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THE UTILIZATION OF L – ASCORBIC ACID IN CATFISH DIETS CULTURED AT DIFFERENT STOCKING DENSITIES

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ABSTRACT

A 14 weeks growth trial was conducted in Central Laboratory for Aquaculture Research, Abbassa to estimate the adequate L- ascorbic acid (A.A) requirement of catfish (*Clarias gariepinus* Burchell) diets and its effect on the growth rate, feed utilization, concentration of A.A in fish tissues and chemical composition of whole fish. A.A supplemented at 50, 100, and 150 mg / Kg – purified diet, respectively. Each diet was fed to triplicate groups with initial average body weight of 150.55g /fish. Fish were stocked at 20 and 30 fish/m^3 within the three vitamin C levels .

Results indicated that, the adequate dietary A.A concentration for optimum growth of catfish was 100 mg/kg diet, and the highest growth rate, feed utilization, chemical composition of fish at lower stocking density (20 fish/m^3) .

It could be concluded from the present study that, the optimum concentration of vitamin C in catfish diet was 100mg/kg which gave the highest growth rates with no clinical signs at low or high stocking densities (20 or 30 fish/m^3, i .e .3 – 4.5 g fish/ l) .

Keywords: L-ascorbic acid- *Clarias gariepinus* - Stocking density.

INTRODUCTION

L.ascorbic acid is essential for most vertebrates including fish, as an important water soluble antioxidant, and acts as a co-factor in various hydroxylation reactions in the tissues (Sandnes *et al.*, 1992 and Lim *et al.*, 2000). Fish are unable to synthesize vitamin c due to a lack of the L-gulonolactone oxidase enzyme, which is necessary in order to convert L-gulonic acid to ascorbic acid (Tolbert, 1979 and Dabrowski *et al.*, 1988). Elbaraasi *et al* .(2004) showed that, the tissue stores of ascorbic acid and / or iron in catfish (*C. gariepinus*) fingerlings increased as a result of feed supplementation, peroxidation process and the amount / activity of the glutathion redux system. The supplement of vitamin C was calculated considering L.ascorbic acid as an essential vitamin for normal growth and physiological function of fish. It functions as a general water soluble redox reagent, in collagen formation (Sato *et al.*, 1982), iron metabolism hematology (Sandnes *et al.*,1990) and stress (Wedemeyer, 1969). Its lack in the diet depressed growth rate (Lim and Lovell, 1978), immune competence (Verlhac and Habaudan, 1994) and susceptibility to bacterial diseases (Li and Lovell, 1985).

Dietary vitamin C is essential for normal growth and for several physiological functions in most fishes (Halver, 1989). High levels of dietary vitamin C were reported to increase resistance to *Edwardisiela tarda* and *E. ictaluri* infection in channel catfish (Li and Lovell, 1985).

In aquaculture, the growth potential depends on the environmental factor, the specific potential of species used and the stocking. Signs of A.A deficiency, such as skin coloration, decreased growth rate and survival

appeared in fish fed un supplemented diet. Weight gain of grouper increased with incremental levels up to the requirement of A.A (Lin and Shiau, 2005).

The objective of the present study was to investigate the effects of stocking density on the utilization of L-ascorbic acid in catfish diet and its influence on growth rate, feed intake, carcass quality and content of L.ascorbic acid in tissues of catfish .

MATERIALS AND METHODS

The feeding experiment was started on July 2, 2003 and continued for 14 weeks. The test diets were fed to 6 treatments, each in triplicates. Six diets were prepared as described previously by Lovell and El-Naggar (1991), a 35% of L-ascorbic acid concentration (La Roche) was used. The diets were prepared by thoroughly mixing the dry ingredients with oil and then adding water until a stiff dough resulted, then passed through a mince and the resulting spaghetti – like strings were air dried. After drying, the material was blended for approximately 3 mm and sieved to a convenient pellet size and stored at – 4°C.

The basal diet was prepared as described in Table (1).

Table (1): The composition of the experimental diet of catfish.

Ingredients	g/kg diet
Low vitamin casein	277.00
Glutin	53.00
Dextrin	270.00
Corn srarch	200.00
Cellulose	50.00
Soybean-corn oil	30.00
Fish oil	50.00
Mineral mix.*	50.00
Vitamin mix. free A.A**	20.00

Ascorbic acid (A.A) source was added at various dietary levels to replace cellulose (50, 100 and 150 mg/ kg).

***Mineral mix. was the same as described by Lim and Lovell (1978).**

****** **Vitamin mix. free A.A was the same as described by Lim and Lovell (1978).**

Six groups of fish *Clarias gariepinus* Burchell (150.55 g/fish) were obtained from Abbassa Fish Hatchery in El-Sharkia Governorate. Fish were reared indoor for 14 weeks in 18 glass aquaria (80 × 50 × 50 cm^3 diameters, 180 l size) and fed with different levels of vitamin C (50, 100, and 150 mg/kg diet), each with two stocking densities (20 and 30 fish/m^3).The photoperiod was 12:12 hr, water temperature was 28±1.20°C, dissolved oxygen was > 5.0 mg / l, salinity was 1.0 ppt, and pH was > 7.10. Water quality parameters (APHA, 1995) were within the acceptable ranges for growth of catfish during the feeding trial. Fish were adapted for two weeks before the experiment start) to the experimental diets and environmental conditions, fish were fed daily the experimental diets at 3% of total biomass of fish at three times daily, at 9.00, 12.00 and 15.00 hr, fish were weighed biweekly and the daily diet was adjusted accordingly. At the end of the feeding trial, all fish were

weighed and counted for each aquarium and survival were calculated. Any dead fish were removed from each aquarium and not replaced during the experiment. All aquaria were weekly cleaned completely and were refilled with un chlorinated filtered water to avoid any bacterial or fungal infection, fish were dipped in dilute potassium permanganate solution twice a week. Biweekly samples of fish were taken to calculate body weight gain., Un-eaten food particles and feces were daily removed regularly by siphon.

Growth rate was evaluated as the differences between wet weight at the beginning and the end of the experiment and calculated as daily growth coefficient (DGC, %).

DGC % = 100 {(final weight – initial weight)} / times

Survival was calculated as the percentage of the differences between the number of live fish during the experiment at the beginning and at the end of the trial.

At the start of the trial, 15 fish were randomly taken and kept frozen until later use for analysis, also 5 fish from each treatment were taken after 14 weeks for determination of whole body proximate analysis for crude protein (CP), ether extract (EE), and ash according to the methods of AOAC (1990). Gross energy (GE) was estimated according to NRC (1993) equation [GE (kcal/kg) = 5.64 x CP + 4.11 x crude carbohydrate + 9.44 x EE].

For the determination of vitamin C content in fish tissue, the whole fish samples (5 fish from each treatment) was homogenized by chopper, and moisture content of the sample was determined from this homogenized mixture. The completely dried material was milled, and 10g were weighed. The L-ascorbic acid content of tissue sample was determined using a 2-4 – dinitrophenyl hydrasine reagent in an acidic solution, following the method described by Omaye *et al.* (1979).

The obtained data were subjected to analysis of variance according to Snedecor and Cochran (1982). Differences between means were tested at the 5% probability level using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSION

All diets were palatable and were readily consumed by fish through the experiment. All the fish, except the T1 and T2 groups were active and appeared healthy at the end of the experiment. Mortality (Table 4) during the periods of the experiment was negligible in all groups. The final body weight(Table 2) in the T2 and T6 groups was the lowest and showed extremely significant differences ($P < 0.05$) compared with the dietary groups fed on vitamin C (100 and 150 A.A mg/kg diets at lower stocking density) because of the lack of feed intake in T1and T2 groups (Tables 2, 3 and 4). The results of this study showed no effects of high level of vitamin C in the diet on catfish growth (150mg/kg diet) at lower stocking density (20 fish/m^3). This finding is in agreement with previous studies on vitamin C nutrition in *Clarias gariepinus* (Elbaraasi *et al.*, 2004).

In the present study, the maximum growth was reported when catfish fed on diet containing 100 mg vitamin C / kg diet (Tables 2, 3 and 4)at the lowest stocking rate.

Table (2): Effects of the dietary L-ascorbic acid on body weight (g/fish) of catfish during the experimental periods (14 weeks).

Treatments	Experimental periods							
	0	2	4	6	8	10	12	14 weeks
T1 S1 50	150.25± 0.91	180.62b±0.04	209.05bc± 0.32	227.01b ± 0.07	236.03d±0.14 d	287.06b± 1.01	299.33bc±11.58	306.12c± 9.75
T2 S2 50	150.90± 0.83	178.30b±3.21	208.61bc± 3.45	227.03b ± 1.78	244.00cd±2.64	272.61c± 1.52	292.33c± 2.51	297.63d± 1.54
T3 S1 100	149.89± 0.83	177.39b±6.51	213.95b± 5.00	229.66b ± 3.21	249.01c±1.00	297.63a± 2.36	324.01a± 5.93	351.63a ± 3.93
T4 S2 100	150.81± 0.50	177.15b±0.59	200.30c± 0.57	241.16a ± 8.76	252.31bc±1.15	279.80bc± 1.76	309.83b± 2.62	322.01b± 2.24
T5 S1 150	150.39± 0.15	186.60a±1.15	216.61ab± 0.96	237.33b±1.53	270.61a± 4.75	288.16b± 3.69	307.83b±1.04	318.11b± 9.90
T6 S2 150	151.03± 3.21	180.73b±2.69	222.66a±11.59	231.61b±4.93	259.61b±4.75	272.11c± 2.63	289.11d± 0.02	293.11d± 0.31

Values with the same letter in the same column are not significantly different ($p > 0.05$).

T1 (20fish/m^3 + 50 mg A.A), T2 (30fish/m^3 + 50mg A.A), T3 (20fish/m^3 + 100mg A.A), T4 (30fish/m^3 +100mg A.A), T5 (20fish/m^3 +150mg A.A) and T6 (30fish/m^3 +150ng A.A).

Table (3): Averages body weight gain (g/fish) of catfish fed on different levels of vitamin C during the experimental periods.

Treatments	Experimental periods						
	0 - 2	2 - 4	4 - 6	6 - 8	8 - 10	10 – 12	12 -14 weeks
T1 S1 50	30.37b ± 0.01	28.43d± 1.11	17.96c± 0.01	9.02e± 0.11	51.03a± 2.09	12.27d± 0.21	6.79d± 0.13
T2 S2 50	22.40c± 2.11	30.31c± 2.13	18.42c± 0.03	16.97d± 0.62	48.61b± 0.21	19.72c± 0.81	5.30e± 0.02
T3 S1 100	27.50c± 0.03	36.56b± 0.03	15.71d± 0.11	19.35c± 0.21	48.62b± 0.22	26.38b± 0.01	27.62a± 0.29
T4 S2 100	26.34c± 0.96	23.15e± 0.80	40.86a± 0.19	11.15e± 0.61	27.49c± 0.83	30.03a± 0.01	12.18b± 0.02
T5 S1 150	36.21a± 2.21	30.01c± 0.31	20.72b± 0.13	33.28a± 0.32	17.55d± 0.01	19.67c± 0.21	10.28c± 0.71
T6 S2 150	29.70b± 0.01	41.93a± 2.00	8.95e± 0.31	28.00b± 0.43	12.50e± 0.11	17.00c± 0.29	4.00f ± 0.02

Values with the same letter in the same column are not significantly different ($p > 0.05$).

Table (4): Averages daily growth coefficient (DGC %), survival rate nutrients (g/fish) and gross energy (kcal/fish) intake of catfish fed different levels of vitamin C.

Items	Treatments					
	T1	T2	T3	T4	T5	T6
Initial body weight (g/fish)	150.25 ± 0.91	150.90 ± 0.83	149.89 ± 0.83	150.81 ± 0.50	150.39 ± 0.15	151.03 ± 3.21
Final body weight (g/fish)	306.12c ± 9.75	297.63d± 1.54	351.63a ± 3.93	322.01b ± 2.24	318.11b ± 9.90	293.11d ± 0.31d
DGC (%)	148.45d ± 0.08	122.60f ± 0.04	192.13a ± 0.16	163.05b ± 0.40	159.73c ± 0.05	135.31e ± 2.13
Survival rate %	98.83±0.02	98.05±0.04	99.01±0.53	98.03±0.03	98.63±0.00	98.59±0.63
DM intake g/fish	255.91bc±3.56	244.92d±5.67	303.61a±3.24	259.21b±1.36	261.59b±2.56	222.90e±3.66
CP intake g/fish	77.03bc±0.34	73.72d±4.21	91.31a±1.68	78.02b±1.00	78.74b±2.03	67.09e±1.34
EE intake g/fish	19.96c±0.09	19.10d±0.03	23.68a±1.44	20.22bc±0.34	20.40b±1.01	17.39e±0.91
GE intake kcal/fish	1301.84b±8.03	1136.43d±6.86	1408.75a±11.15	1202.73c±3.91	1213.78c±13.40	1034.26e±3.26

Values with the same letter in the same row are not significantly different (p > 0.05).

Table (5): Growth performance and feed utilization of catfish fed the experimental diets.

Treatments	Weight gain (WG)	Feed conversion ratio (FCR)	Feed efficiency ratio (FER)	Protein efficiency ratio (PER)	Energy efficiency ratio (EER)
T1 S1 50	155.87d ±3.98	1.64b±0.00	0.61c±0.004	2.02c±0.00	11.97d±0.004
T2 S2 50	146.73e± 2.04	1.67a± 0.02	0.60d±0.001	1.99c±0.01	12.91c±0.003
T3 S1 100	201.74a± 2.00	1.50d±0.02	0.66a±0.002	2.21a±0.02	14.32a±0.006
T4 S2 100	171.20b± 1.96	1.51d±0.01	0.66a±0.001	2.19a±0.01	14.23a±0.001
T5 S1 150	167.72bc± 0.65	1.56c±0.00	0.64b±0.003	2.13b±0.01	13.82b±0.002
T6 S2 150	142.58e± 4.08	1.57c± 0.01	0.64b±0.001	2.12b±0.00	13.74b±0.000

Values with the same letter in the same column are not significantly different (p > 0.05).
FCR=DM intake/ weight gain, FER=weight gain/DM intake, PER=weight gain/DM protein intake and EER %=100 x weight gain/ GE intake.

Also, Halver *et al.*, (1969) reported that small rainbow trout require 100 mg ascorbic acid/kg diet for normal growth while that for coho salmon, 5o mg. vitamin C was sufficient . Increasing stocking density from 20 to 30 fish/m^3 decreased growth performance but there was no significant differences ($P>0.05$) between T4 and T5 groups in final body weight(Tables 2 and 4). Dietary vitamin C was essential for catfish growth and for several physiological functions when fed on diets supplemented with 100 or 150 mg A.A/kg which improved growth performance of catfish at higher stocking density (Table 4).

The results of the present experiment revealed not significant effects of stocking density on catfish survival (Table 4). Fish survival was reasonably good at all stocking densities and ranged from 98.03 to 99.01 %, this finding may indicate that A.A might have a good effect on fish survival when stocked at 30fish/m^3 (T2, T4 and T6 groups). In the present study, no morphological changes were evident in any group, also no structural deformities were recorded in fish fed the diets containing 50, 100 and 150 mg vitamin C/kg diet. The quantitative requirements of ascorbic acid have been determined for a number of fish species. The requirements were found to vary among species, size and age of fish, also environmental conditions (temperature, water pollutants and pathogens) may affect fish growth (Hilton *et al.*, 1978). On the other hand, Lovell and Lim (1978) showed that 30 mg ascorbic acid/kg diet was sufficient for growth but not enough to prevent the distortion of gill filament cartilage or for maximum rate of wound repair, while 60mg of ascorbic acid/kg diet was sufficient. On the other hand, Li and Lovell (1985) found that, catfish fed diet contained 40 or 78 mg A.A/kg had signs of A.A deficiency but grew as well as the fish fed diet contained high levels of vitamin C. This 40 mg of A.A/kg diet appeared to be enough for growth, but not to eliminate deficiency symptoms. Similar findings had been reported, the gross signs of A.A deficiency in fish diets including reduced weight gain, erratic swimming behaviors and spinal deformities (Roberts, 1978).

Increasing stocking density had significantly affected feed, nutrients and gross energy intake. On the other hand, fish fed diets with high doses (100 or150 mg A.A) had improved feed intake in T3, T4 and T5 groups (Table 4). The lowest feed and nutrients intake was obtained by T6 group, a level of 100 mg A.A had been proposed to ensure high resistance of catfish to stressful environmental conditions (high stocking density). Vitamin C in high doses (100 or 150 mg/kg) enhanced feed conversion, protein and energy efficiency ratios (Table 5) of catfish at higher stocking density (30fish/m^3). There was an increment in growth rate according to the concentration of A.A, it was clear that growth and feed utilization enhanced in catfish by the improved physiological conditions of fish fed the experimental diets through the role of A.A in reducing stress. Also it could be suggested that fish fed on A.A diets in excess levels is related to the improvement of the general metabolism in the experimental fish.

It has reported that increasing fish density lead to social stress causing chronic stress response. This leads in turn to impaire fish growth, presumably due to the metabolism of dietary energy by the physiological alteration provoked by the stress response (Kebus *et al.*, 1992). Furthermore, King *et al*

(2000) suggested that stress due space availability was the primary factor inhabiting the growth of summer flounder (*Paralichthys dentatus* L.) larvea stocked at high densities. It was showed that feed intake of fish exposed to low level of L-ascorbic acid (50 mg/kg diet) was the lowest; contrarily, feed conversion rate of fish was higher while the best FCR was obtained with fish fed 100 mg L-ascorbic acid followed by 150 and 50 mg L-ascorbic acid / kg diet. A significant reduction of crude protein (Table 6) was recorded in whole fish fed vitamin C at 150 mg / kg diet (T5) at the end of the experiment which stocked at lower rate (20 fish /m3). Ascorbic acid vitamin (100 mg/kg diet) increased crude protein and ether extract in whole fish stocked at a rate of 20 fish / m^3, but ash was decreased .On the other hand, low level of L-ascorbic acid decreased ether extract (T2 group).

Table (6): Chemical composition (CP, EE and ASH) % of whole fish in catfish fed on the experimental diets (on DM basis).

Treatments		Dry matter (DM)	Crude protein (CP)	Ether extract (EE)	ASH	Organic matter* (OM)
T1	S1 50	21.60c± 0.30	60.80a± 3.21	13.92b± 0.02	25.28c± 0.03	74.72b± 2.01
T2	S2 50	21.01c± 0.12	60.51a± 2.30	12.75c± 0.01	26.74b± 0.11	73.26c± 0.03
T3	S1 100	23.09a± 0.35	61.81a± 2.11	14.39a± 0.00	23.80e± 0.09	76.20a± 0.09
T4	S2 100	22.78b± 1.13	61.62a± 0.93	13.95b± 0.10	24.43d± 0.05	75.57ab± 1.11
T5	S1 150	21.91c± 0.28	59.97b± 0.85	13.86b± 0.03	26.17b± 0.06	73.83c± 1.93
T6	S2 150	21.61c± 0.01	60.03a± 0.86	12.16c± 0.02	27.81a± 0.03	72.19d± 1.33

***Organic matter (%) = CP + EE**

Values with the same letter in the same column are not significantly different (p > 0.05).

Proximate chemical composition of fish at the start was, 19.12% DM, 58.33%CP, 11.27% E, 30.40%Ash and 69.60% OM.

After 14 weeks of the growth trial, there were remarkable differences in fish body ascorbic acid content between the treated groups compared with initial value. The 150 mg vitamin C group had significantly higher body content than the other groups (Table 7). This increase was caused by increasing ascorbic acid levels in the diets. Similarly, Sandnes *et al.* (1992) reported that, the concentration of ascorbic acid in the liver of *S. salar* clearly demonstrated a relationship between dietary ascorbic acid levels and liver ascorbic acid content. Previous study showed that the tissue stores of ascorbic acid in African catfish *C. gariepinus* increased as a result of feed supplementation. The higher amount of L-ascorbic acid suggests some antioxidant effect, but the differences were not statistically significant mainly because of the high individual variation of the measured parameters (Elbaraasi *et al.*, 2004). Also, Abdelhamid *et al.* (1995a&b) found that, liver and eye contents of vitamin-c increased by age advance .They added that the gradual increases of dietary ascorbic acid led to gradual increase of this estimate. The present study showed that catfish require more of a specific nutrients when stocked at high densities, unless there is some sort of severe stress associated with higher stocking density, it is un likely that the nutrient requirements would change, and even then additional effects of any stressors.

Table (7): L-ascorbic acid content of whole fish tissues of the experimental fish (*Clarias gariepinus*).

Treatments	L-ascorbic acid micro g / g tissues
At the start	16.65± 0.03
T1 S1 50	39.90e± 1.60
T2 S2 50	38.86e± 1.33
T3 S1 100	69.22c± 1.92
T4 S2 100	66.32d± 1.75
T5 S1 150	124.05a± 0.36
T6 S2 150	118.39b± 0.36

Values with the same letter in the same column are not significantly different (p > 0.05).

In conclusion, the obtained result showed that the amount of L-ascorbic acid in the diet of catfish should be increased to the value of 100 mg/kg when stocked at higher densities (4.5 g /l)to reduce crowding stress. The highest growth rate was observed by fish fed on 100 mg L-ascorbic acid/Kg diet, may be resulting in a decreased of FCR .

REFERENCES

Abedelhamid, A. M., El-Sadaney H. H., El-Shinnawy M. M., and Dorra T.M. (1995a).Effects of dietary graded levels of ascorbic acid on performance and chemical composition of tilapia fingerlings. J. Agric. Sci. Mansoura Univ., 20: 2731-2742.

Abedelhamid, A. M., El-Sadaney H. H., El-Shinnawy M. M., and Dorra T.M. (1995b).Effects of dietary levels of crude protein, fat, and ascorbic acid on Nile tilapia (*Oreochromis niloticus*) fingerlings performance. J. Agric. Sci. Mansoura Univ., 20: 2743-2766.

A.O.A.C. (1990). Official Methods of Analysis , 15th edition . K. Helrich ed. Association of Official Analytical Chemists Inc., Arlington, V.A.

A.P.H.A. (1995). American Public Health Association Standard Methods for the examination of water and wastewater, 16th ed., Washington DC, 1268pp.

Dabrowski, K.; Hinterleitner, S. ; Sturmbouer, C.; El-Fiky N. and Wieser, W. (1988). Do carp larvea require vitamin C . Aquaculture, 72: 295 – 306.

Delince, E.G. (1992). The Ecology of Fish Pond Ecosystem with Special Reference to African . Academic Publishers. Boston, USA.

Duncan, D. B. (1955). Multiple range and multiple (F) test. Biometrics, 11: 1 – 42.

Elbaraasi, H. ; Mezes. M.; Bologh, K. ; Horvath, L. and Csengeri, L. (2004). Effects of dietary ascorbic acid / iron ratio on some production traits, lipid peroxide state and amount / activity on the glutathione redox system in African catfish *Clarias gariepinus* (Burche 11) fingerlings. J. Aquaculture Research, 35: 256 – 262.

Halver, J. E. (1989). The Vitamins. In: Halver, J. E. (Ed.), Fish Nutrition, 2nd ed., Academic Press, San Diego, CA, pp32-102.

Halver, J; Ashley, L. and Smith, R. (1969). Ascorbic acid requirement of coho salmon and rainbow trout . Tran. Am. Fish. Soc., 98: 762 – 771.

Hilton, J.; Cho, C. and Slinger, S. (1978). Effect of graded levels of supplemental ascorbic acid in practical diets of rainbow trout (*Salmo gairdneri*). J. Fish. Res. Board Can., 35: 431 – 436.

Kebus, M. J ; Coltins. M.T. ; Brownfield , M.S.; Amundson , C.H.; Kayes , T.B. and Malison , J.A.(1992). Effects of rearing density on stress response and growth of rainbow trout. J. Aquatic. Animal Health, 4: 1-6.

King, N. J. ; Howell . W.H. ; Huber .M. and Bengtson , D.A. (2000) : Effects of stocking density on laboratory – scale production of summer flaunder, *Paralichthys dentatus*. J. World Aquaculture Society, 31:43 – 445 .

Li, Y. and Lovell, R.T. (1985). Elevated levels of dietary ascorbic acid increase immune responses in channel catfish. J. Nut., 115:123-1`31.

Lim, C. and Lovell, R.T. (1978). Pathology of the vitamin C deficiency syndrome in channel catfish *Ictaluras punctatus*. J. Nutr. , 108: 1137 – 1146.

Lim, C.; Klesius, P.H.;and Li, M. H. (2000). Interaction between dietary levels of iron and vitamin C on growth, hematology, immune response and resistance of channel catfish (*Ictalurus punctatus*) to *Edwardsiella ictaluri* challenge. J. Aquaculture, 185: 313-327.

Lin, M. F. and Shiau, S. Y. (2005).Dietary L.ascorbic acid affects growth, non specificimmune responses and disease resistance in juvenile grouper, *Epinephelus malabariccus*. J. Aquaculture,244: 215-221.

Lovell, R. and El-Naggar, G. (1991). Vitamin C activity for L.ascorbic acid, L.ascorbyl – 2 sulfate , and L. ascorbyl –2 phosphat Mg for channel catfish. Symp. on Feeding and Nutr. In Fish Toba Japan pp: 159 – 165.

Lovell. R. and Lim, C. (1978). Vitamin C in pond diets for channel catfish. Trans. Am. Fish. Soc., 107: 321 – 325 .

NRC (National Research Council) (1993). Nutrient requirements of warmwater fishes and shellfishes. National Academy Prass, Washington DC, 102pp.

Omaye, S. T. ; Turnbull, J. D. and Sanberlich, H. E. (1979). Selected methods for the determination of ascorbic acid in animal cells, tissues and fluids. Methods in Enzymology , 62 : 3-7.

Roberts, R. (1978). Textbook of Fish Pathology, 1st Ed. ,Baillierc Tindall, Casselltd Co. London.

Sandnes, K.; Hansen, T., Killie, J. E. A. and Waagbo, R. (1990). Ascorbate 2 – sulfate as a dietary vitamin C source for Atlantic salmon *Salmo solar* L. growth, bioactivity, hematology and hormonal immune response Fish Physiol. Biochem. , 8: 419 – 427.

Sandnes, K.; Torrissen, O. and Waagbo, R. (1992). The minimum dietary requirement of vitamin C in Atlantic salmon (*Salmo salar*) fry using Ca-ascorbicte - 2 mono phosphate as dietary source. Fish Physiology and Biochemistry. 10: 315-319.

Sato, M. ; Kondo , T. ; Yashinaka , R. and Kega , S. (1982). Effect of dietary ascorbic acid levels on collagen formation in rainbow trout . Bull . Jpn. Soc . Sci . Fish . , 48: 553-556.

Sndecor, G.W. and Cochran, W.G. (1982). Statistical Methods. 6th Edition. Iowa State Univ. Press , Amer. Ian. , USA, PP 593 .

Tolbert, B. M. (1979). Ascorbic acid metabolism and physiological function. J. Vitamin and Nutrition Research, 19: 127 – 142.

Verlhac , V. and Gabaudan , J. (1994). Influence of vitamin C on the immune system of salmonids. Aqua. Fish. Manage. , 25: 21-36.

Wedemeyer, G. (1969). Stress induced ascorbic acid depletion and cortisol production in two salmonid fishes . Comp. Biochem. Physiol., 24: 1247-1251.

الاستفادة من حمض الاسكوربيك في علائق القراميط النيلى المستزرعة بكثافـــات مختلفة

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من خلال تجربة التغذية والتى أجريت بالمعمل المركزي لبحوث الأسماك و استمرت ١٤ أسبوعا لتحديد الاحتياجات من فيتامين ج (حمض الاسكوربيك) المناسبةلأسماك القراميط النيلى المستزرعة بكثافتين وتأثير ذلك على معدلات النمو، الاستفادة الغذائية، تركيز حمض الاسكوربيك (فيتامين ج) فى أنسجة السمك والتحليل الكيماوى لجسم الأسماك. تم إضافة حمض الأسكوربيك بمستويات ٥٠، ١٠٠ و ١٥٠مليجرام/ كجم عليقة نقيةعلى التوالى ، وتمت تغذية القراميط كلا فى ثلاث مكررات بمتوسط وزن ابتدائى ١٥٠,٥٥ جم/ سمكة ، وتم استزراع الاسماك بكثافة ٢٠ و ٣٠ سمكة / متر مكعب ، كلا مع ثلاث مستويات من فيتامين ج فى العلائق التجريبية. تشير النتائج أن أفضل مستوى لحمض الأسكوربيك للحصول على أعلى نمو للأسماك القراميط النيلى هو ١٠٠مليجرام/ كجم عليقة ، وكان أعلى معدلات نمو، استفادة غذائية ، وتحليل جسم الأسماك عندما غذيت الأسماك على فيتامين ج فى الكثافات الأقل(٢٠سمكة/ متر مكعب). كذلك فإن الأسماك التى غذيت على علائق أضيف اليها ١٠٠مليجرام فيتامين ج أعطت أعلى زيادة وزنية مكتسبة و كفاءة غذائية عن تلك الأسماك الأخرى التى غذيت على علائق أضيف اليها ١٥٠ أو ٥٠ مليجرام فيتامين ج ، خاصة عند استزراعها بكثافات عالية (٣٠ سمكة / متر مكعب). توصى هذه الدراسة أن أفضل تركيز من فيتامين ج فى علائق القراميط النيلى هو١٠٠ مليجرام/كجم ، حيث أعطت أفضل معدلات نمو بدون أى أعراض مرضية سواء استزرعت فى كثافات قليلة أو مرتفعة (٢٠ أو٣٠ سمكة/متر مكعب أى ٣ – ٤,٥ جم سمك / لتر).