# UTILIZATION OF BLACK SEED MEAL (*NIGELLA SATIVA*) IN NILE TILAPIA (*OREOCHROMIS NILOTICUS*) DIETS

**BY**

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## ABSTRACT

A feeding trail was carried out to study the effect of dietary inclusion of different levels of black seed meal (BSM) on growth performance, feed and nutrient utilization, organs indices, body composition and cost-benefit analysis of Nile tilapia. Ten glass aquaria were used, each was stocked with 10 fish (average initial weight 10g/fish). Five experimental diets were formulated to contain 0,25,50,75,and 100% of black seed meal protein instead of soybean meal protein. All the diets were isonitrogenous (30% protein) and isocaloric (18.8 MJ/kg diet, gross energy). Fish were fed on the exp. diet at a rate of 3% of their body weight daily for 10 weeks. The feed amount was given at two times daily. Nile tilapia fed the diet containing 25% black seed meal exhibited the best performance, feed conversion, and protein efficiency ratio compared with the control and other diets. The body composition was not affected by black seed meal up to 50% inclusion level. However, the higher levels of BSM inclusion caused low protein and high lipid contents of fish body than the control diet. Cost-benefit analysis showed high profit index and low incidence cost with the BSM inclusion in the diets.

**Keywords:** Nile tilapia, black seed meal, performance, protein utilization, cost benefit.

## INTRODUCTION

Over the last several years, research efforts centered around the application of herbs in the diets have been directed as means of reducing the symptoms of stress acting as a natural growth promoter

and improving the general health (Abd Elmonem et al., 2002; Shalaby et al., 2003 and EL-Dakar et al.,2004 ) . Medicinal and aromatic plants have been used for many years in human nutrition as a spices and medical additives for animals to increase dietary energy utilization, improve the performance efficiency and as a new source of protein (El-Katcha, 1990 and Abdel-Aal and Attia, 1993). Nowadays, there is an increased demand for using medical plants in therapy instead of using synthetic drugs (Hussein et al., 2000; Abdelhamid et al., 2002, 2003a and 2004 b-e and Abdelhamid, 2003a), which have many adverse effects. Black seed meal (*Nigella sativa*) are used by Egyptian people as diuretic, carminative and flavouring agent for bread (EL-Alfy and Atoama, 1975). The seeds are used for their antibacterial, antifungal, and protective action against hepatotoxicity and cirrhosis (Agarwal et al, 1979, Rathee et al, 1982, Khanna et al 1993, Mahmoud, 1993 and El- Gazzar 1997). *Nigella sativa* oil used as fungicide or fungistatic against twenty fungi including pathogenic and industrial strains (Islam et al.., 1989). Nowadays, Nigella seeds and oil are used in increasing immunity and maintaining good health (Abdel – Aal and Attia, 1993 Hussein et al., 2000). This study was undertaken to determine the usefulness of black seed meal fed to Nile tilapia fingerlings on its growth and economic performance, body composition and organs indices.

## MATERIALS AND METHODS

The present work was carried out at the wet lab.of the Department of Animal and Fish Production, Faculty of Agriculture, Kafr El- Sheikh , Tanta University during year 2005.

**1.fish and rearing :**

A total of number of 100 fingerlings of *Oreochromis niloticus* with an average initial body weight of 10 g were used in this study. The fish were taken from the stock of Moassaset El-Sharaky. The fish were divided into 10 similar group in glass aquaria (60x35x40cm) containing 70 L of water with 10 fish in each. The groups were distributed into the experimental treatments in duplication. Five air pumps and 10 air stones were used for aerating the aquaria waters. Dissolved oxygen was measured by0 means an oxygen – meter model 9070. Analyses of NO2. NO3 and

hardness were carried out using commercial Kits (Hach International Co., Cairo, Egypt). Analyses of PO4 and alkalinity were estimated also by Kits (LaMotte International Co., Cairo, Egypt).

Light was controlled by a timer to provide 14 – h light: 10 h dark as a daily photoperiod. The fingerlings were acclimatized for one week to the aquarium conditions and feeding regime. Five isonitrogenous (30 % crude protein) and isocaloric (20.9 MJ GE / Kg DM) feed mixtures, from indigenous ingredients and imported herring meal were formulated and offered for 10 weeks. The ingredients used and chemical analyses of the mixed diets are presented in Table(2). Fish were offered the diets at a daily rate of 3 % of their body weight. Fish were weighed weekly and the amount of feed quantity for each aquarium was adjusted accordingly. The daily ration was introduced at 2 equal meals at 8 am and 2 pm. Dechlorinated tap water was used to change one third of the water in each aquarium every day.

**2.Diet formulation:**

The black seed meal (*Nigella sativa*) was obtained from El-Mahala Oil Co., the proximate composition of black seed meal comparing with that of soybean meal are given in Table (1). The chemical composition of the tested black seed meal showed that it contained: (on DM basis ) 32 % crude protein 7.25% ether extract; 6.44 % ash; 7.88 % crude fiber; 18.30 MJ/kg diet as gross energy . Black seed meal was added in the experimental diets to replace 0, 25, 50, 75 and 100 % of soybean meal protein.These diets were designated as diet 1 , 2 , 3 , 4 , and 5 , respectively ( Table 2 )

**Table (1): Proximate chemical analysis of black seed meal and soybean meal (on DM basis %)**

| Ingredient | DM (%) | CP | EE | Ash | CF | NFE[a] | GE[b] ( MJ/ kg ) |
|---|---|---|---|---|---|---|---|
| Soybean meal | 89.14 | 44 | 1.1 | 6.3 | 7.3 | 41.3 | 17.81 |
| Black seed meal | 90.5 | 32 | 7.25 | 6.44 | 7.88 | 46.43 | 18.30 |

a) NFE = 100 – (CP + EE + CF + Ash).

b) GE = Gross energy was calculated by multiplication the factors 4.1, 5.6 and 9.44 kcal GE / DM for carbohydrate, protein and fat, respectively (Jobling, 1983).

**Table (2): Composition and chemical analysis of the experimental diets used.**

| Ingredients (%) | Diets No. (%black seed meal) | | | | |
|---|---|---|---|---|---|
| | D1 (control) (0%) | D2 (25%) | D3 (50 %) | D4 (75 %) | D5 (100 %) |
| Fish meal 72% | 10 | 10 | 10 | 10 | 10 |
| Soybean meal 44% | 45 | 33.75 | 22.5 | 11.25 | 0 |
| Yellow corn | 27.7 | 23.49 | 19.27 | 15.05 | 10.83 |
| Wheat bran | 6 | 6 | 6 | 6 | 6 |
| Rice bran | 6 | 6 | 6 | 6 | 6 |
| Sun flower oil | 5 | 5 | 5 | 5 | 5 |
| Vit. & min. (1) | 0.3 | 0.3 | 0.3 | 0.3 | 0.3 |
| Black seed meal 32% | 0 | 15.46 | 30.93 | 46.40 | 61.87 |
| total | 100 | 100 | 100 | 100 | 100 |
| Determined Values (% dry matter basis) | | | | | |
| Dry matter | 89.33 | 88.95 | 89.11 | 88.80 | 89.20 |
| CP | 29.91 | 29.60 | 28.50 | 28.20 | 28.11 |
| EE | 7.10 | 8.11 | 8.70 | 9.00 | 9.75 |
| CF | 4.50 | 5.50 | 6.14 | 6.50 | 6.30 |
| ASH | 5.61 | 6.3 | 6.50 | 6.90 | 6.20 |
| NFE | 52.88 | 50.49 | 50.16 | 49.4 | 49.64 |
| Calculated Values: | | | | | |
| GE MJ/ Kg (2) | 18.86 | 18.78 | 18.70 | 18.61 | 18.93 |
| ME MJ/ kg (3) | 15.7 | 15.6 | 15.6 | 15.5 | 15.8 |
| MgP/KJGE (4) | 15.85 | 15.76 | 15.23 | 15.14 | 14.84 |

(1) Vitamin and mineral mixture (product of HEPOMIX) each 2.5 kg contain: 12.000.000 IU Vit .A; 2.000.000 IU Vit . D3; 10 g Vit. E; 2g Vit. K3; 1g Vit. B1 5g Vit. B2; 1.5 g Vit. B 6; 10g Vit.B12; 30 g Nicotinic acid; 10 g Pantothenic acid; 1g Folic acid; 50g Biotien; 250g Choline chlorid 50%; 30g Iron; 10g copper; 50g Zinc; 60g Manganese; 1g Iodine; 0.1g Selenium and cobalt 0.1g.

(2) GE (gross energy) calculated by the values 4.1, 5.6 and 9.44 Kcal GE/g DM of carbohydrate, protein and fat, respectively (Jobling, 1983).

(3) ME (Metabolizable energy) calculated using the value of 3.49, 8.1, and 4.5, Kcal/g for carbohydrate, fat, and protein, respectively, according to Pantha (1982).

(4) P/E (protein to energy ratio) = mg crude protein / Kj GE.

**3.Physical and Biochemical analysis:**

Fish sample (6-7) at the start and from each group at the end of the experiment were obtained for chemical analysis. Chemical analysis for dry matter (DM), crude protein (CP), ether extract (EE) and ash in the diets, black seed and soybean meals used and in fish body (besides crude fiber, CF in the diets and their ingredients) was carried out according to A.O.A.C.(1980).

**4.Performance parameter:**

Average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR), feed conversion ratio (FCR) , protein efficiency ratio (PER) , protein productive value (PPV) and survival rate (SR) were calculated according to the following equations :

1- AWG (g/fish) = [Average final weight (g) – Average initial weight (g)]
2- ADG (g/fish/day)= [AWG (g) /experimental period (day)]
3- FCR= Feed intake, dry weight (g)/Live weight gain (g)
4- SGR (%/day) = [Ln final (g) – Ln initial weight (g) ]x 100/ experimental period , day
5- PER= Live weight gain (g) /protein intake (g)
6- PPV=100[final fish body protein (g)-initial fish body protein (g)]/crude protein intake (g)
7- Survival rate (SR)= Total number of fish at the end of the experiment x 100 / total number of at the start of the experiment.

**5.Organs indices:**

All fish were killed and soon the abdominal cavity was opened to remove liver, kidney, gonads and spleen and these organs were weighed individually. Liver (HIS), kidney (KSI), gonads (GSI) and spleen (SSI) indices were calculated as fallow:

- HSI (Hepato somatic index) = Liver weight / Gutted fish weight (Jangaard et al., 1967)

- KSI (Kidney somatic index) = Kidneys weight x 100 / fish weight (Alabaster and Lioyd, 1982).
- GSI (Gonado somatic index) = Gonads weight x 100 / fish weight (Tseng and Chan, 1982).
- SSI (Spleeno somatic index) = Spleen weight x 100 / fish weight (Abdelhamid et al., 2004d).

**6.Statistical analysis:**

The obtained numerical data were statistically analyzed using SPSS (1997) for one-way analysis of variance. When F-test result was significant, least significant difference was calculated according to Duncan multiple range test (1955).

## RESULTS

**1.Water quality parameters:**

The water samples were collected for analysis before changing water. The most important physico-chemical parameters of tap water used in the experiment are shown in Table (3) as overall ranges during the experimental period. Data in this table indicate that the values obtained lie within the acceptable ranges required for normal growth of tilapia as mentioned by Abd El-Hakim et al . (2002) and Abdelhamid (2003b).

**Table (3): Some important measured physical-chemical parameters of water.**

| Temperature (ċ) | pH | DO2 mg/l | Alkalinity mg/l | Hardness mg/l | PO4 mg/l | NO2 mg/l | NO3 mg/l |
|---|---|---|---|---|---|---|---|
| 25-28 | 6.5-8 | 5.5-6 | 145-155 | 350-355 | 0.1-0.2 | 0.15-0.16 | 1.25-2.25 |

**2.Growth performance:**

Data of Table (4) showed the means of weight gain, daily gain, specific growth rate and survival rate of Nile tilapia fed diets containing different levels of black seed meal. Maximum growth performance was obtained at inclusion level of 25% BSM.

However, adding up to 50% BSM to Nile tilapia diets resulted in an improvement in SGR and survival rate compared to the control. While the results of the experiment clearly showed that the diets containing 75% and 100% BSM performed slightly lower than the control diet. The specific growth rate and survival rate of the fish fed on the diets containing 25 and 50% BSM were better than those of 75% and 100% black seed meal diets.

**Table (4): Growth performance of Nile tilapia fed on the experimental levels of black seed meal (BSM).**

| Treatment No. (% BSM) | AWG (g/fish) | ADG (g/fish/day) | SGR (%/day) | SR (%) |
|---|---|---|---|---|
| 1- control(0%) | 18.65( b) ±0.85 | 0.27(b) ± 0.02 | 2.19(a) ± 0.06 | 100(a) ± 0.00 |
| 2- (25%) | 20.90(a) ± 0.01 | 0.30(a) ± 0.06 | 2.27(a) ± 0.02 | 100(a) ± 0.00 |
| 3- (50%) | 18.89(b) ± 0.012 | 0.27(b) ± 0.02 | 2.05(a) ± 0.01 | 100(a) ± 0.00 |
| 4- (75%) | 12.00(c) ± 0.30 | 0.17(c) ± 0.01 | 1.62(b) ± 0.01 | 90 (b) ± 0.04 |
| 5- (100%) | 11.80(c) ± 0.30 | 0.17(c) ± 0.01 | 1.12(c) ± 0.05 | 85 (b) ± 0.03 |

a , b and c means in same column bearing the same letter do no differ significantly at 0.05 level.

### 3.Feed and protein utilization:

Data 0f Table (5) showed that the best feed conversion ratio (FCR) and protein efficiency ratio (PER) was found when fish were fed the diet containing 25% black seed meal. These results clearly showed that the diets containing 50,75 and 100% black seed meal converted feed slightly lower than the control diet. Data of feed conversion ratio (FCR), protein efficiency ratio (PER) and protein productive value (PPV) of the experiment fish clearly showed that the diet containing 25% black seed meal was slightly better than those contained 50, 75 and 100%BSM.However, all diets contained BSM resulted in significantly lower PPV than the control diet.

### 4.Bady composition:

Values of dry matter (DM), crude protein (CP) ether extract (EE), and ash of the fish body are summarized in Table (6). Crude protein and EE percentages were significantly higher and lower, respectively, when the fish were fed on the control, 25%and 50% black seed meal diets as compared with those fed on 75 and 100% black seed meal. Yet, all diets included BSM not altered

significantly the ash contents of the whole fish body compared with the control.

**Table (5): Feed and nutrient utilization of Nile tilapia fed on the experimental diets containing different level, of black seed meal (BSM).**

| Treatment No. %BSM) | FCR | PER | PPV |
|---|---|---|---|
| 1- Control(o%) | 1.23 (c) ± 0.04 | 2.70 (a) ± 0.11 | 23.31 (a) ± 0.81 |
| 2- (25%) | 1.08 (d) ± 0.04 | 3.05 (a) ± 0.11 | 21.84 (b) ± 0.11 |
| 3- (50%) | 1.21 (c) ± 0.01 | 2.95 (a) ± 0.24 | 20.96 (c) ± 0.16 |
| 4- (75%) | 1.71 (b) ± 0.04 | 1.95 (b) ± 0.04 | 17.94 (d) ± 0.19 |
| 5- (100%) | 1.97 (a) ± 0.02 | 1.78 (b) ± 0.03 | 17.51 (d) ± 0.40 |

a , b ,c and d means in the same column bearing the same latter do not differ significantly at 0.05 level.

**Table (6): Means±standard errors of proximate chemical analysis (% on dry matter basis) of the experimental fish fed on graded levels of black seed meal.**

| Treatment No. (%BSM) | DM | CP | EE | Ash |
|---|---|---|---|---|
| Control(0) | 25.9 (b) ± 0.16 | 60.18(a) ± 0.01 | 15.88(b) ± 0.03 | 24.00(a) ± 0.02 |
| ( 25%) | 26.25(a) ± 0.10 | 60.23(a) ± 0.02 | 16.09(b) ± 0.05 | 23.79(a) ± 0.05 |
| ( 50%) | 26.33(a) ± 0.05 | 60.15(a) ± 0.01 | 16.80(b) ± 0.05 | 23.88(a) ± 0.03 |
| ( 75%) | 25.96(b) ± 0.03 | 59.93(b) ±0.03 | 16.90(a) ± 0.05 | 23.53(a) ± 0.06 |
| ( 100%) | 26.80(b) ± 0.14 | 59.45(b) ± 0.05 | 16.88(a) ± 0.15 | 24.10(a) ± 0.01 |

a and b means in the same column bearing the same letter do not differ significantly at 0.05 level.

## 5.Internal organs indices:

The main effects of dietary BSM inclusion on fish organs indices were on GSI, and KSI , where 25% BSM increased significantly females , and males GSI and KSI. Diets No.4 and 5 significantly reduced each of HSI, KSI and SSI than the control, but did not significantly alter male and female GSI ( Table 7 ).

**Table (7): Effect of dietary levels of black seed meal on organs indices of the experimental fish.**

| Treatment No.(%BSM) | HSI | GSI ( female) | GSI (Male) | KSI | SSI |
|---|---|---|---|---|---|
| 1-Control(0%) | 2.63 (a) ± 0.08 | 2.78(c) ± 0.28 | 0.64(b)± 0.06 | 0.11(b)± 0.001 | 0.29(a)± 0.002 |
| 2- (25%) | 2.63 (a) ± 0.18 | 3.45(a) ± 0.15 | 1.35(a)± 0.05 | 0.18(a)± 0.001 | 0.28(a)±0.003 |
| 3- (50%) | 2.45 (b)± 0.05 | 2.95(b) ± 0.15 | 1.23(a)± 0.03 | 0.10(b)± 0.001 | 0.29(a)± 0.007 |
| 4- (75%) | 1.85 (b) ± 0.05 | 2.61(c)± 0.51 | 0.65(b)± 0.05 | 0.02(c)± 0.001 | 0.19(c)± 0.001 |
| 5- (100%) | 1.73 (b) ± 0.03 | 2.41(c)± 0.04 | 0.85(b)± 0.05 | 0.02(c)± 0.001 | 0.23(b)± 0.004 |

a, b and c means in the same column had different letters significantly ($p<0.05$)differ.

## 6.Economic study:

The economic parameters of the tested diets are presented in Table (8). The calculations depended on the average price of dietary ingredients of year 2005 ; where local marked price /ton of fish meal were 4000 LE , soybean meal 2000LE , Yellow corn 1000 LE , oil 3000 LE , Vit. & Min. 12000 LE and black seed meal 1450 LE . The calculated figures showed lower cost of one ton of all diets included BSM.However , the control diet recorded the highest price being 1835 LE / ton .

**Table (8): Data of the economical study due to feeding fish on graded levels of Black seed meal .**

| Treatment No. (%BSM) | Feed intake ( g/fish) | Cost (LE) of one ton diet | Decrease feed Cost (LE) in LE | Total gain (g/fish) | Feed cost/kg * Gain (LE) |
|---|---|---|---|---|---|
| 1-Control (0) | 21.67 | 1835 | 0.00 | 18.65 | 2.13 |
| 2- (25%) | 21.85 | 1790.5 | 44.5 | 20.90 | 1.87 |
| 3- (50%) | 21.55 | 1746 | 89 | 18.89 | 1.99 |
| 4- (75%) | 18.45 | 1701.6 | 133.4 | 12.00 | 2.61 |
| 5- (100%) | 17.50 | 1657.2 | 177.8 | 11.80 | 2.45 |

• **Feed cost / kg gain (LE) = feed intake x cost (LE) of ton feed x 1000 / total gain.**

The diets Containing 75%, and 100% BSM showed the lowest fish gain compared with the other diets. Therefore, they showed the highest feed cost / kg gain. However, diets No. 2 and 3 (including 25 and 50%BSM) reflected the best fish body gains. Thus, these low levels (25%, 50% BSM) gave the best feed cost/kg gain being (1.87 and 1.99 LE).

## DISCUSSION

Results indicated that *Nile Tilapia* fed on 25% black seed meal diet exhibited the best growth, feed conversion, protein efficiency ratio , body composition and economic efficiency when compared with the other fish groups. These positive responses of Nile tilapia to utilize this medicinal plant by product at low level (not more than 15.46% of the whole diet) in the present study confirm the previous findings obtained by (*Atwa,* 1997). Zeiwel (1996) found that when the BSM was used at levels of 6.78 and 13.54 %, body weight and weight gain of Japanese quails were significantly higher than those of quail fed the soybean meal based diet. These findings support the present results, which recorded that 25% BSM substitution level is a satisfactory level in Nile tilapia diets. However, using the higher levels of BSM could not significantly improve growth and feed efficiency for fish (Atwa, 1997), quail (Zeiwel, 1996) and duck (Khalifah, 1995) . Atwa (1997) demonstrated that Nile tilapia fed BSM free diet exhibited the highest body weight than those fed different levels (10, 20 and 30%). The reduction of body weight and SGR of fish may be attributed to the following reasons:-

1- Low essential amino acids level in the BSM as compared with the soybean meal.
2- Apparent amino acids availability for soybean meal is higher than for BSM, with the exception of methionine.
3- Possible existing of toxic substances in the BSM (Tennekoon et. al., 1999).

The superiority of diet No. 2 (25%BSM) confirms the results obtained by Abou-zeid (1998), who found that Nigella seeds promoted growth of Nile tilapia because of its digestive stimulating effect through their aromatic substances or essential oils. Literatures show that BSM oil contains more than 100 components, some of which are still unidentified, which work together synergistically. It is a rich source of polyunsaturated fatty acids ( palmitic, oleic , linoleic and linolenic ) which are the building blocks of cells membranes and help the body to produce prostaglandin ( Babayan et. al . 1978). In addition, it contains the following nutrients: thiamin, riboflavin, pyridoxine, niacin, folacin,

calcium, iron, copper, zinc, phosphorus (Khalifa, 1995). In the present study, the survival rate was high being 100% for all fish groups up to 50% BSM level showing clearly that toxic substances in the BSM is not lethal in diets No. 2 and 3. Similar results were found by Atwa (1997) with BSM for the Nile tilapia. However, the best results were found with the level of 25% BSM. Previous studies gave similar results (khalifah, 1995 and Zeiwel, 1996). Dietary inclusion of BSM higher than 25% caused low protein and high lipid contents in bodies than the control diet. Aquaculture in Egypt is a must, since the yearly fish import value exceeded the export value by more than 40 folds for the increased demand and shortage of production from the natural fisheries. Moreover, there is incapable feed resources or scarcity that is one of the causative agents for the aquaculture inadequacy (Abdelhamid, 2002 and 2003c). Therefore, many feed additives and replacers were evaluated as unconventional aqua feeds for tilapia including black seed meal, requette seed meal (Abd Elmonem et. al., 2002), dehulled sunflower meal (El-Saidy and Gaber, 2002), dried dropping date (Srour et al., 2002), fig jam by-product (El-Dakar et.al., 2003) , active yeast (EL- Ebiary and Zaki, 2003), licorice roots (Shalaby et.al 2003), sesame meal (Abdelhamid et.al., 2004c), olive pulp(Abd Elmonem, 2004 ),sesame hulls (Abd Elmonem et.al., 2004), fennel seed meal (El-Dakar et.al.,2004), faba bean middlings ( Shalaby et.al., 2004 ) and other with variable success.

## CONCLUSION

The results suggested the usefulness of black seed meal to replace up to 25 % of soybean meal protein in tilapia fish diets.

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## الملخص العربى

## استخدام كسب حبة البركة في علائق البلطي النيلى

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**٢ـ المعمل المركزي لبحوث الثر وه السمكية بالعباسه ـ وحدة بحوث الثر وة السمكية بسخا.**

تم إجراء هذا البحث لدراسة تأثير الاستبدال الجزئي و الكلى لكسب فول الصويا بكسب حبة البركة كمكون غير تقليدي على أساس نسبة البروتين وذلك بمعدلات (صفر، ٢٥ ،٥٠، ٧٥ ،١٠٠٪) وهذا لكي يتم ألحصول على عليقه رخيصة الثمن نظرا للارتفاع الكبير في أسعار العلائق في الفترة الاخيره وتم استخدام أسماك البلطي النيلى بوزن أولى متوسط ١٠ جم ، حيث تمت التغذية بمعدل ٣٪ يوميا على أساس الوزن الحي للأسماك بالأحواض الزجاجية، و ذلك على مرتين يوميا، و تم عمل مكررتين لكل معاملة . البروتين و الطاقة في العلائق المدروسة كانت في حدود ٣٠٪ و ١٨,٨١ميجاجول طاقة كلية / كجم علف على الترتيب، و استغرقت هذه التجربة ١٠ أسابيع ، و أهم النتائج المتحصل عليها أن معدلات النمو و صفات الأداء الانتاجى كانت متقاربة بين العلائق و الكنترول(ألمقارنه)، و العليقة التي بها نسبة الاستبدال بمعدل (٢٥٪) كسب حبة البركة كانت أحسن

معاملة و ذلك بالمقارنة ببقية المعاملات ( ٥٠، ٧٥ ، ١٠٠٪ )، و تم تحليل الصفات الكيماوية لجسم الأسماك ووجد أنه لا توجد فروق بين الكنترول و باقي المعاملات (٥٠٪ استبدال)، و كان الوزن النسبي للكبد و الطحال كذلك متقارب بين المعاملات(حتى ٥٠٪ استبدال)، و الكنترول ، و تم عمل تقيم اقتصادي للعلائق للوقوف على أفضل عليقة و مدى العائد الاقتصادي من عملية الاستبدال ووجد أن تكلفة الغذاء اللازم للحصول على كيلوجرام من الزيادة في الوزن الحي كانت قليلة في المعاملات( ٢٥، ٥٠ ٪) بروتين من كسب حبه ألبركة على الترتيب حيث حققت ألعليقه ٢٥ ، ٥٠ ٪ اقل تكلفة بالمقارنة بالكنترول . وبالتالي يمكن التوصية باستبدال حتى٢٥٪ بروتين كسب فول الصويا ببروتين كسب حبة البركة (عند توافرها ) دون أضرار.