SUMMARY AND CONCLUSION

5. SUMMARY AND CONCLUSIONS.

The experimental work of the present study was carried out at the Laboratory of Fish Nutrition, Animal Production Department, Faculty of Agriculture, Benha University. Two experiments were conducted in the present study. The first experiment was performed during the period from 15 April until 15 July 2006 (three months), while the second experiment started at 9 December 2006 and continued until 9 March 2007 (three months). The first experiment aimed to study the effect of partial or complete replacement of fish meal (FM) by cotton seed meal (CSM) in diets of Nile tilapia, (*Orcochromis niloticus*), to reduce feed costs, while the second experiment aimed to evaluate the effect of increasing levels of α-tocopherol (vitamin E) as antioxidant for avoiding the side effects of incorporation of CSM in Nile tilapia diets as a replacer of FM.

The experimental fish were obtained from the hatchery unit at the Experimental Station of World Fish Center, Abbassa, Abou Hammad, Sharkia, Egypt.

Five experimental diets contained 0,25,50,75 and 100% CSM as replacements of FM (on CP basis) were used in the first experiment (D1, CSM 0%; D2, CSM 25%; D3, CSM 50%; D4, CSM 75% and D5, CSM 100%).Whereas, eleven experimental diets were used in the second experiment. The first diet (control diet, D1) contained 100% FM (similar to D1 used in the first experiment), FM was completely replaced by CSM on CP basis in the second diet (D2) i.e. similar to D5, CSM 100% used in the first experiment. The second diet (D2) was divided into 10 parts.

The first one was used as a control; the remainder 9 parts were enriched by incremental levels of vitamin E (1,5, 10, 15, 20, 25, 30, 35 and 40 times of gossypol in CSM representing diets 3,4, 5,6, 7,8,9,10, and 11, respectively). All experimental diets were formulated to contain, approximately, 30% CP and 2700 Kcal ME/Kg diet, i.e. isonitrogenous and isocaloric.

Each experimental diet (either tested in the first or the second experiment) was fed for fish in two aquaria (2 replicates for testing each diet), therefore, ten aquaria were used for fish of the first experiment and twenty two aquaria were used for fish of the second experiment. Each aquarium was stocked with 25 fish with an initial weight of 1.5±0.07g in the first experiment and 2.02±0.12g in the second one.

Results obtained could be summarized as follows:

First Experiment.

The final body weight (BW) of fish ranged between 6.32 and 11.96 g.

The final (BW) decreased with increasing the level of replacing FM by CSM. However, the replacement of 25% of FM by CSM had no significant effect on the final BW, while the higher replacing levels (50, 75 and 100%) significantly ($P<0.05$) reduced the final BW of Nile tilapia.

The final Body length (BL) ranged from 6.75 to 8.32 cm, the differences were significant ($P<0.001$.The low replacing level (25%) of FM by CSM had no significant effect on the final BL, while the higher replacing levels (50,75 and 100%) significantly reduced the final BL of Nile tilapia.

At the experimental termination, the highest condition factor (K) value was recorded for fish fed diet, 2 (CSM 25%), followed in a descending order by those fed the control diet, D1 (CSM 0%); D5 (CSM 100%); D3 (CSM 50%) and D4 (CSM 75%). However, the final K values of Nile tilapia were not significantly affected by the replacing levels of dietary FM by CSM.

Values of weight gain (WG) decreased as the level of replacing FM by CSM increased. Differences in WG of fish fed the control diet (D1, CSM 0%) and those fed D2 (CSM 25%) were not significant, whereas, the differences between fish fed the control diet and those fed other diets were significant ($P<0.05$).

Specific growth rate (SGR) values decreased with increasing the level of replacing dietary FM protein by CSM. The differences in SGR values between fish fed the control diet (D1, CSM0%) and those fed D2 (CSM 25%) were not significant. Increasing the level of replacing FM by CSM from 25% to 50, 75 or 100% (D3, CSM 50%, D4, CSM 75% and D5, CSM 100%) significantly ($P<0.05$) decreased SGR values of fish as compared with that of fish fed the control diet (D1).

The highest FI during the entire experimental period (90 days) was recorded by fish fed the control diet (D1) being 15.91 g/fish, followed by that consumed by fish fed D2 (CSM 25%) being 14.30g with no significant differences. Increasing the level of substituting dietary FM by CSM from 25% to 50, 75 or 100% significantly ($P<0.05$) reduced FI, being 13.46, 11.59 and 10.65 g/fish, respectively.

Values of feed conversion ratio (FCR) were 1.51, 1.59, 1.86, 2.10 and 2.26 for fish fed diets CSM0, CSM25, CSM50, CSM75 and CSM100, respectively, indicating that FCR values increased (adversed) as dietary CSM level increased. However, the low substitution level (25%) of FM by CSM had no significant effect on FCR's of Nile tilapia, while the higher replacing levels (50, 75 or 100%) significantly ($P<0.05$) adversed FCR values.

Values of protein efficiency ratio (PER) decreased with increasing the replacing level of dietary FM by CSM. Fish fed the control diet (CSM0) showed the highest (best) PER values, while those fed D5 (CSM 100) recorded the lowest (poorest) one. However, replacing 25% of dietary FM by CSM had no significant effect on PER values, whereas, increasing the replacing level to 50, 75 or 100% significantly ($P<0.05$) decreased PER values of Nile tilapia.

Hematocrit and haemoglobin values (hematological parameters) almost decreased proportionally with increasing the dietary CSM protein level. Compared with fish fed the control diet (CSM0), all replacing levels of FM by CSM (on CP basis) significantly ($P<0.05$) decreased Hematocrit and haemoglobin values and the largest declines occurred among fish fed diets containing 50-100% CSM protein replacements.

Values of serum transaminases (aspartate aminotransferase, AST and alanine aminotransferase, ALT) almost increased with each increase in CSM level as a substitute for FM in Nile tilapia diets. However, AST level (compared to that of the control group) was not significantly affected when 25 or 100% of dietary FM was replaced by CSM, while the other replacing levels (50

or 75%) significantly ($P<0.05$) increased AST level. With respect to ALT activity, results indicated that increasing CSM level in tilapia diets up to 75% did not significantly altered ALT level, whereas, the complete replacement of dietary FM by CSM reduced serum ALT level of Nile tilapia.

Results of proximate analysis of whole Nile tilapia fish showed that as the dietary CSM level increased, protein content of whole fish significantly ($P<0.05$) decreased (compared to that of the control group), while the opposite trend was observed for fat content where the increasing levels of CSM in the experimental diets significantly ($P<0.05$) increased fat content of the whole fish. The inclusion of 25% CSM in the experimental diets had no significant effect on ash content of whole fish, while the other replacing levels (50, 75 and 100%) significantly reduced ash content of whole fish.

Based on the results of the first experiment, it is clear that the replacement of 25% of dietary FM by CSM (on CP basis) had no significant effect on all growth parameters (BW, BL, K, WG and SGR values) and feed utilization parameters (FI, FCR, and PER values) of Nile tilapia. Also, diets contained 25% dietary CSM as a replacer of FM had no adversed effect on hematological parameters (hematocrit and hemoglobin) and serum transaminases (AST and ALT) activities of Nile tilapia. Whereas, increasing the replacing level to 50, 75 or 100% had almost an adversed effect on all these parameters, indicating the possibility of substituting 25% of FM by CSM in Nile tilapia diet to reduce feed cost.

Second experiment.

The final BW ranged between 5.66 and 9.91g and the differences among different fish groups (treatments) were significant ($P<0.001$). The highest ($P<0.05$) final BW was shown by fish fed D1 (control diet contained FM) and the lowest one was recorded by fish fed diet D2 in which dietary FM protein was completely replaced by CSM without vit. E supplementation. Incorporation of vit. E in the other experimental diets (from D3 to D11) almost improved ($P<0.05$) the final BW of fish compared to that of fish fed D2. However, the best ratio between gossypol present in CSM and vit. E showed the higher final BW of fish was found to be 1:1 (D3).

Fish fed the control diet (D1, FM 100%) recorded the longest ($P<0.05$) final BL, while those fed D2 in which FM protein was completely replaced by CSM without addition of vit. E achieved the shortest ($P<0.05$) one. Adding vit. E (as anti-oxidant) to the other experimental diets significantly ($P<0.05$) increased the final BL of fish as compared to that of fish fed D2. Moreover, the best ratio of gossypol to vit. E produced the longest final BL as compared with that of D2 was 1:1 found in D3.

Averages of initial K values ranged between 2.87 and 4.50, whereas, those of final K values varied between 1.97 and 2.71. The initial and final K values for fish fed the different experimental diets varied with no clear trend, moreover, there were no significant differences neither in initial nor in final K values.

The highest ($P<0.05$) WG was recorded by fish fed the control diet (D1, FM 100), while the lowest one was shown by

fish fed D2 (CSM100). Addition of vit. E to the other the experimental diets almost improved ($P<0.05$) the final WG compared to that of D2.The best ratio between gossypol and vit. E produced the highest WG was that of D3 (1:1).

Fish fed the control diet (D1) showed the highest ($P<0.05$) SGR value and those fed D2 (in which FM was completely replaced by CSM) achieved the lowest one. Incorporation of vit.E in the other experimental diets almost improved ($P<0.05$) the SGR values (compared with that of fish fed D2) and the best ratio between dietary gossypol and vit. E added was found to be 1:1(D3).

The highest ($P<0.05$) amount of FI was recorded by fish fed D1 (the control diet), whereas the lowest amount of FI was shown by fish fed D6 (supplemented with vit. E at the ratio of 1:15) followed by those of fish fed D2 and D11 without significant differences between these amounts of FI. However, fish fed diets supplemented with vit. E almost consumed higher ($P<0.05$) amounts of FI as compared with the feed consumed by fish fed D2.

Fish fed D3 (the diet contained CSM and supplemented with vit. E at the ratio of 1:1) and those fed D1 (the control diet) showed the best ($P<0.05$) FCR values, and the poorest ($P<0.05$) ones were shown by fish fed D2 (dietary FM protein was completely replaced by CSM without vit. E supplementation) and D8 (supplemented with vit.E at the ratio of 1:25). Moreover, fish fed diets supplemented with other levels of vit. E recorded best ($P<0.05$) FCR values than those of fish fed D2 and D8.

The best (P<0.05) PER values were recorded by fish fed D3 and D1 and the poorest (P<0.05) ones were shown by fish fed D2 and D8. Moreover, PER values of fish fed diets supplemented with other levels of vit. E were better (P<0.05) than those of fish fed D2 and D8, indicating the same trend observed with FCR values.

Fish fed D1 (control diet) and D6 (supplemented with vit. E at the ratio of 1:15) recorded the highest (P<0.05) percentages of hematocrit, whereas, those fed D4 (supplemented with vit. E at the ratio of 1: 5) and D2 showed the lowest (P<0.05) ones. Fish fed D1 (control diet) showed the highest (P<0.05) hemoglobin level, while those fed D2 recorded the lowest (P<0.05) one. However, there is no clear trend for the effect of graded levels of vit E combined with the experimental diets on hematocrit and hemoglobin levels, but it is clear that fish fed diets supplemented with vit. E had almost higher (P<0.05) hematocrit and hemoglobin levels when compared with those recorded by fish fed D2 (unsupplemented with vit. E).

Fish fed the control diet (D1) recorded the lowest AST and ALT levels, whereas , fish fed D2 , in which dietary FM of the control diet was completely replaced by CSM without vit E supplementation ,showed higher (P<0.05) AST and ALT levels when compared with those of fish fed D1 . Moreover, addition of graded levels of vit E to the experimental diets almost increased the serum AST and ALT levels, but with no clear trend and no significant differences when compared with levels recorded for fish fed D2.

Value of CP of the whole fish ranged between 54.27 % for fish fed D2 and 56.42 % for those fed D9 (1:30) .Incorporation of vit E in all other experimental diets decreased CP content of whole fish body when compared with CP content of fish fed the control diet, and the differences were almost significant ($P<0.05$). Fish fed D2 recorded the highest fat content of whole fish, whereas, those fed D9 showed the lowest one. However, the differences in fat content between fish fed D2 and those fed the other experimental diets were almost not significant. The graded levels of vit E had a significant ($P<0.001$) effect on ash content of whole fish body, but with no clear trend.

Results of the second experiment showed that Nile tilapia fed D_1 (the control diet contained FM) recorded the best values for growth performance traits (BW, BL, K, WG and SGR values) and feed utilization traits (F1, FCR and PER values), whereas, fish fed D2 in which FM was completely replaced by CSM without vit E supplementation showed the poorest ones. Incorporation of the incremental levels of vit E into the experimental diets improved ($P<0.05$) most of the studied traits, and the ratio between gossypol and vit E recorded the most pronounced results was that present in D3 (1: 1). Fish fed the control diet contained FM (D1) recorded almost the highest hematocrit and hemoglobin values; whereas, those fed D2 (CSM 100) achieved mostly the lowest hematocrit and hemoglobin ones. However, there was no clear trend for the effect of graded levels of vit E combined with the experimental diets on both hematocrit and hemoglobin values, but it was clear that fish fed diets supplemented with vit. E had almost higher ($P<0.05$)

hematocrit and hemoglobin values when compared with those recorded by fish fed D2 (unsupplemented with vit. E). Serum transaminase (AST and ALT) showed a reverse trend, as fish fed the control diet (D1) recorded the lowest AST and ALT values, while those fed D2 (CSM 100, without vit. E supplementation) showed higher ($P<0.05$) values than those recorded by fish fed D1.Addition of graded levels of vit. E to the other experimental diets almost increased the levels of serum AST and ALT values, but with no clear trend and no significant differences when compared with levels recorded by fish fed D2. The previous results indicated the possibility of replacing FM by CSM supplemented at 1:1 ratio of vit. E to gossypol in Nile tilapia diets to avoid the toxicity of gossypol present in CSM.