Evaluation of five commercial diets used for fish feeding in Basra governorate, southern Iraq

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Abstract

An nine week laboratory study was carried out to compare the quality of five commercial diets with the brand name Alsabah (SD), Marine Science Center (CD), Aljanaby (JD), Efico sigma 860 (ED) and Arasco (AD) diets in order to ascertain the extent to which they meet the nutritional requirements of common carp *Cyprinus carpio* fingerlings with mean initial weight 15.74±1.04 g. Fish fed AD diet exhibited significantly ($P<0.05$) highest specific growth rate (SGR), feed conversion efficiency (FCE) and protein efficiency ratio (PER). While the lowest values were obtained in fish fed CD and JD diets. Fish fed diets containing approximately 30% protein (AD and SD) had significantly ($P<0.05$) higher PER values indicating maximal protein utilization. Also, results mentioned that satiation level (SL) were affected by energy content, bulk density and water stability of the diets. The lowest SL was observed for fish fed AD and ED diets. Significantly ($P<0.05$) higher water stability was recorded in AD and ED than SD, CD and JD diets. However, the markedly high SGR, FCE, PER and water stability values along with lower SL obtained with AD diet suggested that diet promoted better characteristics for cultured fish comparing with the other diets.

Keywords: common carp, commercial diets, chemical composition, physical properties, growth.

Introduction

Common carp is one of the most cultured fish in the world. This fish is omnivorous, resistant and tolerant to wide variations of abiotic and biotic factors of the environment (Stankovic *et al.*, 2010). It is considered as the main aquaculture species in Iraq especially in the middle and southern regions in Iraq.

Fish feed technology is one of the least developed sectors of aquaculture particularly in Africa and other developing countries of the world, fish requires high quality nutritionally balanced diet for growth and attainment of market size within the shortest possible time, therefore local production of fish feed is very crucial to the development and sustainability of aquaculture (Gabriel *et al.*, 2007). Nutrition and feeding play a central role in sustainable aquaculture and therefore, feed resources as well as costs continue to dominate aquaculture needs, feed accounts for 40-60% of the production costs in aquaculture (Bahnasawy, 2009). Growth and/or net nutrient deposition are the most accurate and important tools in studying fish feed efficiency and nutrient requirements (Belal, 2005). For most practical applications, evaluation of production diets (diets for fingerling and adult production) can be adequately done in feeding trials, the total feed utilization by fish, expressed as food conversion ratio (FCR), or the protein utilization, expressed as protein efficiency ratio (PER), the highest quality production diets will have relatively low FCRs and high PERs (Rice *et al.*, 1994). The objective of feeding fish is to provide the nutritional requirements for good health, optimum growth, optimum yield and minimum waste within reasonable cost so as to optimize profits (Isyagi *et al.*, 2009). Less than optimum diets for growout of fingerlings will result in lowered growth rates and excessive waste, either by excessive fecal material, excessive urinary nitrogen, or uneaten food, thus, less than optimum diets are not only wasteful in terms of money spent on feed, but they can cause increased waste management problems, the key challenge of producing production feeds is the maximization of fish growth with a minimization of waste (Rice *et al.*, 1994).

Most of locally fish feed pellet in market is low in terms of water stability and easily swell when it is immersed in water, these will lead to the nutrient deficiency and environmental problems in fish tanks or ponds (Saalah *et al.*, 2010). Knowledge of the physical properties and process variables influencing them are essential for producing high quality aqua feed pellets, designing equipment for processing facilities, and optimizing unit operations (Tumuluru, 2013).

Therefore, the major objective of current study is to compare the quality (chemical composition and physical properties) of five commercial diets used for fish feeding in Basra governorate, southern Iraq and their effect on growth performance, conversion efficiency and satiation level of common carp fingerlings.

Materials and methods

An investigation was carried out in the laboratory to evaluate five commercial diets with the brand name Alsabah (SD), Marine Science Center (CD), Aljanaby (JD), Efico sigma 860 (ED) and Arasco (AD) diets and their effects on growth and feed conversion of common carp (*Cyprinus carpio* L.) fingerlings. The first three diets are local, while, the last two are imported.

Those diets are available in the market and need to be evaluated to determine if common carp production could be enhanced using them.

Chemical composition

The proximate analysis of experimental diets was carried out according to the procedures of the Olvera-Novoa *et al.*, (1994). Moisture was determined by drying the samples in an oven at 105°C to constant weight (at least 12 h.), ash was determined by incineration in a muffle furnace at 550°C for 12 hours, protein was determined by the Kjeldahl method (N × 6.25) using Kjeldahl digestion and distillation apparatus, lipid was determined by using the Soxhlet method, carbohydrate was calculated by subtracting the difference (DM less the sum of crude protein, crude lipid and ash), gross energy was calculated according to New, (1987) as 5.5, 9.1 and 4.1 Kcal/g for protein, lipid and carbohydrate respectively.

Physical properties: The water stability and bulk density of diets were examined according to Misra *et al.*, (2002), while settling velocity was determined according to Vassallo *et al.*, (2006) and they are described under the following headings.

Water stability: Weight differences between dry feed pellets and pellets immersed in water for different time periods were examined. Feed samples of 5 g each in duplicates were placed in wire net containers immersed in 2 L beaker containing tap water. The beaker was kept for periods of 15, 30, 60, and 90 min. After each time interval the feed samples from container were collected by draining water and dried at 60°C till complete drying. Water stability was calculated by

Water stability (%) = (Dry weight of pellets after immersion (g) / Dry weight of pellets before immersion (g)) × 100

Bulk density: was calculated by:

Bulk density (g/cm^3) = M / (A×L)

where, M = Mass (g) of the pellet, L= Length (cm) of the pellet and A= Cross-sectional area (cm^2) of the pellet = πr^2.

Settling velocity: A 120 cm length glass tank of 10 cm width and depth was used to test the settling velocities of the examined particles. The transparent tank was filled with water and marked 5 cm from the top and every 50 cm from this point ahead. Pellets were carefully laid to the water surface. The settling velocity was determined by manually timing the pellet fall between two marks 50 cm apart. The measurement was repeated for ten pellets of each diet. Finally after the tube was filled with water, pellets were laid one after the other and the time of fall was measured by chronometer. Particles which came into contact with the tank wall during the fall were excluded from statistics.

Growth performance and conversion efficiency

Fish with an initial mean weight 15.74±1.04 g were obtained from Marine Science Center fish ponds. The fish were acclimated to the laboratory condition for one week prior to the commencement of the experiment. It were randomly distributed at a stocking density of 5 fish per tank among fifteen, 25 L circular plastic tanks. The diets were delivered to visual satiety once a day in the morning at 09.00 - 10.00 AM. All of the tanks were covered with nets throughout the experiment to prevent the fish from jumping out. Aeration was continuously provided from air compressors through air stones. Tanks water was replaced with new aged tap water semiweekly. Water quality parameters were checked periodically, pH was 7.82±0.23, water temperature was 24.8±3.39 °C, dissolved oxygen was 8.13±0.51 mg/L. Fish were held under natural photoperiod conditions throughout the feeding trial. Fish weight were recorded every 3 weeks intervals during the 9 weeks rearing period. A completely randomized design was employed, with five treatments and three replicates per treatment. The obtained data were presented as mean ± standard deviation and subjected to the Analysis of Variance (ANOVA) followed by Least Significant Differences (LSD) test at 0.05 level using IBM SPSS statistics 19. At the end of the experiment, fish weight and the amount of the feed consumed in each tank were recorded to calculate the following growth indices.

Weight gain (WG) = final weight (g) - initial weight (g)

Specific growth rate (SGR) %/day = ((ln final weight (g) - ln initial weight (g) × 100) / days of rearing)

Food conversion efficiency (FCE) % = (weight gained (g) / food consumed (g)) × 100

Protein efficiency ratio (PER) = weight gained (g) / protein consumed (g)

Satiation level (SL) % = (food consumed on dry matter basis (g) / body weight (g)) × 100.

Results

Chemical composition

The proximate composition of the five commercial diets has been studied. The results regarding chemical composition of trial diets presented in Table (1). The diets showed significant difference ($P<0.05$) in values of moisture, protein, lipid, ash and carbohydrate. Dietary moisture content varied from approximately 5.62% in ED to 8.11% in SD. Ash in diets ranged between 5.40% in SD to 8.63% in AD. Diet ED showed the highest dietary protein content (46.49%) followed by SD (30.44%) and AD (29.34%) whereas the JD and CD diets had the lowest values (24.19% and 23.53% respectively) with a significant differences ($P<0.05$) among these groups. On the contrary, a reverse result was obtained in case of carbohydrates. The highest significantly ($P<0.05$) gross energy observed in ED diet (4952 kcal/kg) could be attributed to its higher crude lipid percentage level (13.97%).

Table (1). Proximate composition (% of dry mater) of experimental diets

Diet composition	SD	CD	JD	ED	AD
Moisture	8.11±0.46^{a}	7.22±0.23^{a}	7.30±0.49^{a}	5.62±0.55^{b}	5.83±0.38^{b}
Crude protein	30.44±2.08^{b}	23.53±1.22^{c}	24.19±1.23^{c}	46.49±1.74^{a}	29.34±0.61^{b}
Crude lipid	7.27±0.31^{c}	8.43±0.01^{b}	7.25±0.37^{c}	13.97±0.64^{a}	6.22±0.53^{c}
Crude ash	5.40±0.04^{c}	6.10±0.30^{c}	7.98±0.79^{a}	6.51±1.20b^{c}	8.63±0.47^{a}
Carbohydrate	48.79±1.35^{b}	54.74±1.14^{a}	53.29±2.88^{a}	27.42±2.85^{c}	49.99±0.17^{ab}
Gross energy (kcal/kg)	4336±30.56^{b}	4305±19.57^{b}	4175±16.86^{c}	4952±79.72^{a}	4229±21.77^{c}

Means on the same row with different superscripts are significantly different ($P<0.05$).

Physical properties:

Water stability: Table (2) shows water stability (dry matter) of the experimental diets. All diets were stable more than 93% during the first 15 minutes of soaking in water. The significant differences appear after 30 minutes of immersion. At the end of experiment (90 minutes), the highest water stability of 92.07% was recorded in AD diet while the lowest of 33.05% was recorded in CD diet. There was no significant difference ($P>0.05$) between SD and JD diets. Increasing the exposure of the diets to the water increased the percentage of dry matter weight loss in all diets.

Bulk density

Table (3) showed the bulk density of five experimented diets. There were significant differences ($P<0.05$) in the bulk density of tested diets. CD diet exhibited significantly (P<0.05) high bulk density (1.22 g/cm3) than SD, CD and JD diets which showed insignificant differences (P>0.05) among them. However AD diet had the lowest bulk density (0.68 g/cm3).

Table (2). Water stability (%) of experimental diets at different time interval

Time interval (min.)	Water stability				
	SD	CD	JD	ED	AD
15	93.15±3.70[a]	93.54±3.84[a]	94.89±4.21[a]	97.25±3.78[a]	99.06±1.42[a]
30	84.94±4.17[b]	72.52±4.53[c]	88.82±4.03[b]	97.08±3.54[a]	98.72±1.35[a]
60	66.64±4.07[b]	51.83±4.32[c]	65.66±4.51[b]	91.99±3.70[a]	96.99±3.70[a]
90	43.14±4.65[b]	33.05±4.03[c]	45.53±4.56[b]	85.06±4.51[a]	92.07±4.51[a]

Means on the same row with different superscripts are significantly different (P<0.05).

Settling velocity

The settling velocity of the sinking diets was measured by manually timing the descent between two marks 50 cm apart. The results appear in table (3). The pellet of ED diet fall slower than other diets significantly (P<0.05). The pellet of SD diet followed the same pattern as compare with JD and CD diets. Although insignificant (P>0.05) differences between JD and CD diets was recorded. The AD diet was float for more than 3 hours. The results showed that there was a significant (P<0.05) liner relationship (r = 0.944) between bulk density and settling velocity (fig. 1).

Table (3). Bulk density (g/cm3) and settling velocity (cm/sec.) of experimental diets

	Diets				
Physical properties	SD	CD	JD	ED	AD
bulk density	1.16±0.06[ab]	1.22±0.06[a]	1.19±0.09[ab]	1.11±0.03[b]	0.68±0.06[c]
Settling velocity	16.10±0.77[b]	18.06±0.78[c]	17.38±0.79[c]	9.81±0.34[a]	Float >3 h*

Means on the same row with different superscripts are significantly different (P<0.05).

* AD diet was excluded from statistical analysis due to their floatability.

Growth performance

The initial mean weight of the fingerlings used were not significantly (P>0.05) different for each respective diet.

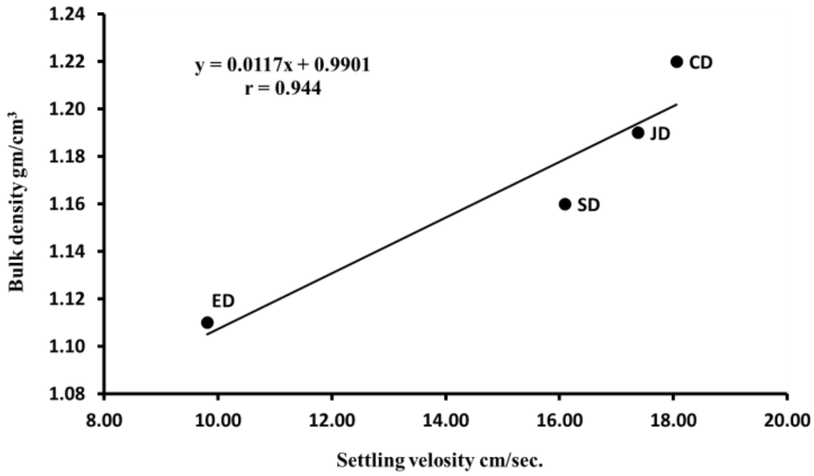

fig. 1. Relationship between bulk density and settling velocity.

specific growth rate (SGR), food conversion efficiency (FCE) and protein efficiency ratio (PER) were higher in fish fed on AD diet as compared with the other diets. SD and ED diets exhibited similar but significantly ($P<0.05$) trend as compared with CD and JD diets except ED in case of PER. The lowest values of these parameters were recorded for CD and JD diets with insignificant difference ($P>0.05$) between them. The best significantly ($P<0.05$) SGR was recorded for groups of fish fed AD, ED and SD diets. There was no significant ($P>0.05$) difference in the FCE values for fish fed with diets AD and ED, the same results were obtained for fish fed CD and JD diets. PER with AD diet was also significantly ($P<0.05$) higher than those fed all other diets, fish fed SD diet gives the same results as compared to other diets except AD. It was noticed that satiation level values were highest in SD, JD and CD diets and lowest in AD and ED diets indicating significant differences ($P<0.05$) between these two groups.

Table (4). Growth parameters and satiation level of common carp fingerlings fed experimental diets

Parameters	SD	CD	JD	ED	AD
Mean initial weight (g)	15.68 ± 1.19^{a}	16.17 ± 1.12^{a}	15.79 ± 1.25^{a}	15.11 ± 0.77^{a}	15.96 ± 1.36^{a}
Mean final weight (g)	26.84 ± 2.16^{ab}	23.60 ± 1.63^{b}	23.53 ± 2.21^{b}	27.59 ± 1.14^{a}	29.97 ± 3.20^{a}
WG (%)	11.16 ± 1.48^{b}	7.44 ± 1.00^{c}	7.74 ± 1.01^{c}	12.49 ± 1.63^{ab}	14.01 ± 1.94^{a}
SGR %/day	0.85 ± 0.08^{a}	0.60 ± 0.07^{b}	0.63 ± 0.04^{b}	0.96 ± 0.12^{a}	1.00 ± 0.05^{a}
FCE	33.26 ± 3.15^{b}	20.80 ± 1.52^{c}	22.46 ± 1.10^{c}	44.41 ± 4.34^{a}	48.50 ± 3.28^{a}
PER	01.09 ± 0.10^{b}	0.88 ± 0.06^{c}	0.93 ± 0.05^{c}	0.96 ± 0.09^{c}	1.65 ± 0.11^{a}
SL %	3.40 ± 0.30^{a}	3.51 ± 0.25^{a}	3.46 ± 0.19^{a}	2.96 ± 0.24^{b}	2.87 ± 0.11^{b}

Means on the same row with different superscripts are significantly different ($P<0.05$).

Discussion

The growth characteristics and feed efficiency of common carp fingerlings were found to be significantly affected by dietary brand. However, the markedly high SGR, FCE and PER values in the AD diet suggested that diet promoted better characteristics for cultured fish comparing with the other diets. This could be due to their optimum dietary nutrients content, highest water stability, lower bulk density and floatability. Protein content could be one of the reasons. Mohapatra and Patra, (2014) mentioned that for maximum growth of fish, optimum protein content in the feed is necessary. Fish fed on CD and JD diets showed significantly reduced growth, confirmed by poor SGR, FCE and PER. Measured protein values indicate that CD and JD diets (approximately 23% and 24% protein respectively) did not meet the protein requirement of common carp fingerlings for optimum growth which is at 30-35% (Al-Jader and Al-Sulevany, 2012; Takeuchi *et al.*, 2002 and Takeuchi *et al.,* 1979). Also, fish fed the highest protein diet (ED) used dietary protein less efficiently, as reflected by the lower PER as compared with fish fed lower protein diets (AD and SD). PER values increased significantly with increasing of dietary protein in the diets up to 30%, then reduced significantly when the dietary protein level was increased to 46%. Similar results were reported in common carp fingerlings (Ahmad *et al.*, 2012), goldfish fingerlings (Souto *et al.*, 2013), Nile tilapia fingerlings (Eid *et al.*, 2003) and Kutum fingerlings (Ebrahimi and Ouraji, 2012). Rice *et al.*, (1994) mentioned that the PER values are reduced when protein levels in the feed are either insufficient or are in excess, optimum protein content in fish feeds is species specific and occurs when PER is maximized. Fish fed on ED diets had consumed comparatively less diet than the fish fed on the other diets except AD. It could be due to the significantly higher energy level in this diet. Diets with excessive energy can actually result in lowered feed intake. It is generally known that fish eat to satisfy their energy needs. Saravanan, *et al.*, (2012) reported that the digestible energy content has been widely suggested to be a major determinant of feed intake control in several fish species. Similar results were also reported by Guroy *et al.*, (2006); Kause *et al.*, (2006) and Boujard *et al.*, (2004). Part of the dietary protein may be utilized as an energy source, if the diet is deficient in non-protein energy, since the use of protein for energy is wasteful from nutritional, economic, and ecological points of view when compared to lipids and carbohydrates, it is worthwhile supplying as much of the required energy as possible as lipid and carbohydrate, since both carbohydrate and lipid have good food value for carp (Manjappa *et al.*, 2002).

In current study the diets quality was evaluated through water stability (Table 2). The AD and ED diets (imported) was almost water stable up to 90 min., while the other diets (local) loss 55-77% during the same period. This could be due to the processing method used in manufacture local diets and the lake in addition of binding agents (Sudaryono, 2001). The best FCE and PER accompanied with minimum feed intake were recorded with AD diet. These results are in agreement with the results of Aas *et al*., (2009); Ali, (2006) and Misra *et al*., (2002), whom denoted that the increased water stability had increased the feed efficiency and decreased feed intake. Thus, increasing in satiation level of CD, JD and SD diets could also be partially attributed to decreasing in water stability (Aas *et al*., 2009).

Furthermore, the lower bulk density of diet AD possibly limited the amount of satiation level. This reduction in satiation level may be due to physical form (bulk density) of the diet, feeds with low bulk density may result in reduced feed intake on a weight, but not volume (Saravanan *et al*. 2012 and Shelton *et al*., 2005). Likewise, Arguello, (2011) suggested that the lower feed intake occurred since the fish were not able to retain as much of this expanded feed in their stomachs.

Floatability was probably another contributing factor enhanced growth performance and FCE in fish fed on AD diet. Jovanovic *et al*., (2009) demonstrated that floating pellets (floating more than 6 h) for carp, had somewhat increased performance benefits (growth rate and FCR) as compared to sinking pellets.

It could be concluded that there is significant variation in nutritive value between local and imported commercial diets, suggesting that the fish were close to experiencing an imbalance in the dietary nutrients and poor physical properties in case of local diets. However, the only possible explanation to significantly poor performance of local commercial diets in comparison to the imported diets could be that feed manufacturers are only interested in profit maximization than meeting the needed requirements for their products.

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تقييم خمسة انواع من العلائق التجارية المستخدمة في تغذية الاسماك في محافظة البصرة، جنوب العراق

رياض عدنان التميمي

قسم الأسماك والثروة البحرية – كلية الزراعة – جامعة البصرة

الخلاصة

اجريت دراسة مختبرية استغرقت تسعة اسابيع لمقارنة خمسة انواع من العلائق التجارية المستخدمة في محافظة البصرة، جنوب العراق لمعرفة كفاءتها في تلبية المتطلبات الغذائية لإصبعيات أسماك الكارب الشائع *Cyprinus carpio* L. العلائق المستخدمة في التجربة هي عليقة الصباح (SD) وعليقة مركز علوم البحار (CD) وعليقة الجنابي (JD) وعليقة ايفيكو سجما 860 (ED) وعليقة أراسكو (AD). بلغ معدل الوزن الفردي للأسماك عند بداية التجربة 15.74 ± 1.04 غم. تفوقت الاسماك المغذات على العليقة AD معنويا ($P<0.05$) بالنسبة لمعدل النمو النوعي SGR وكفاءة التحويل الغذائي FCE وكفاءة تحويل البروتين PER مقارنة بالأسماك المغذات على العلائق الاخرى. بينما سجلت اقل القيم بالنسبة لهذه المقاييس في الاسماك المغذات على العليقتين CD و JD. اشارت النتائج الى ان الاسماك المغذات على العليقتين AD و SD الحاويتين على نسبة بروتين تقارب 30% اظهرت افضل استغلال للبروتين. تأثرت كمية الغذاء المتناولة من قبل الاسماك (مستوى الاشباع) بمحتوى العلائق من الطاقة فضلا عن كثافتها وثباتيتها في الماء، اذ سجل اقل مستوى اشباع في الاسماك المغذات على العليقتين AD و ED. اظهرت العليقتين AD و ED اعلى ثباتية في الماء وبشكل معنوي ($P<0.05$) مقارنة مع بقية العلائق. اشارت النتائج المتعلقة بارتفاع قيم مقاييس النمو النوعي والتحويل الغذائي والثباتية في الماء مصحوبة بانخفاض قيمة مستوى الاشباع الى تفوق واضح للعليقة AD في توفير المتطلبات الغذائية اللازمة لإصبعيات اسماك الكارب الشائع مقارنة بالعلائق الاخرى المستخدمة في التجربة.