Abstract: A laboratory experiment was carried out to investigate the effect of Thepax and Endo Vit. C as feed additives in the formulated diet on the growth performance of grass carp *Ctenopharyngodon idella*. The feed (30.11% crude protein) manufactured in the laboratory using raw local materials diet. Young grass carp (Average weight 3.36± 0.95 g) obtained from Aquaculture Unit ponds in Al-Hartha Station for Agricultural Researches, North Basrah. The fish were stocked in nine glass aquarium, three replicates for each treatment, of dimensions 60×40×30 cm provided with pumping aeration. The experimental diets included a control T1 (0% additives), T2 (1g Thepax/kg diet) and T3 (1g Endo Vit. C /kg diet) were used in feeding trail of current experiment. The experiment lasted for 57 days (from 29 Nov. to 24 Jan.) and fishes were fed six days a week using 5% of fish weight as feeding ratio. Results of current study reveals that grass carp fed on formulated feed supplemented with Endo vit. C having high growth performance (WG, DGR, RGR and SGR). The lowest Feed conversion ratio (2.511) was recorded in T3 this value was statistically significant (P≤0.05) with T2 while the highest value (2.767) was observed on the control. Protein efficiency ratio, feed intake and gross conversion efficiency were also recorded high values in T3, but control displayed superior values compared with Thepax treatment, which showed higher value of Relative feed intake compared to other two treatments.

Keywords: GCE, Thepax, Endo Vit. C, Grass carp.

Introduction

Feed represents about 50–80% of the production cost in aquaculture; therefore, suitable nutrition is one of the critical aspects to achieve a nutritionally balanced diet and low cost of production (El-Sayed, 2014; Hasan & Soto, 2017).

Feed additives were added to improve feed quality, health performance and feeding efficiency of the fishes. Most of these feed additives are non–nutritious and include antibiotics, immunostimulants, antioxidants probiotics, preservative, binder and colorants (Encarnação, 2016; Kord et al., 2021). Feed additives represent several types of molecules, compounds and even organisms that promote ingestion, absorption and assimilation of nutrients (Watts et al., 2020). Products that
improve feed efficiency are particularly important since feed costs are a major expense in aquaculture production (Nates, 2016).

Probiotics are live microorganisms which, when added in suitable amounts, confer a health benefit of the host (FAO/WHO 2002). Yeast was used as feed for farm animals for more than a hundred years (Owens and McCracken, 2007; Bajagai et al., 2016), it contains a high amount of enzymes, amino acids, fatty acids, vitamins and unknown growth factors, but in aquaculture only a few species were used, the most common was Saccharomyces cerevisiae (Encarnação et al., 2016; Agboola et al., 2021). Yeast (Thepax) acts as a probiotic in feed poultry (Yousefi & Karkoodi, 2007; Fazli et al., 2008; Zarei et al., 2011; Boostani et al., 2013) while other researchers consider Thepax as prebiotic (Nikpiran et al., 2013; Al-Mhanawi et al., 2021), however the manufactured companies cite it as prebiotic because its consist from cell wall of yeast Saccharomyces cerevisiae, mannan and glucan (Nikpiran et al., 2013). Most works about Thepax as food additive was applied in broiler performance nutrition such as Japanese Quails (Nikpiran et al., 2013) and broiler chickens (Boostani et al. 2013) which show positive effects on weight performance.

Vitamin C or ascorbic acid is an essential micronutrient for normal growth, antioxidant and immunity of fish, as they cannot synthesize this nutrient because of the lack of L-gulonolactone oxidase (Ching et al., 2015; Trichet et al., 2015; Adeyemi-Doro & Iyiola, 2018), therefore they depend on an exogenous source through the diet, moreover it is unstable and most of its activity in applied diets is lost during manufacturing and storage due to exposure to high temperature, oxygen and light. About 75% of the initial amount of supplemental vitamin C in feeds can be lost during processing at ambient temperature. However, appropriate requirements of vitamin C for grass carp Ctenopharyngodon idella juveniles remain unknown (Nasar et al., 2021).

Grass carp was the most widely cultured and commercially important freshwater fish species that consist about 11% of world aquaculture production (FAO, 2020), it is primarily an herbivorous fish that have a preference for aquatic vegetation (Zolfinejad et al., 2017). One of the main reasons for grass carp production increase related to the use of pelleted feed, that allow higher density or cage monoculture succeeded (Gan et al., 2012).

Little studies in Iraq on grass carp were achieved, and most studies deal with laboratory experiments (Al-Dubakel et al., 2011; Taher, 2017; Sayed-Lafi et al., 2018; Abdullah et al., 2020; Al-Dubakel et al., 2020). While few field studies were conducted (Al-Seyab, 1996; Saleh et al., 2008; Taher et al., 2021).

The objective of the current experiment was to assess the effect of Thepax and Endo Vit. C as feed additives on the growth performance of grass carp fingerlings.

**Materials & Methods**

A laboratory experiment was carried out to investigate the effect of Thepax and Endo Vit. C as feed additives in the formulated diet on the growth performance of grass carp. The feed manufactured in the laboratory using raw local materials (Table, 1) diet formulated to provide 27% crude protein. Grass carp (Average weight 3.36± 0.95 g) obtained from Aquaculture Unit ponds in Al-Hartha Station for Agricultural Researches, North Basrah. The fish after acclimation for seven days were stocked in nine glass aquaria of dimensions 60x40x30 cm
provided with pumping aeration, ten fish in three replicates for each treatment were used for the current experiment at the Laboratory of Live Food- Aquaculture Unit- Agriculture College. The experimental diets included a control T1 (0% additives), T2 (1g/kg Thepax) and T3 (1g/kg Endo Vit. C) were used in feeding trail of current experiment. The experiment lasted for 57 days and fishes were fed six days a week using 5% of fish weight as feeding ratio. All the fishes in each replicate were weighed every two weeks in order to adjust the feeding to new mean body weight.

Growth performance

The experiment started at 29 Dec.2020, and at the end of experiment in 24 Jan.2021 the following growth parameters were used to describe the growth performance of grass carp:

Weight gain:

\[ \text{WG} = W_2 (\text{g}) - W_1 (\text{g}) \]

Relative Growth Rate:

\[ \text{RGR} = [(W_2 (\text{g}) - W_1 (\text{g}))/W_1] \times 100 \]

Specific Growth Rate:

\[ \text{SGR} = (\ln W_2 (\text{g}) - \ln W_1 (\text{g})/(t_2 - t_1)) \times 100 \]

Where \( \ln W_2 \) is the natural logarithm of the final weight at the time \( T_2 \), \( \ln W_1 \) is the natural logarithm of the initial weight at the time \( T_1 \) and \( T_2 - T_1 \) is the period between the two weights.

Feed utilization

Feed Conversion Ratio:

\[ \text{FCR} = R (\text{g})/ \text{WG} (\text{g}) \]

Where R: weight of dry feed intake. WG: wet weight gain (live weight of fish).

Feed intake:

\[ \text{FI} = 100 \times \text{total feed intake}/[\text{feeding days} \times (W_1 + W_2)/2] \]

Relative Feed Intake:

\[ \text{RFI} = \text{FI}/ 0.5 \times (W_2 - W_1) \times d) \times 100 \]

Gross Conversion Efficiency:

\[ \text{GCE(K)} = \text{SGR}/ \text{RFI} \times 100 \]

Protein Efficiency Ratio:

\[ \text{PER} = \text{WG (g)}/ \text{PI (g)} \]

Where WG: wet weight gain (live weight of fish).

PI: weight of protein intake.

Chemical analysis Until the weight is stable

The artificial diets and alfalfa were analyzed according to A.O.A.C. (1990). The moisture content was estimated by drying the samples at a temperature of 105 °C until the weight is stable. The proteins were estimated using the Microkjeldahl device, and the percentage of lipids was estimated using a Soxhlet apparatus in the presence of hexane as an organic solvent. The ash was estimated by burning the samples in Muffle furnace at 550 °C for 4 hours. Total carbohydrates were estimated according to the equation mentioned by Wee & Shu (1989):

\[ \% \text{COH} = \% \text{DM} - (\% \text{EE} + \% \text{CP} + \% \text{ASH}) \]

Nitrogen free extract was calculated according to New (1987) as follow:

\[ \% \text{NFE} = \% \text{DM} - (\% \text{EE} + \% \text{CP} + \% \text{ASH} + \% \text{CF}) \]

Where:

NFE = Nitrogen free extract

DM = Dry matter

EE = Ether extract or crude lipid

CP = Crude protein
CF = Crude fiber
COH = Total carbohydrate

GE (Gross energy) was calculated according to NRC(1993) by using factors of 5.65, 9.45 and 4.22 Kcal per gram of protein, lipid and carbohydrate, respectively, and DE (Digestible energy) was calculated by applying the coefficient of 0.75 to convert gross energy to digestible energy according to Hepher et al. (1983).

Table (1): Ingredients of the experimental diet (g.kg⁻¹).

| Feed Ingredients       | Treatment (Diets) | T1  | T2  | T3  |
|------------------------|-------------------|-----|-----|-----|
| Wheat flour            |                   | 300 | 300 | 300 |
| Wheat bran             |                   | 260 | 260 | 260 |
| Fishmeal               |                   | 200 | 200 | 200 |
| Soybean meal           |                   | 200 | 200 | 200 |
| Vit. and minerals premix|                  | 20  | 20  | 20  |
| Vegetable oil          |                   | 20  | 20  | 20  |
| Thepax¹                |                   | 0   | 1   | 0   |
| Endo Vit. C²           |                   | 0   | 0   | 1   |

¹Thepax produced by Medro- Doxal, contains less than 10× 10⁹ CU/g of Saccharomyces cerevisiae var. Ellipsoideus.
²Endo Vit. C produced by Medro- Doxal, contains 100% ascorbyl monophosphate.

Table (2): Proximate chemical composition of the experimental diet (mean ±SD).

| Proximate composition   | (% Dry Matter) |
|-------------------------|----------------|
| Dry matter              | 92.46 ±0.03    |
| Crude protein           | 30.11 ±0.11    |
| Ether extract           | 6.84 ±0.06     |
| Crude fiber             | 4.35 ±0.19     |
| Ash                     | 10.73 ±0.07    |
| NFE                     | 47.97 ±0.17    |
| GE (Kcal/Kg diet⁻¹)     | 4372.205 ±6.84 |
| DE (Kcal/Kg diet⁻¹)     | 3279.154 ±5.127|
| P/E ratio (mg.Kcal⁻¹)   | 91.823 ±0.19   |

Results

The proximate chemical composition of the experimental diet in table (2), shows that crude protein was 30.11%, the gross and digestible energy were 4372.205 and 3279.154 Kcal.Kg⁻¹ respectively, while protein to energy ratio was 91.823 mg.Kcal⁻¹. Grass carp readily accepted all the experimental diets.

Statistical analysis

The feeding trial was conducted with a completely randomized design, and the differences between the means were tested by analysis of variance (ANOVA) and the significant differences were tested by LSD test at 0.5% probability level by SPSS program Ver. 22.
Present study reveals that grass carp fed on formulated feed supplemented with Endo vit. C having high growth performance (Table 3) i.e., WG, DGR, RGR and SGR values as compared to both control and feed supplemented with Thepax, these values are statistically highly significant (P≤0.05), meanwhile the later feeds best Feed conversion ratio (2.511) was recorded in fish fed on the diet supplemented with Endo vit. C followed by fish received Thepax, while the lower value (2.767) was observed on the control treatment. Protein efficiency ratio, Feed intake and Gross show no significant differences (P>0.05). In different periods of feeding trial, Thepax treatment exhibited higher values in average weight, but at the end and overall weight gain was greater in Endo vit. C treatment (Fig. 1).

After 57 days of feeding trial, there was significant variation in feed utilization of grass carp (P≤0.05), as indicated in table (4). The conversion efficiency were also recorded high values in Endo vit. C treatment, but control displayed superior values compared with Thepax treatment, which showed higher value of relative feed intake compared to other two treatments.

Table (3): Effects of various additives in feed on the growth performance of grass carp.

| Growth parameters | Treatments         | Thepax      | Endo vit. C | Control    |
|-------------------|--------------------|-------------|-------------|------------|
| IW(g)             |                    | 3.232 a     | 3.203 a     | 3.238 a    |
|                   | ±0.128             | ±0.089      | ±0.051      |            |
| FW(g)             |                    | 5.068 b     | 5.373 a     | 5.118 a    |
|                   | ±0.698             | ±0.873      | ±0.461      |            |
| WG (g)            |                    | 1.836 b     | 2.171 a     | 1.880 b    |
|                   | ±0.798             | ±0.822      | ±0.411      |            |
| DGR (g/day)       |                    | 0.032 a     | 0.038 a     | 0.033 a    |
|                   | ±0.014             | ±0.014      | ±0.007      |            |
| RGR(%)            |                    | 57.386 b    | 67.561 a    | 57.922 b   |
|                   | ±26.868            | ±24.451     | ±11.688     |            |
| SGR (%/day)       |                    | 0.779 b     | 0.894 a     | 0.799 b    |
|                   | ±0.289             | ±0.247      | ±0.127      |            |

Data in each row with different letters are significantly different (P≤0.05).
Fig. (1): Average weight of *Ctenopharyngodon idella* fed with different diets during the experimental period (Mean ± SD).

Table (4): Effects of various additives in feed on the feed utilization by grass carp.

| Feed parameters | Treatments         | Thepax | Endo vit. C | Control |
|-----------------|--------------------|--------|-------------|---------|
|                 |                    | Mean   | ±SD         | Mean    | ±SD     |
| FCR             |                    | 2.688 b| ±1.481      | 2.511 a | ±0.603  |
|                 |                    |        |             | 2.767 b | ±0.406  |
| FI              |                    | 1.783 b| ±0.619      | 2.098 a | ±0.029  |
|                 |                    |        |             | 2.138 a | ±0.017  |
| PER             |                    | 1.021 b| ±0.092      | 1.497 a | ±0.416  |
|                 |                    |        |             | 1.319 a | ±0.211  |
| RFI             |                    | 4.100 a| ±2.388      | 3.690 a | ±1.184  |
|                 |                    |        |             | 4.111 a | ±0.820  |
| GCE(K)          |                    | 11.338 b| ±2.230     | 28.369 a| ±19.382 |
|                 |                    |        |             | 20.502 | ±8.108  |

Data in each row with different letters are significantly different (P<0.05).

**Discussion**

In the present study, significant improvements in growth parameters which were (FW, WG, DGR, RGR and SGR) and feed utilization (FCR, FI, PER, RFI and GCE) indicates that supplementation of 1.0 g. kg Endo vit. C-1 promotes the growth performance of grass carp. The values of these parameters in the present study for Endo vit. C treatment was comparable with other studies, i.e., Lin & Shiau (2004) in grouper, *Epinephelus malabaricus*, Naggar & Lovell (1991) in Channel catfish (*Ictalurus punctatus*) and Al-Dubakel & Al-Sanabani (2010) in common carp. Li *et al.* (2018) studied grass carp and recorded higher values for growth parameters, but feed utilization indices were within the range of present results. Ascorbyl monophosphate which used in the present feed experiment seems to act more efficient as Vit. C source, it was chemically stabilized, generally by complexing Vit. C with phosphate to optimize its stability, therefore phosphorylated form of vitamin C is recommended (Wang *et al.*, 2003), as a result it must therefore be supplied via the feed at recommended dosages for active uptake (Trichet *et al.*, 2015; Omoniyi & Ovie, 2018; Luo *et al.*, 2021).
The digestive physiology was affected by in-feed probiotics (Thepax) through improvement of intestinal enzyme activities and significant increase in at least 11% in intestinal lactic acid bacteria population was observed (Adel et al., 2016). While vit. C acts as a reducing agent by being an electron donor to enzymes that assist in synthesizing collagen, carnitine, norepinephrine, peptide hormone, and tyrosine metabolism and have an important antioxidative role (Harrison & May, 2009; Adeyemi-Doro & Iyiola, 2018), however Thepax which used as food additive for grass carp in this study did not show significant differences with control and display lower values for both growth parameters and feed utilization compared with Vit. C treatment, this may be explained due to the small size of fish used in the present study and the alimentary canal was not completely developed so the benefits of the microbial flora balance of intestine did not achieved by Thepax (probiotic), while vit. C may have direct plays an important role in certain aspects of protein metabolism and has a specific effect on fish growth, also few studies about using this additive in fish diets showed that supplemented diet with Thepax enhance growth and immune responses in common carp Cyprinus carpio, but the values of FCR (7.71–7.93) were much higher than the present study (Al-Mhanawi et al., 2021). Al-Jubouri & Saleh (2017) found that Thepax treatment was although significantly different from control but growth parameters of common carp values were less than other fourth treatments. Yousefian et al. (2012) also noticed that the differences of Aqualase (Thepax Aqua) treatment were not significantly with the control group for Kutum Fries (Rutilus frisii kutum). Also when local probiotic was used in the diets of young common carp, the inclusion of 4 and 6 g.kg⁻¹ show values approach to the control diet (Al-Dubakel et al., 2015).

Feed intake in Thepax supplemented diet showed high value compared with other two diets, this finding comparable with the results of Abdel-Tawwab et al. (2008) on Saccharomyces cerevisiae as a growth promoter for Nile tilapia, Oreochromis niloticus fry where the yeast supplementation significantly affected the whole fish body composition and suggested that yeast plays a role in enhancing feed intake (Banu et al., 2020). The inclusion of Thepax in the present study was 1g.kg⁻¹ which recommended by the manufacturer, it may be less than effective ratio as Adel et al. (2016) stated that inclusion rate 1.5% and above were significantly improved all growth performance parameters of rainbow trout Oncorhynchus mykiss. Nikhoo et al. (2010) and Yousefian et al. (2010) got the best results in treatments received 0.15% and 0.2% compared to 0.1% and control in the diet of common carp fingerlings. While these rates are considerably higher than both the present study and manufacturer recommendation, this may be need further confirmation to use it in practical fish diets.

Gross conversion efficiency (GCE) related growth rate to feed intake of fish (de Silva & Anderson, 1995), while Bhilave et al. (2010) recorded very low values (0.0006 – 0.0014%) for GCE for Labeo rohita, Bhosale & Bhilave (2014) recorded high values (11.72 – 39.36%) for grass carp, both recent studies compared formulated feed with conventional feed for 90 days feeding trial. The results of present study were comparable for grass carp fed conventional and 100% replacement with
formulated feed in Bhosale & Bhilave (2014) study. Augustine et al. (2020) also recorded similar values for African catfish *Clarias gariepinus* fed varying levels of yellow maize.

**Conclusion**

The best growth performance and nutrient utilization recorded in grass carp fingerlings fed Endo vit. C as feeds additive, while Thepax did not show any benefits compared to control diet for small size of this species. A regular and adequate intake from exogenous sources for average growth is necessary and also to prevent vit. C deficiency.

**Acknowledgments**

The authors appreciate the efforts of the Aquaculture Unit staff, College of Agriculture for all supports and assistance to complete this research work.

**Conflict of interest**

The authors declared that they have no conflict of interest.

**Ethical approval**

All applicable national and international guidelines for the care and use of animals were followed.

**Orchid**

M. M. Taher: https://orcid.org/0000-0002-2752-7692  
S. J. Muhammed: https://orcid.org/0000-0003-2117-5718  
A. M. Mojer: https://orcid.org/0000-0002-1562-6984  
A. Y. Al-Dubakel: https://orcid.org/0000-0001-9410-5505

**References**

Abdel-Tawwab, M., Abdel-Rahman, A. M., & Ismael, N. E. (2008). Evaluation of commercial live bakers’ yeast, *Saccharomyces cerevisiae* as a growth and immunity promoter for fry Nile tilapia, *Oreochromis niloticus* (L.) challenged in situ with *Aeromonas hydrophila*. *Aquaculture*, 280(1-4), 185-189. https://doi.org/10.1016/j.aquaculture.2008.03.055

Abullah, J. N., Taher, M. M., & Al-Dubakel, A. Y. (2020). Feeding preferences of grass carp (*Ctenopharyngodon idella*) for three aquatic plants. *Journal of Kerbala for Agricultural Sciences*, 7(3), 23-34. https://journals.uokerbala.edu.iq/index.php/Agriculture/article/view/800

Adel, M., Lazado, C. C., Safari, R., Yeganeh, S., & Zorriehzahra, M. J. (2016). Aqualas, a yeast-based in-feed probiotic, modulates intestinal microbiota, immunity and growth of rainbow trout *Oncorhynchus mykiss*. *Aquaculture Research*, 48(4), 1815-1826. https://doi.org/10.1111/are.13019

Adeyemi-doro, O., & Iyiola, A. (2018). Vitamin C: An important nutritional factor in fish diets. *Journal of Agriculture and Ecology Research International*, 16(2), 1-7. https://doi.org/10.9734/JAERI/2018/15528

Al-Dubakel, A. Y., & Al-Sanabani, M. A. (2010). Using vitamin C and sodium bentonite as food additives in the diets of common carp *Cyprinus carpio* L. *Iraqi Journal of Aquaculture*, 7(1), 30-09. https://doi.org/10.21276/jiaq.2010.7.1.2

Al-Dubakel, A. Y., Al-Hamadany, Q. H., & Mohamed, A. A. (2015). Effect of local probiotic (Iraqi probiotic) on the growth of common carp *Cyprinus carpio* L. youngs. *Journal of Basrah Researches (Sciences)*, 41(3), 57-69. https://doi.org/10.4197/Mar.22-2.3

Al-Dubakel, A. Y., Jabir, A. A., & Al-Hamadany, Q. H. (2011). Growth performance and implication of a thermal-unit growth coefficient of grass carp *Ctenopharyngodon idella* and silver carp *Hypophthalmichthys molitrix* larvae reared in recirculation system. *Journal of King Abdulaziz University, Marine Science*, 22(2), 33-43. https://doi.org/10.4197/Mar.22-2.3

Al-Dubakel, A. Y., Taher, M. M., & Abdullah, J. N. (2020). Partial replacement of fish meal with *Azolla filiculoides* meal in the grass carp *Ctenopharyngodon idella* feed. * Biological and Applied Environmental Research*, 4(2), 167-176.

Agboola, J. O., Overland, M., Skrede, A., & Hansen, J. O. (2021). Yeast as a major protein rich ingredient in
Aquafeeds: A review of the implications for aquaculture production. *Reviews In Aquaculture, 13*(2), 949-970. https://doi.org/10.1111/raq.12507

Al-Jubouri, B. S., & Saleh, K. I. (2017). Effect of using bacterial-enzyme mixture, bread yeast and Thepax on production performance of common carp (*Cyprinus carpio* L.) cultured in floating cages. *Journal of University of Babylon, 25*(4), 1406-1414. (In Arabic).

Al-Mhanawi, B. H., Al-Niaem, K. S., & Al-Tameemi, R. A. (2021). Effect of food additives, Thepax and Labazyme on growth performance and immune response of young common carp *Cyprinus carpio* L. *IOP Conf. Series: Earth and Environmental Science, 779*, 012123. https://doi.org/10.1088/1755-1315/779/1/012123

Al-Seyad, A. A. (1996). Evaluation of grass carp *Ctenopharyngodon idella* Val. 1844 efficiency for aquatic plants weeds control in drainage systems. Ph. D. Thesis, College of Agriculture, University of Basrah, 89pp. (In Arabic)

A.O.A.C. (1990). *Official Methods of Analysis: Association of Official Analytical Chemists*. George W., & Latimer, Jr. (Eds.), 20th edition. Rockville, Maryland 20850-3250, 3172pp.

Augustine, O., Eyiwunmi, F. A., & Bolanle, A. S. (2020). Practical growth performance and nutrient utilization of catfish *Clarias gariepinus* fed varying inclusion level of fermented unsieved yellow Maize. *Journal of Natural Sciences Research, 10*(6), 43-50. https://doi.org/10.7176/JNSR/10-6-06

Banu, M. R., Akter, S., Islam, M. R., Mondol, M. N., & Hossain, M. A. (2020). Probiotic yeast enhanced growth performance and disease resistance in freshwater catfish gulsna tengra, *Mystus cavasius*. *Aquaculture Reports, 16*, 100237. https://doi.org/10.1016/j.aqrep.2019.100237

Bhilave, M. P., Nadaf, S. B., & Bhosale, S. V. (2010). Gross conversion efficiency (GCE) of *Labeo rohita* fed on formulated feed. *The Bioscan, 5*(3), 483-485.

Bhosale, S., & Bhilave, M. (2014). Gross conversion efficiency of *Ctenopharyngodon idella* fed with conventional and combinations of formulated feed. *Research Journal of Agricultural Sciences, 5*, 939-942. http://rjas.org/ViewIssue?IssueId=34

Boostani, A., Mahmoodian, F. H. R., Ashayerizadeh, A., & Aminafshar, M. (2013). Growth performance, carcass yield and intestinal microflora populations of broilers fed diets containing thepax and yogurt. *Brazilian Journal of Poultry Science, 15*(1), 1-6. https://doi.org/10.1590/S1516-635X2013000100001

Ching, B, Shit F. Chew, S.F., & Ip, Y. K. (2015). Ascorbate synthesis in fishes: A Review. *International Union of Biochemistry and Molecular Biology, 67*(2), 69-76. https://doi.org/10.1002/iub.1360

De Silva, S. S., & Anderson, T. A. (1995). *Fish nutrition in aquaculture*. 1st ed. London: Chapman & Hall, 319pp. https://www.bookdepository.com/Fish-Nutrition-Aquaculture-Sena-S-De-Silva/978012550300

El-Sayed, A. F. M. (2014). *Value chain analysis of the Egyptian aquaculture feed industry*. WorldFish, Penang, Malaysia. Project Report: 2014-22.

Encarnacao, P. (2016). Functional feed additives in aquaculture feeds. pp. 217-237. In Nates, S. F., (Ed.). Aquafeed formulation. Academic Press: San Diego, CA, 279pp. http://doi.org/10.1016/B978-0-12-800873-7.00005-1

Bajagai, Y. S., Klieve, A. V., Dart, P. J., & Bryden, W. L. (2016). *Probiotics in animal nutrition: Production, impact and regulation.* paper 179. FAO Animal Production and Health, Rome, 89pp.

FAO. (2020). *The State of World Fisheries and Aquaculture*. Food and Agriculture Organization of the United Nation. Rome, 206pp. https://doi.org/10.4060/ca9229en

FAO/WHO (2002). *Guidelines for the evaluation of probiotics in food*. Food and Agriculture Organization of the United Nations/World Health Organization, London, Ontario, 11pp.

Fazli, Z., Azari-takami, G., & Fazli, S. (2008). Effects of yeast probiotic (Thepax) enrichment on biochemical parameters of *A. urmiana* Nauplii. *Pakistan Journal of Biological Sciences, 11*(4), 643-647. https://doi.org/10.3923/pjbs.2008.643.647

Gan, L., Liu, Y. J., Tian, L. X., Yang, H. J., Yue, Y. R., Chen, Y. J., Liang, J. J., & Liang, G. Y. (2012). Effect of dietary protein reduction with lysine and...
methionine supplementation on growth performance, body composition and total ammonia nitrogen excretion of juvenile grass carp, *Ctenopharyngodon idella*. Aquaculture Nutrition, 18(6), 589-598. https://doi.org/10.1111/j.1365-2095.2012.00937.x

Harrison, F. E., & May, J. M. (2009). Vitamin C function in the brain: Vital role of the ascorbate transporter SVCT2. Free Radical Biology and Medicine, 46, 719-730. https://doi.org/10.1016/j.freeradbiomed.2008.12.018

Hasan, M. R., & Soto, S. (2017). Improving feed conversion ratio and its impact on reducing greenhouse gas emissions in aquaculture. FAO Non-Serial Publication 33.

Heber, B., Liao, I. C., Cheng, S. H., & Haseih, C. S. (1983). Food utilization by red tilapia: Effect of diet composition, feeding level and temperature on utilization efficiency for maintenance and growth. *Aquaculture*, 32(3-4), 255-272. https://doi.org/10.1016/0044-8486(83)90223-5

Kord, M. I., Srour, T. M., Omar, E. A., Farag, A. A., Nour, A. A. M., & Khalil, H. S. (2021). The immunostimulatory effects of commercial feed additives on growth performance, non-specific immune response, antioxidants assay, and intestinal morphometry of Nile tilapia, *Oreochromis niloticus*. Frontiers in Physiology, 25(12), 627499. https://doi.org/10.3389/fphys.2021.627499

Li, X.-Q., Xu, H.-B., Sun, W.-T., Xu, X.-Y., Xu, Z., & Leng, X. (2018). Grass carp fed a fishmeal-free extruded diet showed higher weight gain and nutrient utilization than those fed a pelleted diet at various feeding rates. *Aquaculture*, 493(6), 283-288. https://doi.org/10.1016/j.aquaculture.2018.04.058

Lin, M. F., & Shiau, S. Y. (2004). Requirements of vitamin C (L-ascorbyl-2-monophosphate-Mg and L-ascorbyl-2-monophosphate-Na) and its effects on immune responses of grouper, *Epinephelus malabaricus*. Aquaculture Nutrition, 10(5), 327-333. https://doi.org/10.1111/j.1365-2095.2004.00307.x

Luo, K., Xinxin, L., Liu, W., Wanxiu, R., Yang, W. L., Mingzhu, P., Dong, H., Wenbing, Z., & Kangsen, M. (2021). Ascorbic acid regulates the immunity, antioxidant and apoptosis in abalone *Haliotis discus hannai* Ino. Antioxidants (Basel), 10(9), 1449. https://doi.org/10.3390/antiox10091449

Naggar, G. O., & Lovell, R. T. (1991). L-ascorbyl-2-monophosphate has equal antiscorbutic activity as L-ascorbic acid but L-ascorbyl-2-sulfate is inferior to L-ascorbic acid for channel catfish. The Journal of Nutrition, 121(10), 1622-1626. https://doi.org/10.1093/jn/121.10.1622

Nasar, M. F., Shah, S. Z. H., Aftab, K., Fatima, M., Muhammad Bilal, M., & Hussain, M. (2021). Dietary vitamin C requirement of juvenile grass carp (*Ctenopharyngodon idella*) and its effects on growth attributes, organ indices, whole-body composition and biochemical parameters. Aquaculture Nutrition, 27(6), 1903-1911. https://doi.org/10.10111/anu.13327

Nates, S. F. (Ed.) (2016). *Aquafeed Formulation*. Academic Press, San Diego, CA. 279pp. http://doi.org/10.1016/B978-0-12-800873-7.00001-4

Nikkhoo, M., Mehdi, Y., Reza, S., & Milad, N. (2011). The influence probiotic of Aqualase on the survival, growth, intestinal microflora and challenge infection in wild carp (*Cyprinus carpio L.*). Research Journal of Fisheries and Hydrobiology, 5(2), 168-172.

Nikpiran, H., Vahdatpour, T., Babazadeh, D., & Vahdatpour, S. (2013). Effects of *saccharomyces cerevisiae*, thepax and their combination on blood enzymes and performance of Japanese quails (*Coturnix japonica*). The Journal of Animal & Plant Sciences, 23(2), 369-375.

NRC (1993). *Nutrition requirements of fish*. National Research Council National Academy Press, Washington, D. C. 114pp. https://doi.org/10.17226/2115

Omoniyi, A.-D., & Ovie, I. A. (2018). Vitamin C: An important nutritional factor in fish diets. Journal of Agriculture and Ecology Research International, 16(2), 1-7. https://doi.org/10.9734/JAERI/2018/15528

Owens, B., & McCracken, K. J. (2007). A comparison of the effects of different yeast products and antibiotic on broiler performance. *British Poultry Science*, 48, 49-54. https://doi.org/10.1080/00071660601148153

Riaz, M. N., Asif, M., & Ali, R. (2009). Stability of Vitamins during Extrusion. *Critical Reviews in Food
Taher et al., / Basrah J. Agric. Sci., 35(1): 120-131, 2022

Science and Nutrition, 49(4), 361-368. https://doi.org/10.1080/10408390802067290

Saleh, J. H., Al-Mukhtar, M. A., Hsooni, K. H., & Yasin, A. T. (2008). Culture of grass carp Ctenopharyngodon idella Val. in Fadak farm-Basrah/ Iraq. Iraqi Journal of Aquaculture, 5(1), 13-20. (In Arabic).

Sayed-Lafi, R. M., Al-Tameemi, R. A., & Gowdet, A. I. (2018). Evaluation of raw and fermented water hyacinth (Eichhornia crassipes) incorporated diets on growth and feed efficiency of young grass carp (Ctenopharyngodon idella). Basrah Journal of Agricultural Sciences, 31(1), 31-39. https://doi.org/10.37077/25200860.2018.73

Taher, M. M. (2017). Laboratory experiments on cultivation of grass carp Ctenopharyngodon idella (Valenciennes, 1844). Basrah Journal of Agricultural Sciences, 30(2), 91-98. https://doi.org/10.37077/25200860.2017.57

Taher, M. M., Muhammed, S. J., Al-Dubakel, A. Y., & Mejer, A. M. (2021). Effects of initial weight on growth criteria for grass carp, Ctenopharyngodon idella cultivated in earthen ponds. Mesopotamian Journal of Marine Science, 36(1), 41-50. http://mjms.uobasrah.edu.iq/index.php/mjms/article/view/15/4

Trichet, V. V., Santigosa, E., Cochin, E., & Gabaudan, J. (2015). The effect of vitamin C on fish health. pp, 151-171. In: Lee, C. S., Lim, C., Gatlin, D. M., & Webster, D. W. (Eds.). Dietary Nutrients, Additives, and Fish Health. Wiley Blackwell, New Jersey. 355pp. https://doi.org/10.1002/9781119005568

Wang, X., Kim, K-W., & Bai, S. C. (2003). Comparison of l-ascorbyl-2-monophosphate-Ca with l-ascorbyl-2-monophosphate-Na/Ca on growth and tissue ascorbic acid concentrations in Korean rockfish (Sebastes schlegeli). Aquaculture, 225(1-4), 387-395.https://doi.org/10.1016/S0044-8486(03)00303-X

Wee, K. L., & Shu, S. W. (1989). The nutritive value of boiled full-fat soybean in pelleted feed for Nile tilapia. Aquaculture, 81(3-4), 303-314. https://doi.org/10.1016/0044-8486(89)90155-5

Yousef, M., & Karkoodi, K. (2007). Effect of probiotic Thepax® and Saccharomyces cerevisiae supplementation on performance and egg quality of laying hens. International Journal of Poultry Science, 6, 52-54. https://doi.org/10.3923/ijps.2007.52.54

Yousefian, M., Fahimi, S., Safari, R., Seifi, T., Pahnabi, F. T., & Shirdel, A. (2012). Effects of probiotic aqualase on Kutum fries (Rutilus frisii kutum) growth and immunity characteristics. Middle-East Journal of Scientific Research, 11(9), 1190-1195.

Yousefian, M., Nikkho, M., Safari, R., & Nikkhoo, M. (2010). Evaluation of Aqualase as probiotic on wild carp (Cyprinus carpio) growth, immunity characteristics and resistance to Streptococcosis. Research Journal of Fisheries and Hydrobiology, 5(2), 173-178.

Zarei, M., Ehsani, M., & Torki, M. (2011). Dietary inclusion of probiotics, prebiotics and symbiotic and evaluating performance of laying hens. American Journal of Agricultural and Biological Science, 6(2), 249-255. https://doi.org/10.3844/ajabssp.2011.249.255

Zolfinejad, K., Khara, H., & Filizadeh, Y. (2017). Food preference and growth of grass carp, Ctenopharyngodon idella (Cuvier and Valenciennes, 1844) fed some aquatic and terrestrial plants. Iranian Journal of Fisheries Sciences, 16(4), 1278-1286.
تأثير بعض الإضافات الغذائية على معايير النمو لأصبعيات أسماك الكارب العشبي 

Ctenopharyngodon idella

ماجد مكي طاهر وصادق جواد محمد وحمد محسن موجر عادل يعقوب الدبيكل
وحدة الاستزراع المائي، كلية الزراعة، جامعة البصرة، البصرة

المستخلص: أجريت تجربة مختبرية في مختبر الغذاء الحي-وحدة الاستزراع المائي-كلية الزراعة لمعرفة تأثير كل من إضافات غذائية في العلائق على أداء النمو لأصبعيات أسماك الكارب (Endo Vit. C) وفيتامين سي (Thepax) على أصبعيات الكارب العشبي Ctenopharyngodon idella المئوي. تم الحصول على أسماك الكارب العشبي (متوسط الوزن 3.36 ± 0.95 غم) من مزارع وحدة الاستزراع المائي في محطة البحرية للبحوث والتجارب الزراعية التي تقع شمال مدينة البصرة. وضعت الأسماك في تسع أحواض زجاجية متخصصة بمضخات تهوية. تضمنت العلائق الجريبية السيطرة (T1 0% إضافة) والثيباكس 1 غم/كجم (T2) وفيتامين سي 1 غم/كجم (T3). استغرقت التجربة 57 يوماً، غذت الأسماك ستة أيام في الأسبوع باستخدام 5% من وزن الأسماك كنسبة تغذية. أظهرت نتائج التجربة أن أصبعيات أسماك الكارب العشبي المغذى على علبة Endo Vit. C و Thepax وفيتامين سي 1 غم/كجم تتميزت بأفضل الأداء في نمو الأصبعيات، وسجلت أقل نسبة تحويل (SGR) وRGR و DGR و WG. أما أداء النمو الفعلي في معاملة Thepax، فإنها تجاوزت المعاملات الأخرى بمسافة كبيرة. وكمية الغذاء وكفاءة التحويل الكلية تشير أيضاً إلى أن معالمة Thepax أظهرت أفضل نتائج في هذا الجانب. 

الكلمات المفتاحية: فيتامين سي، الثيباكس، كفاءة التحويل الكلية، الكارب العشبي.