EFFECT OF REPLACING FISH MEAL WITH MEAT AND BONE MEAL IN NILE TILAPIA (O. niloticus) DIETS.
1-NUTRITIONAL EVALUATION AND SAFETY ASSESSMENT STUDY
Gomaa, A.H.M.; and G. M. El Moghazy.
Regional Center for Food and Feed, Agricultural Research Center

ABSTRACT
A growth trial was conducted firstly, to evaluate the effects of using meat and bone meal (MBM) instead of fish meal at rate of 0, 25, 50, 75 and 100% in diets on the growth performance and feed efficiency of Nile tilapia (Tilapia niloticus). Secondly, to assess the safety of inclusion MBM as animal protein source in fish feeds. Five iso-nitrogenous (32% crude protein) and iso-energetic (3500 Kcal estimated digestible energy) diets replacing 25, 50, 75 and 100% of fish meal by MBM were formulated. Each diet was randomly allocated to duplicate groups of fish in fiberglass tanks and each tank was stocked with 25 fingerlings (initial average body weight 1.80 ± 0.15g). Fish were hand fed the experimental diets four times per day for 60 days. For microbial safety assessment of examined fish, three samples from each group were collected at the end of the experiment in sterile bags to measure total bacterial count, total faecal coliform count, bacillus cereus, salmonella and staphylococca. There were no significant differences in terms of final body weight, average weight gain percentage and specific growth rate among fish fed the control diet and those fed diets containing meat and bone meal up to 50% replacement. There were also no significant differences in terms of feed intake, feed conversion ratio and protein efficiency ratio between fish fed the control diet and those contained 25% replacement of fish meal with meat and bone meal. The lowest performance had been recorded for the group of fish fed diet containing 100% meat and bone meal. Total Coliform Count, Faecal Coliform count, Bacillus cereus and Salmonella were not detected in all examined samples. The obtained results of Staphylococcal count showed no significant difference between all groups. The economical efficiency study demonstrated that replacing 25% of fish meal with meat and bone meal had the best net revenue 60.92 L.E. followed by the control 60.88 L.E. and 50% replacement of fish meal 58.98 L.E.

Although the present results showed that MBM could safely replace up to 50% of fish meal content in Nile tilapia diets without any adverse effect on Nile tilapia performance and its safety use. Yet, the 25% replacement was the most economical. Keywords: fish meal, meat and bone meal, nutrition evaluation, safety assessment

INTRODUCTION
Aquaculture is the fastest growing animal protein production sector in the world since 1970, with an annual growth rate of 6.9%. Egypt is ranked to be from the first 27th aquaculture producers all over the world with total annual production 1.4 million tons.

Feed represents 40-70% of operating cost. Fish meal is the most important and most expensive protein for commercial aquaculture feed. It provides fish with essential amino acids, fatty acids and trace mineral (USB, 2008). Also, fish meal is highly palatable for fish (Li et al. 2006) and promotes
optimum growth performance (Gomes et al. 1995). Unfortunately, fish meal supply is limited due to increasing demand and decreasing marine fishery resources. Therefore, alternative protein sources, including plant and animal proteins, have been studied by many fish nutritionists (Tacon and Jackson 1985). However, plant proteins usage is limited as they are deficient in some essential amino acids, as well as the presence of anti-nutritional factors and/or poor palatability. Therefore, it was suggested that at least one animal protein source must be found in fish diets to cover fish's amino acid requirements (Gomes et al. 1995).

Meat and bone meal (MBM) is a potential animal protein source to be used in fish feeds because of its' high protein content (47.3 – 54.3% dry base), excellent amino acid profile and compatible price comparing to fish meal (Ferouz, et al. 2012). Previous studies have shown that MBM could successfully substitute fish meal up to 30% in fish feeds (Pongmaneerat and Watanabe 1991; Robaina et al. 1997; Bureau et al. 2000; Kureshy et al. 2000). Higher replacement levels have been reported in gilthead sea bream Sparus aurata (Alexis 1997), Mozambique tilapia Oreochromis mossambicus, (Davies et al. 1989) and rainbow trout Oncorhynchus mykiss (Watanabe and Pongmaneerat 1991).

However, since 2001 there has been a total ban on the use of mammalian meat and bone meal in animal feed due to the presence of prion protein which is expected to be the principle cause of Transmissible Spongiform Encephalopathies (TSE) in animals (FAO, 2004). As a result, many studies have been conducted using different animal species, including fish, as recipients of a TSE agent to answer public concern about safety of food possibly contaminated with TSE agents (NRA, 2009).

Liao et al. (2005) reported that the passage of TSE agents between animals of different species is usually impaired by the species barrier, Dalla Valle et al. (2008) and Chiesa and Harris (2009) reported that, prion could persist in intestine and caecal submucosa and didn't cross the intestinal barrier.

In 2012 FAO has proposed the lifting of the ban for using meat and bone meal only in fish feed.

The aim of the present study is therefore to evaluate the potential of using MBM as a substitute for fish meal keeping in mind the availability of fish meal in markets and to assess the microbial safety of using meat and bone meal in tilapia diets.

**MATERIALS AND METHODS**

**Experimental system and fish:**

Nile tilapia fingerling (*Oreochromis niloticus*), mono sex were brought to the Fish Experimental Unit at Regional Center for Food and Feed, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt, from a fresh water commercial farm in Damietta governorate.

The fish were reared in a closed-recalculating water system. The study was done in 10 fiberglass tanks from this system with capacity of 60 L
water each. Water flow out of each aquaria at 2L/min into a submerged bio-filter after passing through a mesh net to remove solid impurities. Water was then collected in a common reservoir from which the filter water is pumped up to the rearing units. The water used in the system was stored-tap water, which was aerated using a blower aerator-type. Five percent of the total water volume was renewed daily. A thermo-controlled electric heater was used to adjust water temperature about 24±1°C. All the experimental treatments were conducted under an artificial photo period equal to natural light/darkness period (12h light:12h darkness).

Diet formulation

Five experimental diets were formulated to contain ~32% crude protein and ~3500 Kcal estimated digestible energy according to NRC, 1993 (Table 1). The control diet was formulated to contain fish meal and soybean meal as the primary protein sources (D1). The other four experimental diets were formulated to replace 25%, 50%, 75% and 100% of fish meal with meat and bone meal (D2, D3, D4 and D5, respectively).

The proximate analysis, amino acids and minerals of the experimental diets were analyzed according to (AOAC, 2005). While the digestible energy were calculated according to Wang et al., (1985) (Table 1). Calcium and phosphorus were adjusted using monocalcium phosphate. Vitamins and trace minerals were added.

Table (1): Composition of experimental diets (on fed basis).

<table>
<thead>
<tr>
<th>Items</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal (FM) 60%</td>
<td>12.00</td>
<td>9.00</td>
<td>6.00</td>
<td>3.00</td>
<td>.......</td>
</tr>
<tr>
<td>Meat and bone meal</td>
<td>......</td>
<td>3.00</td>
<td>6.00</td>
<td>9.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Soybean meal 48%</td>
<td>43.00</td>
<td>44.00</td>
<td>45.00</td>
<td>46.00</td>
<td>47.00</td>
</tr>
<tr>
<td>Ground yellow, corn</td>
<td>18.40</td>
<td>18.40</td>
<td>18.40</td>
<td>18.40</td>
<td>18.40</td>
</tr>
<tr>
<td>Wheat bran</td>
<td>8.50</td>
<td>8.50</td>
<td>8.50</td>
<td>8.50</td>
<td>8.50</td>
</tr>
<tr>
<td>Corn starch</td>
<td>9.00</td>
<td>8.50</td>
<td>8.10</td>
<td>7.70</td>
<td>7.30</td>
</tr>
<tr>
<td>Grounded mung bean seeds</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Monocalcium phosphate</td>
<td>2.50</td>
<td>2.00</td>
<td>1.40</td>
<td>0.80</td>
<td>0.20</td>
</tr>
<tr>
<td>Vit. &amp; min. mix*</td>
<td>1.60</td>
<td>1.60</td>
<td>1.60</td>
<td>1.60</td>
<td>1.60</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

* Vitamin and mineral premix at 2.5% of the diet supplies the following per kg of the diet: vit. A 75000 IU, vit. D 9000 IU, vit. E 150mg, vit. K 30mg, vit. B1 26.7mg, vit. B2 30mg, vit. B6 24.7mg, vit. B12 75mg, niacin 225mg, pantothenic acid 69mg, folic acid 7.5mg, vit. C 150mg, choline chloride 500mg, Mn 204mg, Fe 93mg, Zn 210mg, Cu 11.25mg, I 1.02mg.

Experimental procedure:

Two hundred and fifty Nile tilapia fingerlings (Oreochromis niloticus) mono sex of mean initial body weight (1.80 ± 0.15g) were randomly distributed on 10 open system 60 liter tanks, where each tank contained 25 fingerlings. Each two tanks (duplicate) represented an experimental treatment. The first 15 days of the experiment were considered as habituation period and thereafter the growth trials were carried out for 60
days. Diets were randomly assigned to the experimental units. Fish were hand fed the experimental diets at three% rate of body weight for six days weekly, four times per day (Jauncey and Ross, 1982 and Coche, 1982). Fish were weighed every two weeks.

**Growth parameters and feed efficiency:**

Growth and nutrient utilization parameters were recorded and analyzed in terms of initial body weight (IBW), final body weight (FBW), weight gain (WG), feed conversion ratio (FCR), specific growth rate (SGR) and protein efficiency ratio (PER). Mortality percentage was calculated at the end of the trial.

**Microbial safety assessment of examined fish:**

Three samples from each group were collected at the end of the experiment in sterile bags and were put in ice box and sent to the laboratory. Subsamples were taken under complete aseptic conditions and were prepared according to (NMKL 2001a). Ten-fold dilutions were prepared using sterile saline solution. Specific media was used for enumeration of all microbial parameters using pour plate technique as; Plate count agar was used for total bacterial count (NMKL 1999a), Violet Red Bile agar (VRB) for Total (NMKL 2001b) faecal coliform count (NMKL 1996), Baird Parker agar for Staphylococcal count (NMKL 1999b), Bacillus cereus selective agar for Bacillus cereus (NMKL 1997), Brilliant Green for Salmonella spp. (NMKL 1999c) and Rose Bengal Chloramphenicol agar for Total Fungal Count (NMKL 1995).

**Economical evaluation**

The use of meat and bone meal in Tilapia diets has been economically evaluated to measure the impact of such practice on the performance efficiency.

The following equations were used to calculate net revenue, economical efficiency and relative economical efficiency of various experimental diets.

Net revenue = Total income (L.E.) – Total feed cost (L.E.)

Were Total income(L.E.)=Total final fish weight Kg * price of one Kg of fish (L.E.)

Total feed cost = Total amount of feed consumed Kg * price of one Kg diet (L.E.).

Economic efficiency = Net revenue (L.E.) / Total feed cost

Relative economical efficiency = calculated as a percentage from the economical efficiency of the control diet.

**Statistical analysis:**

The obtained data were subjected to a two way analysis of variance using the linear model (GLM) of SAS (SAS Institute, 1991). Means were compared using Duncan's new multiple range test (P<0.05) (Duncan, 1955).

**RESULTS AND DISCUSSION**

**Chemical composition of the experimental diets:**

The chemical composition (Table 2) of the experimental diets showed limited variations among these diets; also there was limited variation in methionine, cysteine and lysine contents.
Table 2: Chemical composition of experimental diets (on fed basis).

<table>
<thead>
<tr>
<th>Items</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry matter (%)</td>
<td>92.40</td>
<td>92.10</td>
<td>92.60</td>
<td>92.00</td>
<td>92.00</td>
</tr>
<tr>
<td>Crude protein (%)</td>
<td>32.50</td>
<td>31.95</td>
<td>32.35</td>
<td>32.00</td>
<td>32.10</td>
</tr>
<tr>
<td>Ether extract (%)</td>
<td>1.58</td>
<td>2.13</td>
<td>2.28</td>
<td>2.39</td>
<td>2.84</td>
</tr>
<tr>
<td>Crude fiber (%)</td>
<td>3.08</td>
<td>3.05</td>
<td>3.09</td>
<td>3.22</td>
<td>3.31</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>8.02</td>
<td>7.96</td>
<td>8.08</td>
<td>8.31</td>
<td>8.62</td>
</tr>
<tr>
<td>NFE (%)</td>
<td>47.22</td>
<td>47.01</td>
<td>46.80</td>
<td>46.08</td>
<td>45.13</td>
</tr>
<tr>
<td>Digestible energy (Kcal/kg)</td>
<td>3494</td>
<td>3501</td>
<td>3499</td>
<td>3506</td>
<td>3511</td>
</tr>
<tr>
<td>Total (phos.) (%)</td>
<td>1.36</td>
<td>1.37</td>
<td>1.37</td>
<td>1.37</td>
<td>1.37</td>
</tr>
<tr>
<td>calcium (%)</td>
<td>1.35</td>
<td>1.33</td>
<td>1.35</td>
<td>1.33</td>
<td>1.35</td>
</tr>
<tr>
<td>Lysine</td>
<td>2.09</td>
<td>1.95</td>
<td>1.87</td>
<td>1.78</td>
<td>1.69</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.60</td>
<td>0.57</td>
<td>0.54</td>
<td>0.53</td>
<td>0.55</td>
</tr>
<tr>
<td>Cystine</td>
<td>0.69</td>
<td>0.50</td>
<td>0.48</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Protein energy ratio (mg/kcal)</td>
<td>93.02</td>
<td>91.26</td>
<td>92.45</td>
<td>91.27</td>
<td>91.43</td>
</tr>
</tbody>
</table>

1 NFE = 100 – (% moisture + % protein + %EE + %ash + % Fibre).
2 Digestible energy was calculated using the values 4.5, 4 and 9 kcal/g for protein, carbohydrate and lipid, respectively according to Wang et al., (1985).
3 Protein energy ratio (P/E ratio) = crude protein x 10000 / digestible energy, according to Hepher et al., (1983).

Growth performance:

The present data (Table 3), showed that there was no significant difference (P>0.5) in the average initial body weight among fish used in the trial in all groups.

There were also no significant (P>0.05) differences in term of final body weight, average weight gain percentage and specific growth rate between fish fed the control diet and those fed diets contained meat and bone meal up to 50% replacement.
The results showed that there were no significant differences (P>0.05) in term of feed intake, feed conversion ratio and protein efficiency ratio between fish fed the control diet and that containing 25% replacement of fish meal with meat and bone meal.

These results were in agreement with the finding of (Robaina et al. (1997); Wu et al. (1999); Yang et al. (2004) and Ai, et al. (2006)) who concluded that, MBM could replace fish meal up to 50% without any negative effects on growth.

The least performance had been recorded for the fish fed diet contained 100% replacement of fish meal with meat and bone meal when compared with fish fed the control diet and diets contained either 25% replacement of fish meal with meat and bone meal or 50% replacement. These differences were statistically significant (P<0.05)  

This trend agrees well with the finding Yang et al (2004) and Ai, et al. (2006) who reported that a depression in growth performance occurred when meat and bone replaced fish meal by more than 50%. Watanabe and Pongmaneerat (1991) attributed this depression in growth performance to the poor digestibility and imbalance of essential amino acids of meat and bone meal. In a balanced amino acid diets trial Yamamoto et al. (2002) found that still a depression in growth performance when the replacement percentage of fish meal by meat and bone meal exceeded 50%. They related this depression to the high ash content of meat and bone meal which may produce a faster gut transit rate, thus providing an increased feed intake with poor reflection on growth and thus, poor feed efficiency.

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Table (3): Effect of replacing dietary fish meal with meat and bone meal on tilapia growth performance and feed efficiency

<table>
<thead>
<tr>
<th>Experimental treatments</th>
<th>Replacement levels</th>
<th>IBW²</th>
<th>FBW³</th>
<th>FI⁴</th>
<th>WG%⁵</th>
<th>FCR⁶</th>
<th>PER⁷</th>
<th>SGR⁸</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diet 1</td>
<td>......</td>
<td>1.95</td>
<td>9.50</td>
<td>±0.10</td>
<td>13.62</td>
<td>±0.24</td>
<td>387.18</td>
<td>±10.35</td>
</tr>
<tr>
<td>Diet 2</td>
<td>25%</td>
<td>1.90</td>
<td>9.19</td>
<td>±0.11</td>
<td>13.27</td>
<td>±0.16</td>
<td>383.36</td>
<td>±8.56</td>
</tr>
<tr>
<td>Diet 3</td>
<td>50%</td>
<td>1.80</td>
<td>8.51</td>
<td>±0.10</td>
<td>12.61</td>
<td>±0.25</td>
<td>372.77</td>
<td>±8.87</td>
</tr>
<tr>
<td>Diet 4</td>
<td>75%</td>
<td>1.67</td>
<td>7.34</td>
<td>±0.10</td>
<td>11.28</td>
<td>±0.23</td>
<td>339.52</td>
<td>±4.1</td>
</tr>
<tr>
<td>Diet 5</td>
<td>100%</td>
<td>1.65</td>
<td>6.43</td>
<td>±0.40</td>
<td>9.66</td>
<td>±0.25</td>
<td>289.69</td>
<td>±12</td>
</tr>
</tbody>
</table>

1 values are the mean of duplicate groups of fish. Mean values in columns with different superscripts are significantly different (P<0.05).  
2 IBW Initial body weight (g).  
3 FBW Final body weight (g).  
4 FI Feed intake (g).  
5 WG weight gain (%).  
6 FCR Feed conversion ratio (g/g).  
7 PER Protein efficiency ratio (%).  
8 SGR Specific growth rate (%).
On the contrary, Davies et al. (1989); Watanabe and Pongmaneerat (1991) and Millamena (2002) successfully replaced 750, 800 and 900 g/kg of fish meal protein with MBM combined with other protein sources in diets for Mozambique tilapia, *Epinephelus coioides* and rainbow trout, respectively. These higher acceptable replacement levels of meat and bone might be due to differences in quality of MBM and animal protein blends tested.

**Microbial safety assessment:**

The present data Table (4) illustrate that there was no significant difference in Total Bacterial Count in all treated groups compared to the control group.

**Table (4) Microbial quality parameters in fish fed different levels of MBM:**

<table>
<thead>
<tr>
<th>Test Treatment</th>
<th>TPC CfU/g</th>
<th>TCC CfU/g</th>
<th>FCC CfU/g</th>
<th>Staph CfU/g</th>
<th>B. cereus CfU/g</th>
<th>Salmoela CfU/g</th>
<th>TFC CfU/g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>29x10</td>
<td>-</td>
<td>-</td>
<td>2x10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>25%</td>
<td>47x10</td>
<td>-</td>
<td>-</td>
<td>7x10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>50%</td>
<td>17x10</td>
<td>-</td>
<td>-</td>
<td>8x10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>75%</td>
<td>13x10</td>
<td>-</td>
<td>-</td>
<td>4x10</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>100%</td>
<td>56x10</td>
<td>-</td>
<td>-</td>
<td>15x10</td>
<td>-</td>
<td>-</td>
<td>3x10</td>
</tr>
</tbody>
</table>

TPC= Total Plate count  
TCC= Total Coliform Count  
FCC= Faecal Coliform Count  
Staph=Staphylococcal count  
B. cereus= *Bacillus cereus* count  
TFC= Total Fungal County  
CFU= Colony Forming Unit

Numerical increase in the number of colony forming unit was recorded in the group given 100% MBM as protein source. This observation has no significant negative effect on the judgment on the end product’s microbial quality as the TFC still far below the permissible limits 3log Total Coliform Count, Faecal Coliform count, Bacillus cereus and Salmonella were not detected in all examined samples. The obtained result of Staphylococcal count showed no significant difference among all groups compared to the control group but cfu/g number increased in group fed the 100% MBM as protein source by one log. All treated groups showed negative result of Total Fungal Count while very few colonies was found in group fed on 100% MBM as protein source.

The present data revealed that, using of MBM as protein source in fish diet showed no microbial health hazard as the obtained microbial quality was considered to be of good status and the absence of pathogenic microorganisms and the low quantity of indicator parameters (TCC, FCC, *Staphylococci* and *Bacillus cereus*) indicates the efficient processing of this protein source. The data presented by (FAO, 2004) (Table 5) supported this conclusion.
Table (5): Efficacy of rendering system in the destruction of pathogenic bacteria (FAO, 2004).

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Pre rendering</th>
<th>Post rendering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clostridium perfringens</td>
<td>71.4 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Listeria species</td>
<td>76.2 %</td>
<td>0 %</td>
</tr>
<tr>
<td>L. monocytogenes</td>
<td>8.3 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Campylobacter species</td>
<td>29.8 %</td>
<td>0 %</td>
</tr>
<tr>
<td>C. jejuni</td>
<td>20.0 %</td>
<td>0 %</td>
</tr>
<tr>
<td>Salmonella species</td>
<td>84.5 %</td>
<td>0 %</td>
</tr>
</tbody>
</table>

Data obtained in the above table show that, heat treatment of meat and bone meal can destroy all micro biological hazards even those which are resistible to unfavorable conditions; like clostridium perfringens bacteria which is gram positive (has thick cell wall) spore forming bacteria giving an idea about the safety usage of it as protein source in fish feeding. This results agreed with those obtained of Miles and Jacob (1998) and Yu (2004).

Economical evaluation:

Table (6) illustrated that the most economical diet was D2 containing 3% meat and bone meal (replacing 25% fish meal), which gave net revenue 60.92 L.E. followed by D1 60.88 L.E. than D3 58.98 L.E. the worst net revenue presented by D5 (replacing 100% fish meal) 46.34 L.E.

Table (6): Economical efficiency of Nile tilapia (tilapia niloticous) fed the experimental diets.

<table>
<thead>
<tr>
<th>Items</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total amount of feed consumed (Kg)</td>
<td>13.62</td>
<td>13.27</td>
<td>12.61</td>
<td>11.28</td>
<td>9.66</td>
</tr>
<tr>
<td>Price of one Kg diet (L.E.)</td>
<td>3.90</td>
<td>3.72</td>
<td>3.55</td>
<td>3.37</td>
<td>3.19</td>
</tr>
<tr>
<td>Total feed cost (L.E.) *</td>
<td>53.12</td>
<td>49.36</td>
<td>44.14</td>
<td>38.01</td>
<td>30.82</td>
</tr>
<tr>
<td>Total fish weight (Kg)</td>
<td>9.50</td>
<td>9.19</td>
<td>8.51</td>
<td>7.34</td>
<td>6.43</td>
</tr>
<tr>
<td>Price of one kg fish (L.E.) **</td>
<td>12.0</td>
<td>12.0</td>
<td>12.0</td>
<td>12.0</td>
<td>12.0</td>
</tr>
<tr>
<td>Total income (L.E.)</td>
<td>114.0</td>
<td>110.28</td>
<td>102.12</td>
<td>88.80</td>
<td>77.16</td>
</tr>
<tr>
<td>Net revenue (L.E.)</td>
<td>60.88</td>
<td>60.92</td>
<td>58.98</td>
<td>50.79</td>
<td>46.34</td>
</tr>
<tr>
<td>Economical efficiency</td>
<td>115</td>
<td>124</td>
<td>134</td>
<td>134</td>
<td>150</td>
</tr>
<tr>
<td>Relative economical efficiency (%)</td>
<td>100</td>
<td>108</td>
<td>117</td>
<td>117</td>
<td>130</td>
</tr>
</tbody>
</table>

* Economic evaluation was calculated depending on the prevailing prices being : price of D1, D2, D3, D4 and D5 was 3900, 3720, 3550, 3370 and 3190 L.E. respectively,
** However Kg of tilapia fish was 12 (LE).

The economical efficiency could be used to compare the differences among the experimental treatments. The priority of the diets goes to the more economical ones.

The results showed that diets containing meat and bone meal (D2, D3, D4 and D5) scored the least feed cost (L.E.) values, when compared to the control group. The least value (30.82) was for 100% meat and bone meal (D5) while, the highest value (53.12 L.E.) was for 100% fish meal (D1.
control). The best relative economical efficiency (130%) was for the group fed 12% meat and bone meal (D5) followed by 6% and 9% meat and bone meal (D3 and D4) (117% for each). It could be concluded that replacing 25% fish meal with meat and bone meal in Nile tilapia diets can be used to get better net revenue (LE).

CONCLUSION

Although the present study indicated that meat and bone meal could be used as an animal protein source to replace fish meal up to 50%, without adverse effects. Yet 25% replacement was the most economical. More work is needed however to explore the possibility of reducing the ash content of MBM and improving the digestibility of meat and bone meal by improving processing methods.

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تأثر إستبدال مسحوق السمك بمسحوق اللحم والعظم في علانق البلطي النيلي
1- تقييم تغذوي وأمان استخدام
أشرف هاشم محمد جمعه، و جيهان محمد المغازي
المركز الاقليمي للأغذية والاعلاف،مركز البحوث الزراعية،جيزة-مصر

تم إجراء تجربة نمو اولاً لإعادة تقييم تأثير إحلاً مسحوق اللحم والعظم محلل مسلحوق
السللمع علللا داء النمللو  والالللاءي الي الايللأ ملل  للألانل علاللالل ة ثانيللا لتقيلليم سلللامة
استخدام مسحوق اللحم والعظم بنسبة صلر،25،52 و055% امصدر بروتين حيلوان
تي ية الأسماعة  تم ترايب خمس علالا  متزنأ م  محتواهلا ملن البلروتين 25% و محتواهلا ملن
ال اقأ 2255
ايلو االوري علا اساس ال اقأ المهضومأ الملترضلأ)تحتوي عللا صللر ،2،6،9 و05% مسحوق لحم وعظم  ة تم توزيع العلالا  عشوالايا بحيث اانت ال عليقأ تقدم لمجموعتين
امللن الأسللماع المتواجيلى حللوار مللن الليبللر جلللاس بحيللث إحتللو  اللل حللور علللا عللدد
52 إصباعيأ   متوس  وزن البدايأ 0.1 ± 5.02 جم )ة وقد قدمت العلالا  التجريبيأ يدويا  ربلع ملرات
خلال اليوم للترة 65 يوماًة بالنسبأ لتحايم الأمان المياروب   للأسماع المختبرلي، ثلثلاث عينلات ملن
ً
مجموعلهلا ملل  نهايللأ متللرة التجربللأ ملل   ايللاس معقمللأ و للع لقيللاس العللد الباتيللري
الال ،الباتريللا المتحوصليلأ، الباسليلس سليل، سلامونيلا و السللمونيلا، وضع مسحوق لحم وعظام عند مستو  إحلال
25% ة بينما للم يلاحلظ  ي ملارق معنلوي ملن حيلث اميلة اليل اء الملأاول ، معامل
التحويل الي  و الاءة البروتين النسب  بين الأسماع الت  ت علا العليقأ القياسليأ وتللع الميل اي علللا علالالل  إحتللوت علللا
مسلحوق لحللم وعظم عند مستو  إحلال
52%
للم يلاحلظ  ي ملارق معنلوي ملن حيلث اميلة اليل اء الملأاول ، معامل
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