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Effects of two pressed and extruded foods on the pigmentation of the flesh and filleting yield of rainbow trout (Oncorhynchus mykiss)

Authors:
Mustapha ABA[1], Belghyti Driss [1], Elkharrim khadija[1], Benabid Mohammed[2].

Institution:
1. Biology and Health Laboratory. Environmental and Parasitology Team / UFR Doctoral Parasitology compared: Medical and Veterinary Applications." Sciences Faculty. Ibn Tofail University. Kénitra B.P. 133, 14000. Morocco.

2. National Center of Hydrobiology and Pisciculture (NCHP) Azrou Morocco.

Corresponding author:
Mustapha ABA.

Email:
aba_mustapha@yahoo.fr.

Phone No:
212661570488.

Web Address:
http://jresearchbiology.com/Documents/RA0201.pdf.

ABSTRACT:

In order to compare the pigmentation of meat thread of rainbow trout Oncorhynchus mykiss, double pressed and extruded foods, an experimental test was conducted in a fish farm. Comparison of two different formulation of food and energy are performed in different energy requirements. Following this study two plans were formulated that extruded with 42% crude protein, 28% fat and 17% carbohydrate and 50 ppm of astaxanthin while pressed and 44.7% crude protein, 15% fat, 28.6 carbohydrate and 40 ppm of canthaxanthin with 20.9 MJ of digestible energy 16.48 MJ and the initial average weight of trout with 474 g higher in two circular tanks of fresh water open circuit, each group was fed twice a day. After 60 days of experimentation the average weight for the final extruded feed was 759 g (60.12% weight gain) and pressed for the 724 g (52.74%). The best conversion rate was obtained with the feed extruded with1.17 against 1.56 with a survival rate of 98.85% and respectively 97.72%.While for the pigmentation of the skin it was obtained at using the scale of Salmofan 26,46 and 23,35 for the extruded and pressed respectively .Filleting yield was 65.14% for the extruted diet and 60.64% for the pressed diet.

Keywords:

Pelleted, extruted, nutrition,pigmentation,carotenoids, fillet yeild.

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INTRODUCTION

Diet plays a major role on the nutritional quality and taste of the flesh of fish.One of the strengths of farmed fish is the quality control (Regost 2001), and increasing the fat content of foods,that is followed by a decrease in the ratio protein / digestible energy food which, leads to improved growth performance and reduced nitrogen discharges. (Corraze 1999, Aba 2011).

A special feature of aquaculture in relation to fishing is that it is possible to obtain some control over the quality of fish meat for consumption through the diet (Kolditz 2008). Numerous studies have shown that the composition of the food and its energy content directly affect the body composition of fish (Medale 2010, Kolditz 2008, Aba 2011). The quality of farmed fish includes both the ability to transform in particular the notions of performance gutting, filleting (Regost 2001) but also one of the qualities of the flesh of fish fillet; pigmentation considered by the consumer as a factor in visual quality (Choubert 1999), the color of the net is one of the most important factors motivating purchase and acceptability of a product by the consumer (Buttle *et al*., 2001; Baker and Gunther, 2004, Liu et al., 2004).

The setting of carotenoid pigments in fish is dependent on many factors among these factors that there is a food. The fish are not able to synthesize carotenoids de novo and must therefore be found in their diet. (Choubert 1999).

This pigmentation is due to food-borne carotenoids, mainly astaxanthin and canthaxanthin (Torrisenet and al., 1989), these compounds are added to feed the fish and the synthesis of carotenoids supplementation increases the cost of the food about 15% to 20% (Choubert 1999). Carotenoids are classified according to a color scale based on differences in astaxanthin, which gives a pink red and canthaxanthin, which gives more of a yellow color (Knockaert, 2006). Therefore, the color of the fish is a decisive quality criterion that must be maintained and optimized. Carotenoids can not only help improve quality by improving the color, but could also contribute to a better image in the minds of consumers of aquaculture products. In addition to their role pigmentosa, these compounds may have biological activities, some of which are fundamental precursor of vitamin A, antioxidant or immuno-stimulating (Choubert and al., 2006), but most research conducted to date have focused on their role as pigments.

Several factors may affect the pigmentation of salmonids, including fish size, the genetic factors sex, age, time to Pigment supplementation, food composition, source and concentration of carotenoids. Among them many there are other factors that can influence the pigmentation of the flesh of fish found food composition (Torrissen, 1985).

In addition to the pigmentation of the flesh, the net yield is considered an important quality criterion for aquaculture technology, because fish fillet, as the main edible portion of fish, hold the main economic and nutritional interest of fish production. Increasing fillet yield, without any negative effect on flesh quality, is a major challenge for fish farmers (Bugeon 2010) increased net yield is related to muscle development proportionately higher than other tissues. This muscle development may impact on the quality of the flesh in terms of composition in addition to the technological quality leading to the return on gutting and filleting as a low cut performance can lead to economic losses (Bugeon, 2006).

It is in this context that this test is performed to compare the effectiveness of two food and extruded and pelleted food , and determine the interaction between these foods their formulation and their effects on the pigmentation of trout fillets by supplementation of carotenoids, and yield of filleting.

MATERIALS AND METHODS

experimental design

The experiment was conducted between April 15, 2009 and June 27, 2009 at the fish farm located about 70 km from Azrou (Morocco). This test was conducted in two circular tanks of 22 m^3 volume at the open circuit with an initial load of 14 kg fed by spring water at a constant temperature of around 14 ° C and a flow rate of 30 m^3 h-1 , with a time of renewal of water 1.4 times per hour with oxygen levels above 80% saturation. The average content of dissolved oxygen in the outlet of the ponds was 7.1 ppm.

biological materials

1400 juvenile trout females triploid of average weight 474 g from the same batch of eggs were divided randomly into two circular tanks. The test was conducted in monoculture, fish were fed manually and the daily ration was split into two meals distributed at 09 AM and 03 PM, for 60 days, according to the feeding table provided by the supplier of food (71 Ecolife of Biomar). Every two weeks 30 fish of each batch have been anesthetized after 24 h of fasting in order to measure the size and the weight of each fish .for measurements of weight and size.The quantities of food distributed were weighed to estimate the consumption by the fish between two weighings.

experimental foods

Formulation and chemical composition of experimental diets are shown in **Table 1a,1b and 2. food composition**

The rate of feeding

The experimental test was aimed at comparing two non-isoenergetic foods to different formulations on their growth performance of fish, and their flesh quality in isoenergetic condition. The amount of food distributed is consistent with the feeding tables of extruded and pressed foods that have different digestible energy 20.90 Mj ,16.48 Mj, respectively. These rates of rationing depends on the temperature of the water colsely of the site, we have set the rates according to the temperature of the site which is about 14 ° so that the quantitative ratio for the same food energy intake is: amount of food extruded 1.27 = amount of pressed food (or amount of food extruded 0.78 = amount of pelleted food). Gross energy was calculated using the following values: crude protein = 23.7 kJ g-1, crude lipids = 39.5 kJ g-1 and carbohydrate = 17.2 kJ g-1 proposed by Brett and Groves (1979). The calculation of digestible energy is obtained by the coefficient of digestibility of protein, fat and carbohydrates gelatinized or raw (Guillaume et al., 2001).

Body Measurements

Body mass, length, and organ mass were recorded to evaluate the condition factor (CF) = [total body weight (g)] / [total body length (cm)]^3 ;

Table 1a : Ingredient and proximate compositions (g/100 g dry matter) of the truted diets

Ingrédients	Extruted diet
Fish meal	30%
Soybean meal	15%
Rapeseed oil	12%
Fish oil	10%
soy concentrate	8%
wheat	6%
Rapeseed meal	6%
Krill meal	5%
Vitamin A - (UI/kg)	5000
Vitamin D3 –(UI/Kg)	1000
Vitamin E - (mg/kg)	180
Vitamin C - (mg/kg)	100
Astaxanthin	50 ppm
ashes	7%

Table 1b : Ingredient and proximate compositions (g/100 g dry matter) of the pelleted diet.

Ingrédients	Pressed diet
Fish meal	41,5%
Fish oil	11,5%
Corn gluten	15%
Wheat Flour	30%
vitamin complex	2%
Cantaxanthin	40 ppm
ashes	6,1%

viscerosomatic index (VSI) = ([viscera weight (g)] / [total body weight (g)] x 100) (Ricker, 1979).

Zootechnical parameters

Calculations: The following variables were calculated:

Weight gain (WG, %) =100 x (final body weight - initial body weight) / initial body weight

Survival(%) =100 x (final amount of fish /initial amount of fish)

Average daily growth (g) = (final wt – initial wt) /no. of days

Feed conversion ratio (FCR) = g feed consumption/ (g final biomass –initial biomass).

Specific Growth Rate (SGR) = 100 (Ln final weight (g) - Ln initial weight (g)) / time (days).

Chemical analysis

Crude protein, crude fat and ash were determined from the ventral muscle, according to AOAC (1990).

Eight fillets of final fish carcasses and muscles were sampled and stored at -25°C for proximate analyses,which were performed according to AOAC. Dry matter was determined after drying at 105°C until a constant weight was obtained. Ash content was measured by incineration in a muffle furnace at 525 °C for 12 h. Crude protein was analyzed by the Kjeldahl method after acid digestion using the Gerhardt system. Lipid was determined by folch method (1957)

Table 2 : Proximate composition of diets (%)

	Extruted diet	Pressed diet
Dry matter	96 %	93,2 %
Protéins	42%	44.7 %
Lipids	28%	15 %
carbohydrates	17%	28.6 %
Fiber	2 %	2 %
Ash	6 %	6,1 %
Moisture	4 %	6.80 %
phosphorus	1 %	1,15 %
Gross Energy (GE, Mj Kg^{-1})	24,28	21,58
Digestible energy (DE, MJ Kg^{-1})	20,90	16,48
DP / DE (g MJ^{-1}) (DP:Digestible Prtoein)	18,08	24,41
Ratio P /L	42/28	44,7/15

Technical Variables

- Pigmentation of the flesh was done by the use of scale rock SalmoFan

The perceived color of the nets was determined on fresh fillets in the processing plant using the color scale, the SalmoFan (F. Hoffman-La Roche Ltd, Basel, Switzerland). Three people have made separate determinations for each fillet in natural light.

- Fillet yield was calculated as F%=(Fw/Bw) ×100, where Fw was the fillet weight and Bw was the body weight in grams.

Statistical studies

Our results are compared statistically (R Development Core Team, 2011). All parameters of growth and yield were subjected to analysis of variance test (ANOVA). The results were subjected to analysis of variance and any differences were estimated by the Duncan test (1955) at the 0.05 level.

RESULTS

Our experimental test showed that the performance of zootechnical parameters vary significantly ($p < 0.05$) between the two dietary treatments **(Table 3).** Indeed the final weights of fish are between 724 and 759 g for diets extruded and pressed . Duncan's test showed a significant difference between the final weights ($p<0.05$). The percentage weight gain was 52.74 for the pelleted food, where as it was 60.12 for extruded feed. There it showed a significant difference between the two values of the two systems ($p<0.05$). The TCS was calculated as 0.7% for fish fed with the diet in a pressed feed and 0.8% for the extruded diet, there was a significant difference ($p<0.05$) between these results. The VI was 7.88 for the pressed food and 10.29 for the extruted food.The survival rate was 97.72% for pelleted food and 98.85% for the extruded food the difference between the two groups was not significant. The rainbow trout fed with extruded feeds had high levels of lipid in

Table 3 : Results of Rainbow trout performances obtained during this experimental test

Paramèters	Pelleted diet	Extruted diet
Initial average weight (g)	474	474
Final average weight (g)	724[a]	759[b]
Weight gain (%)	52,74[a]	60,12[b]
Specific growth rate (%)	0,7[a]	0,8[b]
Feed conversion ratio	1,56[b]	1,07[a]
Viscerosomatic index	9,58[a]	10,99[b]
Survival (%)	97,72	98,85

fillet compared with rainbow trout fed with pelleted feeds ($p<0.05$). The pigmentation of the fish fillet differ ($p<0.05$) among fish fed with extruded and pelleted feeds.The yield to evisceartion was 90,58 for pelleted food and 89,61 for extruted food , the difference between two diets were significant.The filleting yield was 60,64 for the pelleted diet ,where as it was65,14 forthe extruted diet ($p<0.05$).

DISCUSSION

Increasing the level of digestible energy in fish feed incorporating a rate well digestible carbohydrates by the extrusion treatment (Kaushik, 2000) and a high rate of fat has resulted in improved animal performance. More over, this diet is a nutritional strategy applied to get a savings of protein without compromising the growth of trout (Cho & Bureau 2001). This sparing effect by supplementation of fat and carbohydrates has been well demonstrated for salmonids and sea bass (Watanabe, 1982, Dias et al. 1998; Torstensen et al., 2001, Aba 2011), perch Scortum barcoo Song and al., (2009) relates the value of the digestible energy and digestible protein levels, any decrease in the ratio PD / ED has a direct impact on the retention of proteins that is becoming more efficient, or the food pressed is characterized by a ratio of PD / ED high, this is found in the trout food poor performance (Aba and al, 2011) given that in salmonids, the optimal PD / ED in the order of 17-18mg/kJ (Kaushik, 1997), which is lower when compared with that of later recommended 22-24mg/kJ value (Cowey, 1992).

The growth observed in this study represented by the weight gain are comparable to those obtained by Pfeffer and al. (1991) and those reported by Pokniak (1999). These results are consistent with those reported by Zoccarato and al. (1996). With their experimental work concerning the trout, the pressed and extruded foods, the extruded food is high in fat, thus provides more energy than the pressed food.

Similar results were observed in the silver perch (silver perch Bidyanus bidyanus) by Booth (2002) and in the Nile tilapia (Oreochromis niloticus) by Ammar (2008) whose body weight has been a big success win with the extruded food compared to food in a hurry. Guroy (2006) work on the sea bass (Dicentrarchus labrax) with isoenergetic diets for pressed and extruded was observed its weight and better performance of the IVS to extruded food

In addition, we can say that the diet can be extruded to have a greater incorporation of lipids, which probably increased by the IVS increased visceral fat,which is seen in the viscera that there are more deposition of fat in the rainbow trout (Corraze, 1999, Richard, 2006; Kolditz, 2008; Medale, 2009) and IV obtained in this study is almost consistent with the results of Gelineau (2001).

The increase in dietary energy intake (via the amount of food distributed or the energy content of food) leads, in almost all species, with an increase in body fat accompanied by a decrease in water content (Dias, 1998, Corraze and Kaushik, 1999, Medale 2010, Aba 2011),

Table 4 : Results of Rainbow trout technical variables obtained during this experimental test

Paramètres	Total lipid content of fillet	Pigmentation Scale of Salmofan	Yield to evisceration	Filleting yield
Aliment pressé	5,58[a]	23,35[a]	90,58%	60,64 %[a]
Aliment extrudé	8,35[b]	26,46[b]	89,61%	65,14 %[b]

this lipid accumulation in fish has been obtained in several species of fish such as rainbow trout (Caballero et al, 2002. Chaiyapechara et al, 2003), sea bass (the Pirin and Gatta, 2000) and Atlantic salmon (Hamre, 1998). The results obtained in this trial are consistent with those obtained by Quillet et al (2007).

Salmonid pigmentation by carotenoids are affected by the dietary source of pigments, the rate of pigments, length of farming and food composition. Bjerkeng (2001) found that the food composition may be related to the manufacturing technology of the food that can lead to a food pressed or extruded above the pigmentation of trout fillets which has a close relationship with the lipid in food as food extrusion can incorporate more fat (Aba et al., 2011) this increase in dietary fat causes an increase in muscle lipid content and increased color of the fillets. As a triploid trout , the pigmentation will have impact on the nets and skin color (Choubert 1999). During this test we obtained the best pigment for the food extrusion since it contains high levels of fat. Several studies have shown that it is possible to increase the determination of carotenoids in the muscles of salmonids by altering the level of dietary lipids (Torrissen, 1989, Nickell and Bromage, 1998 (a) Barbosa et al., 1999). And as the carotenoids are fat-soluble compounds, their absorption and digestibility are related to the lipid content of the food (Choubert, 1999; Bronstad and al., 2002). Moreover, the binding of astaxanthin is better by compared to canthaxanthin. This difference is attributed to better absorption of astaxanthin in rainbow trout Rainbow (Torrissen,1989, Choubert 1999).

Similar results were observed in the same fish (Nickell and Bromage, 1998; Choubert and Baccaunaud, 2006) and in Atlantic salmon (Bjerkeng et al. 1997; Bencze Rora, 1998; Einen and Thomassen, 1998) in brown trout (Salmo trutta) (Regost et al., 2001). Rainbow trout uses astaxanthin more efficiently than canthaxanthin and astaxanthin is more stable during and after processing of the product, and these results are consistent with those of Torrissen (1986, 1989), and No (1992) and (Baker et al., 2002). the effectiveness of astaxanthin is related to its high digestibility of up to 60% while than that of canthaxanthin, it is only 30%. According to Choubert (1999), in addition to the most effective dose for optimal retention of dietary pigments in Atlantic salmon 40-60 mg/kg of astaxanthin, rainbow trout in fresh water level ranged from 50 to 70 mg / kg of astaxanthinand this is consistent with our results.(Nickell and Springate, 2001)

For yielding we noticed that the technological performance of evisceration is almost 90% for the two foods but yield to evisceration of the pelleted food is squeezed slightly higher compared to that of the extruded and this can not be explained by the large deposits of fat in the viscera in trout fed the feed extruded (Medale, 2009) and our results are consistent with those of Quillet (2007). While for the filleting yield there is an increased performance for the extruded diet, it is governed by a better retention of protein due to the low ratio of digestible protein / digestible energy by the high rate of fat found in food extruded and subsequently the protein / lipid. This decreases when the protein sparing effect and subsequently a better retention of proteins resulting in better optimization of the use of proteins (Lee and Kim 2001) and a better yield to the thread and our results are in agreement with those obtained by caballero et al (2002) and De Francesco and al (2004).

CONCLUSION

The mastery (control) of growth performance and pigmentation of fish and technological performance are related to the composition of the food and its method of manufacture. The extruted feed offers the best trout growth performance by its energy content, buoyancy, digestibility and digestible protein ratio / digestible energy and non-protein energy level factor. In intensive fish farming using extruded diets despite their price can be justified by the savings resulted from their feeding efficiency through better conversion and their contribution to sustainable aquaculture. In addition to feeding efficiency extruded food also contribute to improve the quality of fish through improved pigmentation which is closely related to the lipid content in the food and also by a better performance due to thread better retention and better protein fat content that allows a more attractive pigmentation of the net of the rainbow trout.

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