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Evaluation of Hydrolyzed Feather Meal As a Dietary Protein Source For Common Carp(*Cyprinus carpio* L.) Fry

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□ ABSTRACT □

This study aimed at investigating the effect of hydrolyzed feather meal on the growth performance and survival of *Cyprinus carpio* fry. Four isonitrogenous (45 % protein and 600 kcal GE/100g) diets were tested, the first with fish meal as a major protein source, the second contained a mixture of fish meal and hydrolyzed feather meal, while the third one contained hydrolyzed feather meal as a major protein source, and the last diet contained a mixture of hydrolyzed feather meal and soybean meal. The common carp fry were fed three times a day to satiation for 21 days.

The results showed that the first diet produced the best performance, and significant differences ($P<0.05$) were found compared to the other diets, the worst results were found in the third diet, while the growth was better using the second and the fourth diet compared to the third one.

Survival rate was not affected ($P>0.05$) by the first, second and fourth diets, while the mortality of fry was important using the third diet.

Key words: *Cyprinus carpio*, Fry, Hydrolyzed Feather Meal, Growth Performance, Survival.

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تقييم استخدام مسحوق الريش كمصدر للبروتين الغذائي لصغار سمك الكارب العادي(*Cyprinus carpio* L.)

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□ ملخّص □

أجري هذا البحث لدراسة تأثير اضافة مسحوق الريش كمصدر للبروتين على مظاهر النمو والبقاء على قيد الحياة لصغار سمك الكارب العادي *Cyprinus carpio* . تم تحضير أربع خلطات علفية احتوت على نسبة واحدة من البروتين (45 % و 600 كح/100 غ عليقة) حيث احتوت الخلطة الأولى مسحوق السمك كمصدر رئيس للبروتين، بينما تضمنت الثانية مزيج من مسحوق السمك و مسحوق الريش، واحتوت الثالثة مسحوق الريش كمصدر أساسي للبروتين وتكونت الخلطة الأخيرة من مزيج من مسحوق الريش و مسحوق فول الصويا. غذيت صغار الكارب بمعدل ثلاث مرات في اليوم حتى الشبع لمدة 21 يوما".

أشارت النتائج أن أفضل معدلات للنمو و معامل تحويل الغذاء تم الحصول عليها من الصغار التي علفت على الخلطة الأولى، حيث وجدت فروق معنوية ($P<0.05$) بين نتائج هذه الخلطة و الخلطات الأخرى، في حين أعطت الخلطة الثالثة أسوأ النتائج، بينما تحسن الأداء لحد ما عند استخدام الخلطتين الثانية و الرابعة بالمقارنة مع الثالثة ($P<0.05$).

كما دلت النتائج على أن معدل البقاء على قيد الحياة ($P>0.05$) لم يتأثر بمصادر البروتين في الخلطات الأولى، الثانية والرابعة بينما كانت نسبة النفوق عالية عند الصغار التي علفت على الخلطة الثالثة.

الكلمات المفتاحية: صغار الكارب العادي – مسحوق الريش– مظاهر النمو– البقاء على قيد الحياة.

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Introduction:

Carps (Cyprinidae) are the biggest group of cultured fish throughout the world (after salmonids). This may due to the combination of several factors such as feeding habits at a low level of the food chain, high survival & growth performances under culture conditions and tolerance of high variations of water quality and diseases, all of these had led to the development of numerous production systems in both temperate and tropical regions (Kestemont, 1995). The common carp (*Cyprinus carpio* L. 1758) has been cultured for several thousands years ago and is now widely distributed ; it is the second in the world aqua- cultural production. Common carp is cultured on almost all countries under a wide range of geographic, climatic and technological conditions (Jeney, 1995).

Nutrition is the most expensive component in intensive aquaculture industry, where it represents over 50 % of operating costs. Moreover, protein itself represents about 50 % of feed costs in intensive culture (Sultan, 2009).

Fish meal (FM) is the main and best protein source in aquafeeds, due to its high content of high quality proteins, essential amino acids, high contents of phospholipids and essential fatty acids, high level of digestibility and palatability (Barlow, 2003). The limiting factors in applying FM in the production of aquafeed are high prices, limited sources and microbiological quality (Du and Niu, 2003).

Data from FAO (2006) showed that the total world production of FM in the last two decades was about 6 to 7 million tons. From the total production of FM, 46 % was used in aquafeed production. In the year 2004, 19.5 million tons of aquafeed was produced, with feed for Cyprinids comprising 45 % (Tacon, 2005).

As a result of high demands and shortage and high prices, it necessitates replacing FM with another available and cheaper protein sources either of animal or plant origin. Vegetable protein sources are widely available, but the replacement of FM by those vegetable protein sources is limited with some aquatic species. The main nutritional problem associated with higher utilization of plant protein sources are unbalanced amino acids profile, lower digestibility of amino acids, higher fiber content, presence of anti-nutritional factors and low availability of Phosphorus (Uran *et al*., 2008). On the other hand, protein sources of animal origin are more reliable in aquafeed around the world. One of these animal protein sources are recycled by-products of terrestrial animals which have had an application in aquafeed production for many years. These by-products include edible beef suet, fat, meat and bone meal, meat meal, hydrolyzed feather meal, poultry by-product meal, blood meal, liver and lung meal and egg powder (Stankovic *et al*., 2011). Rendered products are a cheap source of good quality proteins, a good source of lysine, sulfur amino acids and phosphorus (El-Sayed, 1998). Animal by-products are very palatable for many fish species (Otubusin *et al*., 2009). Their application was limited in the ‘70 and ‘80 due to the studies that indicated low digestibility in fish, but new technologies of processing of rendered by-products showed a significant increase of digestibility providing an increase in their use in fish feed production (Cho *et al*., 1982; Gill, 2000).

One of the alternative ingredients is hydrolyzed feather meal HFM, which considers as a valuable protein source (72% protein) and should be used as alternative protein source in diets for fish and shrimp. HFM is deficient in Methionine (Met.), Lysine (Lys.) and Histidine (Hist), but it contains a lot of Cystine. It is high in water soluble amino acids such as arginine, proline, glycine and aspartic acid (Sultan, 2009).

Aim of the Research:

Carps constitute a high proportion of cultured fish in Syria, they are eatable and accepted in many cities in Syria. Natural food is used in the larval stages, then supplemented diets are used to fulfilled the nutritional requirements. As mentioned above, FM is very expensive and rare especially in Syria, so this research is dealing with a very important issue concerning the supply of diets of a good protein quality, local, cheap and available around the year. Indeed, no previous studies were performed in Syria concerning the usage of hydrolyzed feather meal in fish diets either in government fish farms or private ones, although its usage is common in poultry industry. This paper is trying to deal with the possibility of using this protein source for common carp fry as a protein source alone or as a mixture with other protein sources.

Materials and Methods:

This experiment was achieved at the Research Laboratory, Zoology Department, Faculty of Science, Tishreen University, Lattakia, Syrian Arab Republic. *Cyprinus carpio* fry (0.16g mean initial weight) were transported from the El-Sin Fish Farm, in plastic containers supplied with air produced by a pump. In the laboratory, fry were put randomly in glass aquaria to rest and kept unfed for one day. The dead fry (due to manipulation and transportation) were removed and a commercial diet was offered for two days. Then, fry were distributed in 8 (duplicate for each treatment) glass aquaria (25 liter capacity) at a ratio of 100 fry/aquarium, or 4 fry/ liter, and started to fed the experimental diets in order to get used on them for two days before starting the study. The aquaria were cleaned daily to remove the feces and the expelled water was replaced with another dechlorinated tap water. The aquaria were provided with an air stone for aeration. Water temperature, pH and dissolved Oxygen were recorded daily using (Dissolved Oxygen Kit-WTW milti 34oi), the water temperature changed between 21.6-27.14 °C, pH 7 - 7.3 and dissolved Oxygen 5.39 - 6.11 mg/liter.

Common carp fry were fed four diets containing the same protein level (45 % protein and 600 kcal GE/100g diet) with different protein sources. The first diet was used as a control (FM, as a protein source), while the second diet contained a mixture of HFM and FM, the third diet contained HFM as a major protein source, and the last diet had HFM with soybean (SBM) meal as a protein source. The composition of the tested diets is given in table (1), the diets were prepared as described by El-Sayed (1990). The fry were fed the diets to satiation, three times daily (at 8 am, 12 and 4 pm), seven days a week for 21 days (from 1-6-2012 to 21-6-2012).

To study the effect of the tested diets on fry performance, the initial weight (g/fish), the final weight (g/fish) and the amount of given food (g/fish) were recorded and the rate of survival was calculated.

At the end of the experiment, the fry in each aquarium were netted and weighed to obtain the final body weight (g/fish). The statistical analysis was performed by using a two-way analysis of variance (ANOVA) to test the effect of the four diets on the fry growth performance.

Table (1): Composition of the experimental diets (%) fed to *Cyprinus carpio* fry.

Ingredients	Diets			
	Diet (1)	Diet (2)	Diet (3)	Diet (4)
	FM	HFM+FM	HFM	HFM+SM
Fish meal (62% protein of dry matter)	55g	31g	-	-
Hydrolyzed feather meal (72% protein of dry matter)	-	31g	50g	32g
Soybean meal (44.8% protein of dry matter)	20g	-	13g	45g
Wheat bran (15.2% protein of dry matter)	10g	15g	11g	13g
Corn meal (9.6% protein of dry matter)	5g	13g	16g	-
Fish oil	4g	4g	4g	4g
Plant oil	6g	6g	6g	6g
Total	100	100	100	100

Results and Discussion:

The results of this experiment revealed that the diet (1) which contained FM as a major protein source, produced the best growth rate, feed conversion ratio and survival as shown in table (2). FCR of fry fed FM was about 1.46 which could be a good parameter. Fry of this group were active, well accepted to the tested diets.

The picture was reversed by the usage of HFM as a protein source. In diet two (50% HFM+ 50% FM), significant differences had been registered ($P<0.05$) in growth rates, feed conversion ratio (FCR declined to 3), although survival rate was slightly higher in fry fed diet 2 than those fed diet 1 (figure 1), this could be explained by technical reasons concerning manipulation with fry during the course of the experiment or their health state. While the third diet (HFM as a major protein source) showed the worst results, in which growth rates parameters declined dramatically as shown in table (2), FC (8) retreated to the worst result could be recorded by any diet given to any fish. So, significant differences ($P<0.05$) were found among diet 3 and diet 1, and even with diet 2. Survival rate also drastically declined where it was 25 %, despite the fact that this group of fry fed diet 3 had begun with higher initial weight than the other three groups. Also we noticed that fry appetite to this diet was very bad, then they were hardly moved towards given food, this was recorded within the first week of the experiment. Fry in this group showed also a weak movement. The growth was better in fry fed diet 4 (HFM+SM). From table (2) a remarkable improvement in growth performances was reported than fry fed diet 3. FCR was better where it became 4 than 8, but still lower than those recorded for fry fed diets 1 & 2. Survival rate also improved in this group (4), and fry movement and palatability were better than previous group.

Table (2): Growth rate and feed conversion ratio of *Cyprinus carpio* fry fed different tested diets for 21 days.

Parameters	Diets			
	Diet (1)	Diet (2)	Diet (3)	Diet (4)
	FM	HFM+FM	HFM	HFM+SM
Initial weight (g/fish)	0.16	0.17	0.16	0.16
Final weight (g/fish)	0.29	0.22	0.17	0.19
Given food (g/fish)	0.19	0.15	0.08	0.12
Weight gain[1] (g/fish)	0.13	0.05	0.01	0.03
%Weight gain[2]	81.25	29.41	6.25	18.75
Feed conversion ratio[3]	1.46	3	8	4

[1]Weight gain = final body weight (g) - initial body weight (g)
[2]Percent weight gain (%) = W_2-W_1/W_1×100
[3]Feed conversion ratio (FCR) = dry feed intake (g) /fish live weight gain (g)
Where: W1 = initial weight (g), W2 = final weight (g).

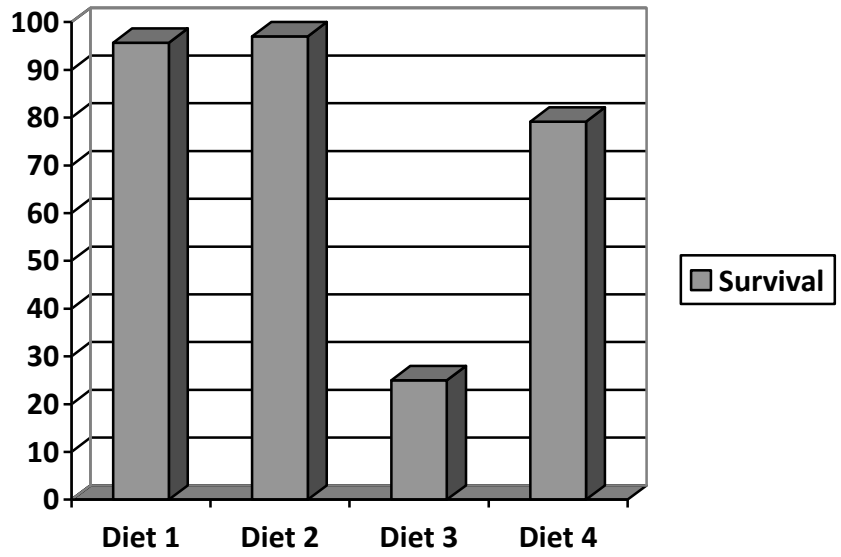

Figure (1): Survival rates of *Cyprinus carpio* fry fed different protein sources for 21 days.

The results of the present experiment clearly demonstrate that the best growth rate, feed utilization efficiency and survival rate of *Cyprinus carpio* fry were affected by diets regime, in which we recorded a remarkable influence of protein sources on fry performances. The best final body weight, weight gain, % weight gain, feed conversion and survival were obtained from fry fed diet 1 with FM as a major protein source. This finding is in agreements with almost all studies that indicated that FM is the best protein source used in aquafeed, especially at early stages of fish life cycle (Hasan *et al*., 1997; Hardy & Tacon, 2002; Barlow, 2003; Gumus *et al*., 2009 and Stankovic *et al*., 2011). As

we mentioned above in this article, FM is one of the most expensive macro-nutrients in an aqua-culture diet because it is used in high proportions (Gumus *et al*., 2009). Moreover, its availability is limited by various factors such as climatic conditions, the increasing demand for FM use in animal feed, especially in aquafeed, and decline of fish stocks used to produce FM (Gumus *et al*., 2009). Restricted FM supplies can no longer meet the needs of the expanding fish feed industry as a result of aquaculture development (Dong *et al*., 1993). It is crucial to reduce the FM used in aquaculture feed by replacing it with other unconventional protein sources. The efficiency of less expensive animal and/or plant protein sources as partial or complete substitute for FM has been evaluated in fish diet, e.g. poultry-feather meal (Hasan *et al*., 1997), Poultry by-products (Yang *et al*., 2006), sunflower meal (El-Saidy and gaber, 2002), soybean (Webster *et al* ., 2000), gambusia meal (Abdelghany, 2003), Turkey meal (Muzinic *et al* ., 2006) and tuna liver (Gumus *et al*., 2009).

In the present paper we tried to replace FM with hydrolyzed feather meal (HFM) which is a good protein source (protein contents varied from one country to another, in some papers, it contains between 84.9 to 98.6 % (Watanabe, 2002), but in Syria it has 72%, this may due to the processing method) available all around the year in Syria and cheap compared to FM. The results revealed that in diet 2 (HFM+FM) a significant difference was noticed concerning the growth performances, FCR and survival rate when comparing with diet 1. But the results deteriorate more and more in fry fed diet 3 which contained HFM as a major protein source, where weight gain was only 0.01 throughout the experiment, FCR was 8 and even the recorded mortality was the highest rate comparing to other diets, so only 25 fry stayed alive at the end of the experiment and the remaining ones were so weak. The fry performance improved when fed diet 4 (HFM+SM), where all growth parameters were better, FCR was 4 and even the mortality decreased as shown in figure (1).

The previous findings can be related to the quality of HFM, which, despite the fact that it contains a remarkable amount of protein, but is often considered to be an inferior source of protein for fish because of its poor digestibility and biased essential amino acid profile (Roley *et al*., 1977).The insolubility of feathers is mainly due to the protein keratin, which contains a high percentage of the amino acid cysteine as mentioned earlier. However, feathers hydrolyzed by cooking at a high temperature under sufficient pressure are highly digestible (Hasan *et al*., 1997). In fry fed diet 2 (FM+HFM), the unbalanced amino acids of HFM was lowered by the presence of FM, this could explain the recorded improvement in growth, in the meantime clarify the reason of bad results get from diet 3 (HFM). The improvement of the results at fry fed diet 4 (HFM+SM) could be explained by the good quality of soy bean meal. Soybean meal is the most important feed of plant origin in the fish feed industry. It is a source of biologically valuable proteins that are very similar in the structure of amino acids to proteins of animal origin (Watanabe, 2002). The nutritional value of soy is determined by its amino acid composition and content of antinutritional factors (Vucelić-Radović *et al*., 2005).

Few studies concerning with the effect of HFM on fish growth of carps or other cultured fish were published. Most studies dealt with poultry by-products (PBM) as a protein source to replace FM. Hasan *et al*. (1997) have recommended the use of hydrolyzed poultry-feather meal at 20% of the diet level (i.e., up to 50% of total protein) for Indian major carp, *Labeo rohita* fry (1.2g initial weight) without compromising growth and feed conversion. In the present study, the inclusion level of HFM in diets 2,3 & 4 was 22.32, 36 and 23.04% of total protein, respectively. As it is shown the inclusion in our

study was lower than those of Hasan *et al*. (1997) although we get less growth. In another study, it was found that up to 20% of FM protein in *C.carpio* fry diet can be replaced by Tuna liver meal without adverse effects on fish growth (Gumus *et al*., 2009). Most of studies are focused on PBM as an animal protein replacer of FM in aquafeed. PBM has been tested at varying success so far in different fish species (Fowler, 1991; El-Sayed, 1998 Yang *et al*., 2004; Yang *et al*., 2006; Saoud, 2008 and Sultan, 2009).

Finally, we recommended the great needs of further investigation concerning the usage of HFM as a protein source for carps at all life stages and also the possibility of using it for other cultured fish in Syria. Virtually, HFM can be used, but the results presented in this paper need more work to fulfill the possibility of the inclusion of HFM in fish diets, more work should be done about its deficiencies in some essential amino acids. The study require more experiments to compensate the gabs concerning the economic point of view of using this protein source.

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