

## **EFFECT OF TRIPLOIDY INDUCTION ON MATURATION AND GROWTH TRAITS OF NILE TILAPIA, *OREOCHROMIS NILOTICUS***

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### **ABSTRACT**

An experiment was conducted during 7 months to test the effect of triploidy on growth, sexual maturation, carcass and chemical analysis of *O. niloticus*. Triploid *O. niloticus* had heavier and longer bodies than diploids from 3 to 7 months of age, and the differences were not significant only for body length. This trend was also observed for condition factor, daily gain and specific growth rate. Feed conversion ratios were better for triploids at some studied ages.

In triploid of both sexes, the values of Gonado-somatic indices (GSI) were smaller than diploids with significant differences between the two ploidy groups. But Hepato-somatic indices, (HSI) of triploid *O. niloticus* males were larger than that of diploid with significant differences between the two groups. However HSI of triploid females were smaller than that of diploid females but the differences were insignificant.

Carcass traits of *O. niloticus* had the higher percentages of dressing, viscera, by-products and lower percentages of flesh as compared with that obtained from the diploid.

Chemical analysis of flesh indicated that protein, fat and ash percentages in triploid flesh were higher than in diploids, while the opposite trend was obtained with respect to moisture percentages.

Triploid by-products had the higher percentages of fat and ash and lower percentage of crude protein and moisture with significant differences for moisture only.

## INTRODUCTION

Tilapias (*Oreochromis*, *Sarotherdon* and *Tilapia* spp.) are a group of fishes of major economic importance in tropical and subtropical countries, but their uncontrolled and prolific breeding at a small size in mixed sex culture constitutes a serious constraint on their efficient production. Early sexual maturation resulting in unwanted reproduction and overcrowding has long been accepted as a major limitation in the culture of most tilapia species, particularly the commonly cultured *Oreochromis niloticus* and *O. mossambicus*. This unwanted reproduction generally results in suppression of growth and reduction in yields in cultured populations. The females continue to spawn at frequent intervals, even if the eggs are not fertilized. This, results in diverting the energy from growth to egg production and consequently reduced weight gain. In a mixed population, when eggs are fertilized and develop, the females do not feed during the mouth incubation and brooding period, which is a considerable drain on body reserves.

Numerous solutions to this problem (the unwanted reproduction) have been proposed including manual sexing and separation of the sexes, culture in cages, controlled use of predator species, production of monosex hybrids, and direct hormonal sex reversal (Mair and Little, 1991).

Sterility by triploidy induction in commercial fish stocks has the potential to increase production yields as metabolic energy which be used for gonadal development is redirected to somatic growth (Nagy,

1987). Triploid females do not undergo a maturation process so metabolized energy that would normally be used for gamete production can be redirected for somatic growth (Johnson et al., 1986). As well as, they do not suffer from the associated decrease in flesh quality (Benfey, 1991). Males, and especially females, divert energy which could be utilized for somatic growth into gamete production and behavioral interactions. In addition, competition with recruits in confined environments further suppresses the growth of stocked fish and can result in 30-50% of harvested biomass consisting of largely unmarketable recruits, Mair et al., (1995). Therefore the production of triploid *Oreochromis* species has attracted considerable attention as an alternative to the use of hybridization and hormones as means of producing monosex male fry to avoid the excessive reproduction and to compare the relative performance of diploid and triploid fry (Hussain et al., 1991).

Gonadal weight and development in triploid *O. niloticus* were in general lower and retarded, respectively, Brämik et al., (1995). Hussain et al., (1995) and Hussain et al., (1996) found highly significant differences in ovary weight and gonadosomatic index (GSI) between triploid and diploid *O. niloticus* females from 5 months to 10 months of age, and the string-like ovaries of triploid contained many oogonia and very few small oocytes, in contrast, diploid ovaries were packed with developing or well developed secondary and vitellogenic oocytes. Triploid testes contained watery milt with a very few motile spermatozoa, while diploid testes were full of motile spermatozoa. The same results were shown by Puckhaber and Hörstgen-Schwark (1996), they also added that, tests showed a lower average GSI (49.4%) for triploid males than for diploid males and in females GSI difference was even more distinct (91.3% lower for triploids than for diploids).

Hussain et al., (1995) found that, triploid *O. niloticus* males and females were not significantly different from diploid males and females

in growth rate. Brämick *et al.*, (1995) demonstrated that, while no differences in growth between triploids and diploid *O. niloticus* could be observed at the age of maturation, triploid males exceeded body weights of respective control diploids on average by 66% whereas triploid females displayed higher increase in body weight compared to diploid ones (95%) at the end of the experiment (285 day).

With other fish species, Johnson *et al.*, (1986) found that, there are no significant differences between length, body weight, gut weight and condition factor in triploid and diploid coho salmon. On the other hand, Maguire *et al.*, (1995) reported that, triploid pacific oysters grew faster than diploids as they approached commercial size and were 23.4% larger than diploids on a whole weight basis. Nell *et al.*, (1995) found that the average whole weight of triploid Sydney rock oysters was 41% greater than that of the diploid controls after 2.5 years growth and also had higher condition index than diploid.

Flajshans *et al.*, (1993) found that triploid females of tench, *Tinca tinca* displayed 13.52% higher live weight than diploid females and triploid males displayed 23.66% higher live weight than diploids males and the differences between diploid and triploid males and females were significant.

Flajshans *et al.*, (1993) found that triploid females of tench, *Tinca tinca* displayed 3.49% higher dressing percentage than diploid females but triploid males displayed 1.3% lower dressing percentage than diploids males and the differences between diploid and triploid males and females were not significant. Hussain *et al.*, (1995) found that there were significant differences in gutted fish weight and dress-out percentage, whereas, triploid had the higher gutted body weight and the higher dress-out percentage compared with diploid *O. niloticus*.

The induction of sterile fish by triploidy seems to induce stimulation of fat retention which is also associated with an increase in growth rate, (Recoubratsky *et al.*, 1992). Hussain *et al.*, (1995) found no

significant differences between the muscle of diploid and triploid of *O. niloticus*, within a sex, for the percentage of crude protein, crude lipids, moisture or ash, but they have a significant differences in the percentage of crude protein, crude lipid and moisture between the sexes.

## MATERIALS AND METHODS

The present study was conducted during the period between April 1997 and December 1997 at the warm water recirculation system of Institute of animal and Genetics, University of Göttingen, Germany. The aim of comparing the growth, sexual maturation, carcass traits and chemical composition of triploids *O. niloticus* and their diploid sibs.

The *O. niloticus* stock used in this experiment originates from Lake Manzala, Egypt, and was obtained from the Institute of Aquaculture, Stirling University, Stirling, Scotland. Individual brood fish were marked and held in glass aquaria at  $28\pm 2^{\circ}\text{C}$ . Both male and female fish were held in separated aquaria and used as broodstock for the production of diploid and triploid fish used in this experiment.

### **Triploidy induction:**

#### **Collection of gametes:**

Females held in transparent aquaria were observed several times a day. Ready to spawn, females are identified with swollen and reddened papillae, then netted out of the aquarium and then anaesthetised using few drops of Ethylenglycolmonophenylether in a half bucket full of water. After washing the chemical away, female was gently handstripped and the eggs were collected in 500 ml glass vial containing physiological saline (0.9% NaCl). An appropriate male was taken out of the aquarium and then stripped of the sperm by using suitable pipette. This was added into the glass vial containing physiological saline (0.9% NaCl). No anaesthesia was used to strip males, and the sperm obtained was microscopically examined for motility.

### **Egg Fertilization and heat shock**

In order to produce diploid and triploid full sibs, the eggs were stripped from a single female were fertilized with fresh milt from a single male and then divided into two groups, untreated (diploid), eggs of the other group were heat-shocked to induce retention of the second polar body. Heat-shock treatment was applied at 41°C for a duration of 4.5 min, 4 min post fertilization as described by Puckhaber and Hörstgen-Schwark (1996).

### **Incubation of fertilized egg**

Based on recommendations of Habitzky-Biester (1987), maximum of 150 fertilized eggs were put into glass cups of 35 cm<sup>3</sup> and were incubated at 28°C. The outflow of eggs from incubation glasses, due to the tangential movement caused by the adjusted water, was protected by fitting smooth ended cylindrical meshes on the top of the cups.

### **Triploidization assessment:**

Triploidization success was confirmed by chromosome preparations (Kligerman and Bloom, 1977, adapted by Puckhaber and Hörstgen-Schwark, 1996) in eight embryos out of each treated batch.

### **Fry rearing and on-growing:**

The first rearing of triploid and diploid fry (10-12 day after fertilization) occurred after transferring them from incubator into 5 liters aquaria for three weeks and then transferred to 80 L indoor aquaria, provided with a recirculated, aerated and controlled temperature (28±2°C) water supply. Triploids and diploids were kept separately at a stocking rate of 200 fry/aquarium for two months and fed commercial trout starter pellets (42% protein) at a percent of 5% of the total fish mass. At the end of this rearing period, the triploid (11.9 g) and diploid (11.4 g) fry were stocked separately into 300 l aquaria (in two replicates) at a density of 80 fish/aquarium and kept on a 12-hour photoperiod in a

recirculated water system maintained at 28°C. On-growing fish were fed twice daily at 3% body weight with carp pellets (30% protein).

### **Fish samples and measurements**

Random samples (50 fish of the two replicates of each treatment) were taken biweekly during the experimental period and used for measuring body parameters and growth traits. Feed conversion ratio (FCR) was determined by using the following formula:  $FCR = \text{dry feed fed (gm)} / \text{wet weight gain (gm)}$

Gonado-somatic index (GSI) and hepato-somatic index (HSI) were determined by the equations used by Hussain et al., (1995) as follows:

$$GSI = [\text{gonad weight (g)} / \text{fish weight (g)}] \times 100.$$

$$HSI = [\text{liver weight (g)} / \text{fish weight (g)}] \times 100.$$

Carcass analysis was carried out according to the methods described by Lovell, (1981) and the chemical analysis of fish according to A.O.A.C (1990).

### **Statistical analysis**

The statistical analysis of data was carried out by applying the computer program Harvey (1990) by adopting the following model.

$$Y_{ik} = \mu + T_i + e_{ik}$$

where,  $Y_{ik}$  = observation of the  $ik$ -th fish,  $\mu$  = overall mean,  $T_i$  = fixed effect of the  $i$ -th treatment,  $e_{ik}$  = a random deviation of  $k$ -th fish, this item is assumed to be independently randomly distributed  $(0, \sigma^2)$ . Differences among means were tested for significance according to Duncan's multiple range test (1955).

## **RESULTS AND DISCUSSION**

### **Body measurements**

Table (1) outline the means and standard errors of body weight, body length, condition factor and body depth belonging to successive age groups of triploid and diploid *O. niloticus*.

The results of body weight indicated that triploid fish were heavier than diploids at all ages studied (3-7 months) but these differences in weights were not significant. The insignificant differences among diploids and triploids *O. niloticus* perhaps attributed to carrying out the experiment in aquaria which relatively prevent uncontrolled reproduction. These results agreed with studies on triploid *O. niloticus* carried out by (Brämick *et al.*, 1995 and Hussain *et al.*, 1995), channel catfish (Wolters *et al.*, 1982), tench *Tinca tinca* (Flajshans *et al.*, 1993), common carp (Cherfas *et al.*, 1994), Sydney rock oysters (Nell *et al.*, 1995) and Atlantic salmon (Galbreath and Thorgaard, 1995). It seems that breeding activities of fish were responsible for decreasing the growth in diploid compared with triploid *O. niloticus*. On the other hand Puckhaber and Hörstgen-Schwark (1996) indicated that triploids *O. niloticus* showed poorer growth performance than diploids

Table (1) also show that triploid *O. niloticus* had the longest bodies compared with diploids with significant differences between the two groups in some studied ages of this experiment and this trend was also observed for condition factor and body depth. Hussian *et al.*, (1996) reported insignificant length differences between triploids and diploids of *O. niloticus*.

Galbreath and Thorgaard, (1995) stated that, condition factor was greater for diploid Atlantic salmon than triploid. On the other hand, Hussain *et al.*, (1995) found that condition factor (K) of triploid *O. niloticus* female was higher compared with diploid females. Also Johnson *et al.*, (1986) found that there were no significant differences between triploid and diploid coho salmon in body length, body weight and condition factor.

### **Growth traits**

Sterile fish may convert a greater part of the nutrients absorbed on body weight gain and therefore may attain a higher growth rate and more efficient feed conversion compared with the diploid ones.



As described in table (2) triploid *O. niloticus* had higher daily gain, specific growth rate compared with diploids at most studied ages and these results are not in agreement with that obtained by Hussain et al., (1995), Brämick et al., (1995) Galbreath and Thorgaard (1995) found non significant differences between diploids and triploids of *O. niloticus* in regard to growth rate.

### **Feed conversion ratio**

Table (2) shows that feed conversion ratio had no clear trend for diploids and triploids *O. niloticus*. Feed conversion ratio was better for triploids at some studied ages, while diploids had better feed conversion ratio at the other ages. Cassani and Caton (1986) stated insignificant differences between triploids and diploids grass carp in regard to feed conversion ratio. Also Henken et al., (1987) found that diploids and triploids of African catfish, *Clarias gariepinus* converted their feed with similar efficiency.

### **Gonadal development**

Gonadal development in triploid *O. niloticus* at the end of the experiment was retarded compared to diploid. In triploids of both sexes average gonads (expressed as **GSI**) were smaller than diploids with significant differences between the two ploidy groups (Table 3).

GSI of triploid males is 0.59 compared to 0.84 for diploid males and 1.03 compared to 4.64 for triploid and diploid females, respectively. The large values in females may be due to the large weight of ovaries compared to spermatocystes. Similar findings have been reported for tilapia by Brämick et al., (1995), Hussain et al., (1995) Hussain et al., (1996) and Puckhaber and Hörstgen-Schwark (1996) and for other fish species, Cyprinid loach, *Misgurnus anguillicaudatus* (Suzuki et al., 1985), Coho salmon, *Oncorhynchus kisutch* (Johnson et al., 1986), African catfish, *Clarias gariepinus* (Henken et al., 1987), white crappies, *Pomoxis annularis* (Parsons, 1993), tench, *Tinca tinca*

(Flajshans *et al.*, 1993) and Atlantic salmon (Galbreath and Thorgaard, 1995).

The results of 6 different crosses between triploid males and normal diploid females show that triploid spermatozoa were unable to fertilize the eggs obtained from diploids females and the same result also obtained when the eggs from triploids female were used to be fertilized by spermatozoa normal diploid males. Therefore, this experiment had confirmed that both female and male triploid *O. niloticus* were functionally and reproductively sterile. Such reproductive sterility in mixed-sex culture of *Oreochromis* species would improve production by preventing precocious sexual maturation, particularly in ponds.

#### **Hepatosomatic index (HSI)**

HSI of triploid males were larger than that of diploids with significant differences between the two groups (Table 3) but the HSI of triploid females were smaller than that of diploids but the differences were not significant (table 3). Similar findings have been reported for coho salmon, *Oncorhynchus kisutch* (Johnson *et al.*, 1986) but for *O. niloticus*, Hussian *et al.*, (1995) found insignificant differences between triploids and diploids males and females *O. niloticus* for HSI.

#### **Carcass traits**

Analysis of fish carcass traits at the end of this experiment (table 3) showed that triploids *O. niloticus* had higher percentages of dressing, viscera and by-products and lower percentage of flesh as compared with that obtained from the diploid fish. These results are not in agreement with that obtained by Galbreath and Thorgaard (1995), they reported that the dress-out percentage of diploids Atlantic salmon were significantly did not differ from that obtained from triploid fish. Also Hussian *et al.*, (1996) reported insignificant differences between diploids and triploids *O. niloticus* in the percentage of dress-out and gut weight. On the other hand Henken *et al.*, (1987) found that triploid African

catfish *Clarias gariepinus* had higher gutted weight compared with diploids fish.

Percentages of viscera and by-products were higher in bodies of triploids compared with diploids. Higher percentages were caused by accumulation of more fat around viscera of sterile triploids. Due to fish sterility, fat had not been mobilized for egg and spermatozoa production. A similar findings was observed by Hussian et al., (1995) in *O. niloticus*. This suggests that lower energy diets may well be more appropriate for these fish to avoid the build-up of this wasted lipid.

### **Chemical analysis**

Chemical analysis of flesh (table 3) indicated that protein, fat and ash percentages, in flesh of triploids, were higher than in flesh of diploids and the differences between the two ploidy groups were insignificant for protein, fat and ash percentages, but diploids had the higher percentage of moisture compared with for triploid fish and the differences were highly significant (table 3). These results agreed with that obtained by Hussain et al., (1995) with *O. niloticus*.

Chemical analysis of fish by-products (table 3) show that protein and moisture percentages, in by-products of triploids, were higher than in by-products of diploids, while fat and ash percentages show the opposite trend.

This experiment has shown that the use of triploid tilapia may have important benefits for aquaculture and would help to avoid many of the problems associated with the precocious maturity and excessive reproduction display by tilapia in pond conditions. The problems lie with finding economic methods of producing large numbers of triploid tilapia fry particularly as the direct production of triploids using tetraploid females and diploid males, respectively which appears to impossible in *O. niloticus* at the present time (Belay, 1995).

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Table (1): Least square means and standard errors for body measurements of diploid and triploid *O. niloticus*.

Age (month)	Body weight (gm)		Body length (cm)		Condition factor (K)		Body depth (cm)	
	Diploid	triploid	Diploid	triploid	Diploid	triploid	Diploid	Triploid
3	15.9±1.0	16.5±1.0	9.1±0.2	9.4±0.2	1.98±0.04	1.91±0.04	2.9±0.07 b	3.1±0.07 a
3.5	19.9±1.1	21.6±1.1	9.9±0.2	10.0±0.2	2.04±0.02	2.06±0.02	2.9±0.06	3.0±0.07
4	23.9±0.7	24.2±0.7	10.2±0.4	10.2±0.4	2.24±0.04	2.27±0.04	3.3±0.05	3.3±0.06
4.5	36.5±1.7	40.2±1.7	12.1±0.2	12.2±0.2	2.06±0.04	2.14±0.04	3.7±0.07	3.8±0.07
5	50.9±2.3	55.4±2.3	13.2±0.2	13.4±0.2	2.16±0.04 b	2.44±0.04 a	4.3±0.09	4.5±0.09
5.5	64.0±2.8	70.4±2.8	14.1±0.2 b	15.1±0.2 a	2.26±0.07 a	2.06±0.07 b	4.2±0.12 b	4.6±0.12 a
6	84.1±4.9	91.5±4.9	15.8±0.3	15.8±0.3	2.04±0.03 b	2.25±0.03 a	4.8±0.11 b	5.3±0.11 a
6.5	104.6±0.7	118.5±0.7	16.4±0.3 b	17.4±0.3 a	2.26±0.03 a	2.08±0.03 b	5.5±0.13	5.6±0.13
7	121.2±7.2	138.1±7.2	17.7±0.3	18.5±0.3	2.07±0.03	2.10±0.03	5.6±0.14	5.9±0.14

Table (2): Growth traits of diploid and triploid *O. niloticus*.

Age (month)	Daily gain (gm)		Specific growth rate		Feed conversion ratio	
	Diploid	triploid	Diploid	triploid	Diploid	Triploid
3.0-3.5	0.27	0.34	1.50	1.80	1.75	1.45
3.5-4.0	0.27	0.17	1.22	0.76	2.22	3.85
4.0-4.5	0.84	1.07	2.82	3.38	0.85	0.68
4.5-5.0	0.96	1.01	2.22	2.14	1.37	1.19
5.0-5.5	0.87	1.00	1.53	1.60	1.75	1.67
5.5-6.0	1.34	1.41	1.82	1.75	1.43	1.49
6.0-6.5	1.23	1.80	1.33	1.72	2.04	1.52
6.5-7.0	1.24	1.31	1.11	1.02	2.50	2.70



Table (3): Reproduction traits, carcass traits and chemical analysis of diploid and triploid *O. niloticus*.

Variable	Diploids		Triploids		P
	N	Mean $\pm$ SE	N	Mean $\pm$ SE	
GSI (male)	20	0.84 $\pm$ 0.06	20	0.59 $\pm$ 0.06	0.005
GSI (female)	20	4.64 $\pm$ 0.21	20	1.03 $\pm$ 0.21	0.001
HSI (male)	20	2.03 $\pm$ 0.19	20	3.02 $\pm$ 0.19	0.001
HSI (Female)	20	2.70 $\pm$ 0.11	20	2.51 $\pm$ 0.11	0.234
<u>Carcass traits:</u>					
Dressing %	20	51.68 $\pm$ 0.79	20	53.01 $\pm$ 0.79	0.239
Flesh %	20	35.94 $\pm$ 0.62	20	34.12 $\pm$ 0.62	0.045
Viscera %	20	7.08 $\pm$ 0.37	20	7.36 $\pm$ 0.37	0.607
By-products %	20	61.46 $\pm$ 0.90	20	62.36 $\pm$ 0.90	0.472
<u>Chemical analysis</u>					
<u>Flesh</u>					
Moisture%	20	77.10 $\pm$ 0.43	20	75.42 $\pm$ 0.43	0.009
Protein%	20	63.62 $\pm$ 1.03	20	64.96 $\pm$ 1.03	0.366
Fat%	20	10.62 $\pm$ 0.52	20	11.16 $\pm$ 0.52	0.468
Ash%	20	6.85 $\pm$ 0.53	20	7.14 $\pm$ 0.53	0.700
<u>By-products</u>					
Moisture%	20	66.67 $\pm$ 1.11	20	63.09 $\pm$ 1.11	0.028
Protein%	20	37.17 $\pm$ 1.23	20	35.45 $\pm$ 1.23	0.329
Fat%	20	31.23 $\pm$ 0.94	20	32.27 $\pm$ 0.94	0.438
Ash%	20	21.55 $\pm$ 0.38	20	21.83 $\pm$ 0.38	0.610

## تأثير إنتاج أسماك ثلاثية المجموعات الكروموسومية على النضج الجنسي وصفات النمو لأسماك البلطي النيلي

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أجريت هذه التجربة فى الفترة من إبريل ١٩٩٧ وحتى ديسمبر ١٩٩٧ وذلك بمعهد رعاية ووراثة الحيوان-جامعة جوتنجن-ألمانيا وذلك بهدف إجراء مقارنة لصفات النمو والنضج الجنسي وصفات الذبيحة وكذلك التحليل الكيمائى لأسماك البلطي النيلي ثنائية وثلاثية المجموعات الكروموسومية (٢،٣ ن على التوالى). ولذلك فقد أخذت عينات عشوائية من هذه الأسماك (٥٠ سمكة من كل مجموعة) بفواصل زمنى أسبوعين وذلك لقياس بعض مقاييس الجسم وصفات النمو بالإضافة إلى دراسة مكونات الذبيحة والتركييب الكيمائى لهذه الأسماك وكانت أهم النتائج المتحصل عليها من هذه التجربة مايلى:

١- أعطت الأسماك ثلاثية المجموعات الكروموسومية (٣ ن) أوزان وأطوال الجسم أكبر من تلك التى أعطتها الأسماك العادية (٢ ن) وذلك من الشهر الثالث وحتى الشهر السابع من التجربة وكانت الفروق بين المجموعتين فروقاً معنوية بالنسبة لطول الجسم. وقد حصلنا على نفس الإتجاه بالنسبة للصفات الأخرى مثل معامل الظروف، عمق الجسم، الزيادة اليومية فى وزن الجسم وكذلك بالنسبة لمعدل النمو النسبى ومعدل التحويل الغذائى الذى كان أفضل بالنسبة للأسماك ثلاثية المجموعات الكروموسومية مقارنة بمجموعة المقارنة الغير معاملة (الكنترول) عند جميع فترات التجربة.

٢- فى نهاية التجربة تم حساب دليل وزن الغدد الجنسية (GSI) (وذلك بحساب النسبة المئوية لوزن الغدد الجنسية لكلاً من الذكور والإناث بالنسبة لوزن الجسم) وكذلك دليل وزن الكبد (HSI) (وذلك بحساب النسبة المئوية لوزن الكبد لكلاً من الذكور والإناث بالنسبة لوزن الجسم) وقد أظهرت النتائج أن ذكور وإناث الأسماك المعاملة (٣ ن) كان لها GSI أقل من مجموعة الكونترول (٢ ن) بينما كان ال HSI أكبر فى هذه المجموعة مقارنة بمجموعة الكونترول وقد كانت الفروق بين المجموعتين فروقاً معنوية.

٣- أظهرت نتائج تحليل الذبيحة أن ذبائح الأسماك المعاملة (٣ ن) قد أحتوت على نسب عالية للذبيحة والأجزاء الغير مأكولة من الذبيحة ونسب أقل للحم مقارنة بالكونترول (٢ ن).

٤- كما وجد كذلك أن نسبة البروتين والدهن والرماد فى لحوم الأسماك المعاملة (٣ ن) كانت أكبر من مثيلتها الموجودة فى مجموعة المقارنة. أما بالنسبة للأجزاء الغير مأكولة من هذه الذبائح فقد أحتوت على نسب أكبر من الدهن والرماد والرماد ونسب أقل من البروتين الخام والرطوبة مقارنة بالأسماك الغير معاملة (٢ ن).