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EFFECT OF ORGANIC ACID SALT SUPPLEMENTATION ON GROWTH PERFORMANCE AND FEED UTILIZATION IN PRACTICAL DIETS OF HYBRID TILAPIA (♀ *O. Niloticus* x ♂ *O. aureus*) FINGERLINGS

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SUMMARY

A 84 day experiment was conducted to evaluate the effect of sodium diformate NDF® as commercial feed additives on growth performance and feed utilization of hybrid tilapia (♀ O. niloticus X ♂ O. aureus) fingerlings. Four treatments were applied; three levels of NDF® (1 g kg^{-1}, 3 g kg^{-1}and 5 g kg^{-1}) in addition to the control. The experimental diets containing (320 g kg^{-1} crude protein and 19.3 MJ GE) were applied into 24 fiberglass tanks, six replicate, stocked randomly with 25 hybrid tilapia fingerlings initial BW (15 ± 0.5 g) each. The efficiency of diformate supplementation was evaluated by parameters of growth response, crude protein (using body composition data). Generally, significant difference ($P<0.05$) were detected in growth performance with groups of fish fed on diets supplemented by NDF® compared to the control group. The diet supplemented by 3 g kg^{-1} NDF® had a mean final body weight 95.5g while control diet was 87.9 g. In terms of feed utilization, supplementation of 3 g kg^{-1} NDF® showed a statistical significant ($P<0.05$) improvement in terms of FCR (1.28), PER (2.71) and PRE (40.3) compared with other groups of fish at various supplementation levels of organic acids salts and better than control. Apparent protein and lipid digestibility among fish groups fed the experimental diets supplemented by NDF® improved significantly ($P<0.05$) compared to the control group. From these results it can be concluded that the dietary organic acids have the potential beneficial effects on growth and feed utilization in tilapia feeding.

***Keywords**: Growth performance, Feed utilization, Protein digestibility, Organic acid salts, Hybrid tilapia*

INTRODUCTION

Aquaculture is a fast-growing sector of agriculture with tremendous growth of more than 30 percent worldwide during the last ten years (FAO 2010). The rapid growth of the aquaculture industry requires high-quality feeds, which should contain not only necessary nutrients but also complementary feed additives to keep organisms healthy, favor growth and environment-friendly aquaculture. Despite strong progress in tilapia nutrition and feed formulation during the last twenty years, disease outbreaks in tilapia ponds lead to farming setbacks and increased used of antibiotic growth promoters (AGP). However, growing awareness from consumers and producers of aquaculture species has resulted in a demand for responsible and sustainable aquaculture. Regulatory authorities in most exporting countries now focus on the misuse of AGPs in aquaculture, while public attention has shifted towards sustainable production methods. Thus, alternative additives to replace AGPs, which have been EU-banned in animal feeds since 2006, have had to be tested. Consequently, a wide variety of products ranging from plant extracts, prebiotics, and probiotics have been evaluated as alternatives to antibiotics (Li and Gatlin, 2004, 2005, Yanbo and Zirong (2006), El-Dakar, *et al.*, 2007, Mohamed 2007 and Al-Dohail *et al.*, 2009), but the results obtained are inconsistent. One of the more promising additives is the group of organic acids, particularly organic acids' salts (Lückstädt &Kühlmann 2011). Organic acid salts are also non-antibiotic feed additives that improve production by improving growth, feed efficiency, and reducing stress and mortality. The using of organic acids such as benzoic, formic, lactic and propionic have traditionally been used as storage preservatives to control pathogenic bacteria such as *Salmonella spp*. and *Escherichia coli* for food and feed ingredients. Even though the anti-microbial effects of organic acids had been well understood (Booth & Stratford 2003), the explanation for the growth-promoting effects of these compounds remains speculative (De Wet 2005). After the success that has been achieved by supplementation of organic acid in poultry and swine feeding, which improved growth, feed intake, feed utilization efficiency and health (Alp *et al*., 1999; Partanen *et al*., 2002; Kluge *et al.*, 2006).Currently, there is considerable interest in the commercial use of organic acids in fish diets, both to enhance growth performance and to control disease. Several researches have reported that the effect of using organic acids, their salts or mixtures can improve growth, feed utilization and disease resistance in fish (Baruah *et al*., 2007; Hossain *et al*., 2007; Sarker, *et al*., 2007;Ng *et al*., 2009; Ng *et al*., 2011). Despite the reported improvement in the nutrient availability of organic acid-supplemented diets, contradictory results have been reported on the growth-promoting effects of dietary organic acids, which seem to depend on the fish species and/or the type of organic acid tested (Lückstädt 2008). Therefore, the present study was conducted to evaluate the effect of Sodium diformate (NDF®) supplementation as a commercial feed additives on growth performance, feed utilization, body composition and apparent digestibility in diets of hybrid tilapia (♀ O. niloticus X ♂ O. aureus) fingerlings.

MATERIALS AND METHODS

Experimental conditions

The experiment was carried out in Fish Resarch Center, Suez Canal University, Ismailia, Egypt. The tested diets were applied in a semi-closed out-door water recirculation system with 24 circular plastictanks (200-L/tank), four nutritional groups and each group contain 6 replicates. Each tank was continuously supplied with a mixture of fresh water (approximately 10%) and biologically filtered fresh water. Water temperature (27±0.8 ºC). The other water quality parameters including pH, ammonia, $N0_2$ and $N0_3$ were recorded weekly and found to be within the acceptable ranges reported by Plumb (1999).

Experimental fish

All male juvenile hybrid tilapia (♀*O. niloticus* X ♂*O. aureus*) juveniles were obtained (from a private hatchery) Elkantara, Ismailia governorate. Fish were acclimatized to experimental conditions for two weeks before being distributed into fiberglass tanks of 200-L water capacity each. Fish with an average of 15 ± 0.5 g initial body weight were distributed into 24 circular experimental plastic tanks. Six replicate tanks; 25 fish per tank of each nutritional group were utilized in 84 d growth experiment. All fish in each tank were weighed every 14 days. During the growth period, each diet was offered to fish groups by hand, 3 meals / day until apparent satiation.

Experimental diets

Four iso-nitrogenous and iso-caloric diets were formulated from practical ingredients to contain almost 32% crude protein 19.3 MJ GE (Table1). The diets were based on (Fish meal, Soybean meal, Corn gluten, Wheat bran and Corn). One basal diet as contral diet and 3 diets were supplemented with NDF® 1g kg^{-1} , 3g kg^{-1} and 5g kg $^{-1}$, respectively. Soy oil was added as a major dietary lipid source to make all diets isolipidic. The vitamin and mineral mixture used was added to all experimental diets at a constant level of 2% (Tram *et al*., 2011). As an indigestible marker 0.5% Cr_2O_3 was incorpotated. The wet mixture was passed through granule machine with 2 mm diameter. The produced pellets were dried at room temperature for three days (approximately 10 % moisture was achieved).

Sample collection and chemical analysis

At the beginning of the experiment, ten fish were analyzes for body composition. Three fish / tank were sampled at the end of experiment, killed by anesthetic over dose (Ethylene-glycol-monophenyl-ether), autoclaved (110 ºC, 3 h), homogenized with lab mixer and stored at -20 ºC for subsequent chemical analysis. Chemical analyses of ingredients, diets and homogenized fish for crude protein (CP %), ether extract (EE %), crude fiber (CF %), ash (%) and dry matter were conducted according to A.O.A.C. (1995). The nitrogen free-extract (NFE %) was calculated by differences [100 - (Crude protein + ether extract + crude fiber + ash %)]. Gross energy of the diet was calculated according to NRC (2011), based on crude nutrient analyses. The chromic oxide content in feed and feces were determined spectrophotometerically according to the method described by Furukawa and Tsukahara (1966).

Digestibility study

Apparent Digestibility Coefficient (ADC) of protein and lipid was performed by indirect methods using the chromic oxide as inert marker methods according to Cho and Kaushik (1985). ADC for the nutrients of the tested diets and the control were estimated according to Cho *et al*. (1979) as follows:

$$ADC = 100 \times [1-(F/D)\times(Di/Fi)]$$

Where: ADC = Apparent Digestibility Coefficient, F= Nutrient in feed, Fi= Marker (Cr_2O_3) in feces (%), D = Nutrient in feces (%), Di = Marker (Cr_2O_3) in feed (%). Triplicate groups each include 10 tilapia with an initial body weight of 100 g were fed two meals daily up to apparent satiation. Fecal collection was performed by simple siphoning 2 h after feeding following a modified method of Zhou *et al*. (2004). The collected feces were pooled in clean dried vials and stored in freezer (−20 °C) till analysis.

Parameters of the growth studies

Calculation of parameters for growth performance (weight gain and specific growth rate SGR (%)) and feed utilizations (feed conversion ratio FCR (g/g) , feed intake FI (%), protein efficiency ratio PER (g/g), and protein deposition PRE (%) were calculated according to Takeuchi (1988) and Tacon (1990).

Weight gain% = 100 × (final body weight- initial body weight)/initial body weight.

Specific growth rate (SGR) = (Ln. Final body weight- Ln. Initial body weight) x 100/ (days of experiment)

Feed efficiency = (Body weight gain (g)/ feed intake (g).

Feed conversion ratio = g dry feed consumed/g wet weight gain.

Protein efficiency ratio = fish wet weight gain/protein intake.

Protein retention efficiency = 100×(final body protein – initial body protein)/total protein fed.

The model:

Based on equation (1), the applied model was according to Liebert and Benkendorff (2007a, b):

(1) $NR = NR_{max}T\,(1 - e^{-b \cdot NI})$

Where:

NR = daily N-retention (ND + NMR) [$mg/BW_{kg}^{0.67}$]

ND = daily N-deposition [$mg/BW_{kg}^{0.67}$]

NMR= daily N-maintenance requirement [$mg/BW_{kg}^{0.67}$]

NI = daily N-intake [$mg / BW_{kg}^{0.67}$]

$NR_{max}T$ = Theoretical maximum for daily N-retention [$mg / BW_{kg}^{0.67}$]

$ND_{max}T = NR_{max}T - NMR$

b = slope of the N-retention curve (Indicating the feed protein quality)

e = basic number of natural logarithm (ln)

Model parameters (NMR = 70mg / $BW_{kg}^{0.67}$ / day; $NR_{max}T$ = 388mg / $BW_{kg}^{0.67}$ / day) were taken from (Liebert *et al.*, 2006; Liebert 2009), dietary protein quality (b) is quantified making use of equation (2):

(2) $b = [\ln NR_{max}T - \ln (NR_{max}T - NR)] : NI$

Table 1. Composition of the experimental Tilapia fingerling diets (g kg^{-1})

Feed Ingredients	Experimental Diets			
	Control	**1**	**2**	**3**
Fish meal	50	50	50	50
Soybean meal	320	320	320	320
Corn gluten	150	150	150	150
Wheat bran	150	150	150	150
Corn	245	244	242	240
Soy oil	40	40	40	40
Vit Min Mix [1]	20	20	20	20
DCP [2]	10	10	10	10
Cr_2O_3	5	5	5	5
CMC[4]	10	10	10	10
NDF[5]	----	1	3	5
Total	1000	1000	1000	1000
Chemical composition				
Crude protein	321	327	328	320
Crude lipid	82.8	83.5	83.2	86.0
Ash	61.4	61.2	61.8	61.4
Crude fiber	45.3	45.0	44.7	44.1
N-free extract	489.5	483.3	482.3	488.5
Gross energy (kJ g^{-1})[5]	19.2	19.3	19.3	19.4
P:E (g MJ^{-1})	16.7	16.9	16.9	16.6

1- Each Kgvitamin & mineral mixture contained Vitamin A, 4.8 million IU, D_3, 0.8 million IU; E, 4 g; K, 0.8 g; B_1, 0.4 g; Riboflavin, 1.6 g; B_6, 0.6 g, B_{12}, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg , Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.
2-DCP: Di Calcium Phosphate
3-CMC: Carboxyl methyl cellulose
4-NDF: Sodium Diformate (ADDCON®, Germany)
5-Gross energy. Based on 5.65 Kcal/g protein, 9.45 Kcal/g fat and 4.1 carbohydrate Kcal/g (NRC2011)

Statistical analysis

All data of growth performance and feed utilization were analyzed by one-way analysis of variance (ANOVA) using the general linear models procedure of statistical analysis system (SPSS) version 17, (2009). Duncan's multiple range test (Duncan, 1955) was used to resolve differences among treatment means at 5% significant level using the following model. $Y_{ij} = \mu + T_i + E_{ij}$

Where

μ = over all mean.

Yij =the observation of the individual from T treatment

Ti= the fixed effect of T diet.

RESULTS

Organic acids salts NDF at the dietary levels tested did not have any toxic effects on the fish and all fish appeared to be healthy and were actively feeding with no mortality observed at the end of the experiment, which confirms that the present study fell under the optimal defined for nutritional evaluations in juvenile Nile Tilapia. The growth performances of Nile tilapia fingerlings fed on the experimental diets are shown in Table 2. Average body weight (g) of all male Nile tilapia fed the experimental diets at the start did not differ, indicating that groups were homogenous. At the end of the feeding trial, the weight gain of all male tilapia-fed diets supplemented with NDF at 3 g kg^{-1} , was numerically higher 11% followed by NDF 5 g kg^{-1} and NDF 1 g kg^{-1} (10.5% and 10.2% , respectively) compared with the fish fed the control diet. The fish groups fed on diet 2 had significantly (*P>0.05*) higher SGR than the rest of the experimental groups (Table 2). However, at the end of the trial, SGR values were 2.10 (control diet), 2.20, 2.14 and 2.11 %/d for fish groups fed on diets containing 0.3, 0.5 and 0.1% (NDF®), respectively. In terms of feed utilization, the results of feed conversion ratio, protein efficiency ratio and protein retention efficiency among treatment groups get a trend towards improvement with groups fed on diets supplemented with organic acids salts. Diet 2 which supplemented by sodium diformate at level of 3g kg^{-1} diet showed high statistical significant (*P>0.05*) in terms of FCR (1.28), PER (2.71) and PRE (40.3) compared with other organic acids salts supplemented groups at various dietary levels and better than control (Table 2). The results of feed efficiency followed the same trend as FCR and PER which was found to be 0.69 for control diet, 0.73 for diet 1, 0.72 for diet 3 and 0.78 for diet 2. In the present study, the commercial feed additives (NDF) used, significantly (*P>0.05*) enhanced feed efficiency. These observations were also supported by results of protein quality evaluation as yielded from application of on an exponential N-utilization model, eliminating the influence of varying feed intake on response of protein deposition Table (2). The results of apparent Protein and Lipid digestibility for all diets were improved; diet 2 supplemented with 0.3% NDF had the highest protein and Lipid digestibility (87.1%) and (94.5%) respectively, there was a significant (*P>0.05*) trend (Table3). These results indicate the efficiency of using NDF as feed additives; it increased protein digestibility in the diets supplemented with organic acids salt compared with the control diet. The results of whole-body composition showed that the addition of NDF to the experimental diet had no negative effects on the whole-body composition of all male Nile tilapia (Table 4). Body moisture, protein and lipid were not significant (*P<0.05*). However, the results of ash content were mostly significantly (*P>0.05*) affected by the increasing of NDF in dietary treatment.

Table 2. Growth data of tilapia fingerling fed on experimental diets

Parameter	**Experimental Diets**			
	Control	**1**	**2**	**3**
Initial Weight(g)	15.1	15.2	15.1	15.0
Final weight(g)	87.9±2.9[b]	89.3±2.6[b]	95.5±1.9[a]	90.8±2.2[b]
Weight gain (%)[1]	482.1±9.1[c]	487.5±8.3[c]	532.4±6.7[a]	512.0±6.6[b]
SGR[2]	2.10 ±0.06[c]	2.11±0.05[b]	2.20±0.04[a]	2.14±0.04[b]
Feed Intake	104.2g	101.5g	103.0g	105.2g
FE(g/g)	0.69 [b]	0.73 [b]	0.78 [a]	0.72 [b]
FCR[3](g/g)	1. 43±0.03[b]	1.37±0.03[b]	1.28±0.01[a]	1.38±0.02[b]
PER[4](g/g)	2.47±0.05[b]	2.50±0.05[b]	2.71±0.02[a]	2.53±0.04[b]
PRE[5](%)	36.6±0.76[c]	37.8±0.76[b]	40.3±0.20[a]	38.2±0.60[b]
Protein quality (modle parameter)	100	103	110	104

*Means in within same row sharing the same superscript are not significantly different (*P≤0.05*)
[1)] Weight gain% = 100 × (final body weight- initial body weight)/initial body weight.
2)Specific growth rate (SGR)%/d = (Ln. Final body weight- Ln. Initial body weight) x 100/ (days of experiment)
3) Feed efficiency = (Body weight gain (g)/ feed intake (g).
4)Feed conversion ratio = g dry feed consumed/g wet weight gain.
[5)] Protein efficiency ratio = fish wet weight gain/protein intake.
[6)] Protein retention efficiency=100×(final body protein – initial body protein)/total protein fed.

Table 3. Growth data of tilapia fingerling fed on experimental diets

Parameter	**Experimental Diets**			
	Control	**1**	**2**	**3**
ADC_P	82.9±1.3[c]	83.5±1.01[b]	87.1±0.9[a]	84.8±1.1[b]
ADC_L	90.1±1.01[c]	91.8±1.1[b]	94.5±0.3[a]	92.3±0.8[b]

*Means in within same row sharing the same superscript are not significantly different (*P≤0.05*).
ADC_P Apparent digestibility coefficient of Protein
ADC_L Apparent digestibility coefficient of Lipid

Table 4. Body composition of tilapia fingerling fed on experimental diets as (g/kg^{-1}) dry matter

Experimental Diets	Whole body composition			
	Dry matter ($g\ kg^{-1}$)	Protein Content	lipid Content	Ash
Initial	228.3	575.7	233.4	190.9
1	$252{\pm}0.46^{a}$	$568{\pm}1.10^{a}$	$296{\pm}1.90^{a}$	$136{\pm}0.76^{c}$
2	$257{\pm}0.16^{a}$	$559{\pm}0.04^{a}$	$303{\pm}0.63^{a}$	$138{\pm}0.58^{b}$
3	$258{\pm}0.04^{a}$	$561{\pm}0.51^{a}$	$300{\pm}0.14^{a}$	$139{\pm}0.04^{b}$
4	$265{\pm}0.63^{a}$	$553{\pm}0.90^{a}$	$301{\pm}1.00^{a}$	$146{\pm}0.63^{a}$

*Means in within same column sharing the same superscript are not significantly different ($P \leq 0.05$).

DISCUSSION

Hybrid tilapia (♀ *O. niloticus* X ♂ *O. aureus*) fed organic acid-supplemented diets in this experiment tended to increase body weight gain compared with fish fed the control diet without any added organic acids as given in Table 2. These results are in agreement with the results of Cuvin-Aralar*et al*. (2011) who reported that the addition of NDF or KDF at level of 3g kg^{-1} improved growth performance and feed utilization of all male Nile Tilapia. Zhou *et al*. (2009) reported an increase of 11.8% in the weight gain of hybrid tilapia (*O.niloticus* × *O. aureus*) fed diet with 3 g kg^{-1} KDF, they also reported that higher levels of KDF supplementation did not result in any improvement in growth rate of this tilapia hybrid. Similar results were reported by Ramli *et al*. (2005) who found a significant improvement in growth and feed utilization efficiency in terms of feed conversion ratio and protein efficiency ratio in hybrid tilapia fed a casein-based diet containing 2, 3 or 5 g kg^{-1} KDF which are in agreement with the results of the current investigation. In contrast with the present study, Petkam *et al*. (2008) reported that the supplementation of organic acid did not significantly improve growth performance of (*O. niloticus* L.), similar result was reported by NG *et al*. (2009) with red hybrid tilapia *Oreochromis* sp. Contradictory results on the growth-promoting effects of organic acids and their salts have been reported in the literature for other fish species, with some studies showing a significant impact (Gislason *et al*., 1996; DeWet 2005; Baruah *et al*., 2007 ; Lückstädt 2008 and Christiansen and Lückstädt 2008) and other reporting no significant effect (Owen *et al*. 2006; Hossain *et al*., 2007; GAO *et al*., 2011). In terms of feed utilization, the present investigation reports also a significant improvement in feed conversion ratio, protein efficiency ratio and protein retention effeminacy. This finding was supported by complex protein quality parameters derived from an exponential N-utilization model, eliminating the influence of varying feed intake on protein deposition. These results are in agreement with Ramli *et al*. (2005); Zhou *et al*. (2009) and Cuvin-Aralar *et al*. (2011). Furthermore, the present study of protein and lipid digestibility showed significantly higher digestibility compared to the control diet and is in agreement with Partanen *et al*. (2007) who showed that dietary organic acid mixture of formic acid, sorbate and benzoate resulted in improved digestibility of protein and many amino acids in pigs Table (3). However, there was a clear tendency to improved protein digestibility, as is often reported after the inclusion of an organic acid salt into the diets of animals (Metzler and Mosenthin, 2007). Lückstädt & Schulz (2008) found improved protein and fat digestibility in Atlantic salmon fed with dietary KDF. In addition Morken *et al*., (2011) found that the inclusion of NDF improved both nutrient digestibility and physical quality of diets for rainbow trout, While Storebakken *et al*., (2010) determined a significantly improved amino acid digestibility after KDF was added in extruded diets for the salmon. Organic acids further lower gastric pH, thus eventually accelerating the conversion of pepsinogen to pepsin which in turn improves the absorption of amino acids and minerals (DeWet., 2005; Ng *et al*., 2009 and Park *et al*., 2009). As our knowledge about NDF application on dietary nutrient digestibility in aquaculture is scarce, further investigation is needed to clearly identify its role in fish metabolism. The results of body composition given in Table 4 showed increasing of whole body ash content with the increasing of level of NDF corruption in tested diets. These results are confirmed by positive effects on mineral utilization in fish fed organic acid-supplemented diets which have been reported for red sea bream, *Pagrus major* (Hossain *et al.* 2007; Sarker *et al*., 2007), and rainbow trout, *Oncorhychus mykiss*) (Vielma & Lall, 1997; Sugiura, Dong and Hardy1998). While, the results for protein or lipid whole body content showed no significant differences, these findings are agreement with (PARK *et al*., 2009 and NG *et al*., 2011). However, it should be pointed out that the fish in this study were cultured in suitable farm conditions. The results of the present study with hybrid tilapia (♀ *O. niloticus* X ♂ *O. aureus*) fingerlings given 0.3% NDF are in agreement with the results of Cuvin-Aralar*et al*. 2011. In addition, the organic acid salts NDF has a significant effect on the overall culture performance of hybrid tilapia (♀ *O. niloticus* X ♂ *O. aureus*) fingerlings, with better final weights, growth rates and feed utilization.

CONCLUSIONS

The present results show an improvement on growth response and feed utilization; therefore, call is for the inclusion of organic acid salts, sodium-diformate, in the formulated feeds for farmed tilapia under commercial field conditions.

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العنوان : تأثير أضافة ملح الحامض العضوى على أداء النمو و الأستفادة الغذائية فى علائق أصبعيات أسماك هجين البلطى (أناث البلطى النيلى x ذكور البلطى الأوريا)

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المكان: قسم الانتاج الحيوانى والثروة السمكية – كلية الزراعة – جامعة قناة السويس- - ٤١٥٢٢ - الاسماعيلية - مصر

أجريت تجربة لمدة ٨٤ يوم لتقييم تأثير الصوديوم داي فورمات كإضافات للأعلاف الغذائية التجارية علي أداء النمو والاستفادة الغذائية لاصبعيات البلطي الهجين(*O. aureus* ♂ X *O. niloticus* ♀) . تم تطبيق أربعة معاملات، ثلاثة مستويات من الصوديوم داى فورمات (١ جم/ كجم، ٣ جم / كجم و٥ جم / كجم) بالإضافة إلى العليقة الكنترول. أحتوت العلائق التجريبية على (٣٢٠ جم/ كجم من البروتين الخام وطاقة كلية ١٩,٣ ميجاجول) وتم تطبيق التجربة فى ٢٤ حوض فيبرجلاس ستة مكررات لكل معاملة، حيث تم وضع ٢٥ أصبعية من سمك البلطي ذات وزن (١٥ ± ٠,٥ جم) لكل حوض. تم تقييم كفاءة مكملات داي فورمات عن طريق قياس استجابة النمو ، البروتين الخام (باستخدام بيانات تركيب الجسم). وبصفة عامة، أظهرت النتائج اختلافات معنوية في أداء النمو مع مجموعات الأسماك التي تتغذى على العلائق الغذائية المحتوية على الصوديوم داى فورمات مقارنة بالعليقة الكنترول.وصل وزن الجسم النهائي للأسماك التي تتغذى على العليقة المحتوية على٣جم / كجم صوديوم داى فورمات الي٩٥,٥ جم بينما كان الوزن ٨٧,٩ جم بالعليقة الكنترول.من حيث الاستفادة الغذائية، أظهرت اسماك البلطي المغذاة على العليقة المحتوية على ٣ جم / كجم صوديوم داى فورمات ارتفاع معنوى كبيرمن حيث معدل التحويل الغذائى(١,٢٨)، الكفاءة النسبية للبروتين (٢,٧١) وكفاءة أحتجاز البروتين (٤٠,٣) بالمقارنة بالمجاميع الأخرى من الأسماك المغذاة على مستويات مختلفة من أملاح الأحماض العضوية وأفضل من العليقة الكنترول. تحسن هضم البروتين والدهن معنويا بين مجموعات الأسماك التي تتغذى على العلائق المحتوية على الصوديوم داى فورمات بالمقارنة بالعليقة الكنترول. ويمكن تلخيص نتائج هذا البحث فى الأتى أن أضافة الأحماض العضوية لعلائق الأسماك لها تأثيرات أيجابية على أداء النمو والاستفادة الغذائية في تغذية أسماك البلطي تحت ظروف الأستزراع التجارى.