCKM on growth performances and protein utilization by C. batrachus fingerlings.

Materials and Methods

Collection of Jatropha Seed and Preparation of Kernel Meal

Mature seeds of Jatrophacurcas were collected from the surroundings of Syamsundar college and stored in a polythene packet at room temperature. At the start of the experiment, seeds were deshelled and kernels were washed with tap water. Then the seeds were sun-dried and ground into a powder to pass through 1 mm. sieve. The kernel powder was then boiled at $100^{o}C$ for 30 mins. to eliminate the anti-nutritional factors present in JCKM. All other feed ingredients used in feed formulation were purchased from local market. Proximate composition of test diet and JCKM were estimated according to the methods of AOAC (1990).

Formulation of Diet

The experimental diets were prepared using JCKM for replacing soybean meal on a dry basis. Four isonitrogenous and isoenergetic diets were prepared in which boiled JCKM was mixed at 0,10,20, and 30% inclusion levels. The diets with 0% kernel meal is used as control. All the ingredients were mixed together using a kitchen mixer. Vitamin premix, mineral premix and oil were added later. The mixed ingredients were made to paste by adding water and passed through a pelleting machine. The pellets were sun-dried to a constant weight. Percentage composition of the test diets is shown in Table 1.

Table-1

Percentage Composition of the Test Diets

Ingredients	Diet 1	Diet 2	Diet 3	Diet 4
Boiled JCKM	------	7.50	15.20	24.00
Soybean Meal	36.50	30.00	24.50	16.50
Fish Meal	22.00	23.50	23.50	24.20
Groundnut Cake	15.50	15.50	15.70	16.50
Maize Meal	17.50	15.00	12.60	10.30
Vitamin Premix	3.00	3.00	3.00	3.00
Vegetable Oil	2.00	2.00	2.00	2.00
Mineral Premix	2.50	2.50	2.50	2.50
Lysine	1.00	1.00	1.00	1.00
Total	100	100	100	100

Table-2

Proximate Composition of Boiled and Unboiled JCKM

Components	Boiled JCKM	Unboiled JCKM
Moisture	7.52	5.30
Crude Protein	38.20	32.04
Crude Lipid	30.48	28.26
Crude ash	4.00	5.35
Crude fibre	3.75	4.35
N2 free extract(NFE)	23.57	30.00
Gross energy (Kcal/ g)	602.64	570.62

NFE=100-(crude protein+crude lipid+crude fibre+total ash)

Vitamin Premix (per gram): A 300 IU, D 300 IU,E 7.5 mg, B1, B2, B3, B6, B12 2.5 mg each, Niacin 25 mg, C 40 mg, Folic acid 0.5 mg.Mineral Premix (mg / g) : Ferrous fumerate 20, Manganese chloride 0.5, MgO 1, Calcium gluconate 150, ZnO 2, KI 1.7, $CoCl_2$ 10.5.

Experimental Design and Feeding Trial

For each diet three replicates were set up. Each replicate containing 15 fishes were fed as a group. Clariusbatrachus fingerlings were purchased from local fish market. Fishes were acclimatized for 10 days in the laboratory conditions and during this period they were fed with a commercial diet. A set of 12 rectangular plastic tanks of 50 L capacity each was arranged for the feeding trial. A total of 180 Clariasbatrachus fingerlings of average initial weight 30.50+0.40 g were used. Fishes were fed with the test diets twice daily at a fixed time (09:00 and 15; 00 hrs.) and fixed rate (5% of body weight / day). All the fishes were weighed collectively at the start of the experiment and 7 day intervals. Feeding trials were conducted upto 8 weeks. Growth performances were estimated as follows:Body Weight Gain (BWG)=(FBW- IBW) / IBW ; Daily growth rate (g/day)=BWG / No. of days ; Percentage weight gain(%)= (BWG / IBW)x100 ; FCR=Feed intake(g) / BWG(g) ; Protein fed(g) = (% protein in diet x feed intake) / 100 ;PER= BWG (g) / protein fed (g); Specific growth rate (%/day) = [(In FBW-In IBW) / dt] x 100.

BWG=body weight gain; IBW=initial body weight; FBW= final body weight; FCR= feed conversion ratio; PER= protein efficiency ratio; dt=no. of days.

Water Quality Assessment

Throughout the experiment water quality was monitored every week. Water temperature and pH were measured daily using a digital pen meter. Dissolved oxygen was measured by Winklermethod and conductivity was determined by a digital conductivity meter.

Statistical Analysis

All data were analysed with one-way analysis of variance (ANOVA) and the significance of difference between the means were tested by Duncan,s multiple range test ($P<0.05$) (Duncan,1955). Values are expressed as means+ standard deviation.

Results & Findings: Proximate Composition of Boiled and Unboiled JCKM

Chemical composition of boiled and unboiled JCKM were shown in Table 2. The crude protein content of boiled kernel is higher (38.20%) than that of the raw kernel(32.04%).Both boiled and unboiled kernel contained high crude lipid(30.48% and 28.26% respectively) which were reflected in higher gross energy level. The nitrogen free extract of raw and boiled JCKM were 23.57% and 30.0% respectively.

Proximate Composition of Experimental Diets

Proximate composition of all the test diets were presented in Table 3. Diet 4 contained the highest crude protein level (40.70%), whereas Diet 1 had the highest fibre content(3.92%). As far as crude lipid level is concerned, diet 1 had the highest level (9.90%) . The Nitrogen Free Extract was highest in diet 1 (40.40%), while diet 1 had the lowest NFE (39.17%). The gross energy level(Kcal/g) was almost similar in all the test diet .

Table-3

Proximate Composition of the Experimental Diets

Parameters	Diet 1 (0%)	Diet 2 (10%)	Diet 3 (20%)	Diet 4 (30%)
Moisture Crude protein Crude lipid Crude ash Crude fibre NFEGross energy (Kcal/g)	8.6440.36 9.906.653 .9239.174 85.62	10.2040. 569.526. 523.663 9.74485. 20	7.5240 .429.4 06.463 .6040. 12484. 64	7.0240. 709.206. 363.344 0.40485. 46

NFE=100-(Crude Protein + Crude Lipid + Crude Fibre+Total Ash).

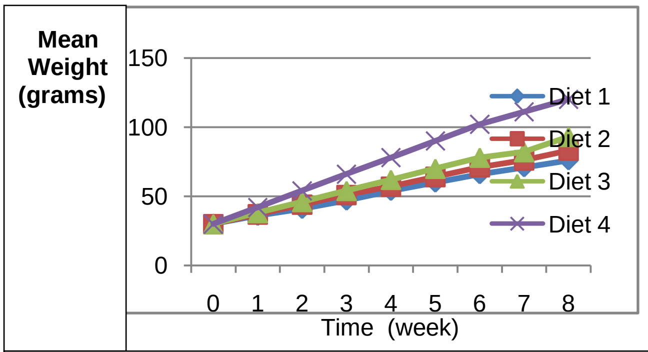

Fig 1: Mean Weight of Clarias batrachus finger lings Fedon Boiled JCKM

Growth Performances

Growth performances and feed utilization of Clariasbatrachus fingerlings fed with boiled JCKM –based diet as shown in Table 4, revealed that diet 4 has the highest value of mean weight gain (90.18g), while diet 1 has the lowest value of mean weight gain(45.14g). This trend in body weight gain has also been reflected in daily growth rate as well as specific growth rate of fishes. Fishes fed with diet 4 showed highest values of both the above mentioned parameters while those values are lowest in fishes fed with diet 1. The best growth response as reflected in percentage weight gain, was shown by 30% inclusion of boiled JCKM in diet 4.The feed conversion ratio (FCR) ranged between 1.94 (diet 4) to 2.93 (diet 1) which also indicates the highest growth performance of fishes fed with diet 4. The protein efficiency ratio (PER) ranged between 0.84 (diet 1) to 1.29 (diet 4). Fig. 1 shows the weekly growth performances of Clariasbatrachus fingerlings fed with graded levels of boiled JCKM. Throughout the experimental period , an acceptable range of water quality parameters for aquaculture practices was maintained. Water temperature ranged between 25.3 to 28.5^{0}C, dissolved oxygen 5.2 to 5.8 mg/l, pH 7.6 to 8.0 and conductivity 30 to 350 uhom/ cm3.

Table 4

Growth Performances of Clariasbatrachus Fingerlings Fed with Boiled JCKM.

Growth parameters	Diet 1 (0%)	Diet 2 (10%)	Diet 3 (20%)	Diet 3 (30%)
1. Initial Body Weight (G)	30.50+0.40	30.56+0.42	30.60+0.45	30.65+0.48
2. Final Body Weight (G)	75.64+0.68	82.62+0.94	92.42+1.42	120.83+0.96
3. Body Weight Gain (G)	45.14+0.56	52.06+0.86	61.82+1.60	90.18+1.82
4. Daily Growth Rate (G/Day)	0.80+0.42	0.93+1.28	1.10+0.86	1.61+0.56
5. Percentage Weight Gain (%)	148.00+1.42	17035+6.58	202.02+3.40	294.22+6.24
6. Specific Growth Rate (%/Day)	1.62+0.01	1.77+0.06	1.97+0.03	2.45+0.08
7. Total Feed Consumed (G)	132.50+1.2	140.25+3.67	152.62+2.02	174.62+1.62
8. Feed Conversion Ratio (FCR)	2.93+0.04	2.69+0.12	2.46+0.06	1.94+0.18
9. Protein Fed (G)	53.48+1.30	56.88+1.68	61.69+0.92	71.07+1.68
10. Protein Efficiency Ratio (PER)	0.84+0.02	0.91+0.06	1.00+0.04	1.29+0.06

Table : Mean in the Same Row With Different Superscripts Differ Significantly

Discussion & Suggestions

In animal nutrition, requirement of protein has been given top priority because it is the single factor that is required in the largest quantity for proper growth and development of animals and also it is the most precious component in diet formulation (Lovell,1989; NRC,1993; Fakunle et.al., 2013). A number of nutritional study have been conducted with Jatropha kernel meal as a substitute for fish meal in different fish species (Makkar and Becker,1999; Kumar et.al. 2008; 2010; 2011;2013; Mukherjee et.al., 2014; Alatise et.al.,2014; Hisano et.al., 2015). But attempts to replace fishmeal by alternative sources of protein have not been equally successful because it depends on the nature and composition of ingredients, inclusion level and methods of detoxification (Alatise et.al.,2014). Studies on the replacement of fishmeal by JCKM for catfish production are very scanty(Solomon et.al.,2016). To my knowledge, this is the first study on the replacement of fishmeal by boiled JCKM in the diet of Clariasbatrachus. The results on the growth performances and feed utilization of C. batrachus fingerlings fed with boiled JCKM at different inclusion levels showed that percentage weight gain issignificantly different (P<0.05) in comparision to fishmeal based diet. It clearly indicates that kernel protein has effectively been preferred and utilized by the fishes. Boiling has removed the anti-nutritional factors present in JCKM which may, otherwise, cause irritation of digestive tract leading to decrease in feed intake and growth(Fukunle et. al.,2013). In the present study, more or less constant water quality parameters were maintained which was within the suitable range of catfish culture(Azzaza et. al., 2011). Fishes showed differential growth patterns due to dietary inclusion of boiled JCKM.(Workagegn et.al.,2013). Both the feed utilization and protein efficiency ratio are higher in fishes fed with diet 4 which differed significantly (P<0.05) from those of other diets. But Fukunle et. al. (2013) obtained better performances of African catfishes fed with graded levels of boiled JCKM. Similarly, Kumar et.al., (2011) reported higher growth of Cyprinuscarpio fed with detoxified kernel meal. They concluded that principal cause of differences might be due to acceptability of diets, presence of toxic and anti-nutritional factors as well as digestibility of proteinsin the diets. Hence, 30% inclusion of boiled JCKM along with added amino acids in the diet 4 resulted significantly different growth performances from those of other diets. Boiling may have reduced the level of anti-nutritional components of the diets. Similar observations were recorded by Kumar et. al., (2008); Azzaza et. al. (2011) and Workagegn et.al. (2013). They concluded that inclusion level of JCKM in the diet had an effect on digestibility and absorption of proteins. Thus, incorporation of dietary JCKM upto 30% level after simple boiling can be a good protein source for Clariasbatrachus fingerlings. Therefore, JCKM has the potential to be one of the promising protein sources in future aquaculture practices which will gradually replace both the fishmeal and soybean meal from fish diet. Incorporation of more JCKM in fish diet can further be increased by applying different detoxification methods like chemical and /or biological treatments.

Aim of the Study

In aquaculture practices, the price of fish feed covers about 50-60% of the total operation and the factor behind the increment of cost of aqua feed is the rapid growth of the industry. In fact, global aquaculture has been the fastest growing food production sector. One of the main steps in solving this problem is to search for an alternative source of protein food that will replace the costly fish meal or soya bean meal from fish diet. Jatropha curcas kernel meal has the potential to be one of the cheapest protein sources for aquaculture in future. If the kernel meal is freed from toxic and anti-nutritional substances, it will be a good competitor of both fish meal and soya bean meal in fish feed market. The present study aims at the use of boiled JCKM as a substitute of fish meal in the diet of Juveniles of a cat fish Clarias batrachus. The purpose of this experiment is to find out the efficacy of JCKM in growth performances in fish model so that this low-cost protein supplement can be recommended in future aquaculture practices.

Conclusion

An experimental feeding trial was designed to evaluate the growth performance of Clarias batrachus fingerlings fed with boiled JCKM as a replacement of fish meal. Fingerlings were fed with artificial diets containing varied levels of inclusions of JCKM up to 8 weeks. The mean weight gain, feed conversion ratio, specific growth rate and protein efficiency ratio were significantly higherin fishes fed with diet-4 having 30% level of inclusion of JCKM. The present study shows that a carnivorous fish like C.batrachus can tolerate 30% inclusion of JCKM in the diet without affecting the growth and nutrient utilization of the fish. On the basis of the result of this study, it can be concluded that JCKM after simple boiling, can be a good source of protein in aqua feed market which will minimize the cost of operation as well as will not compete with human feed ingredients.

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