

Evaluation of the three diets of different biochemical compositions on the zootechnical performances of the rainbow trout (*Onchorynchys Mykiss walbaum, 1792*) and their impact on the water of the Oum Er-Rbia River (Morocco)

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Abstract— In order to compare the effects of three types of extruded foods (A, B and C) on the growth of rainbow trout, an experimental test was conducted on June 15, 2015 at the Oum Er Rbia Fish, Morocco.

The comparison of three foods of different composition and energy is performed in isoenergetic condition. In this study, three extruded foods were tested: food A with 39% protein, 27% fat and 19.2 MJ / kg, food B with 41% protein, 24% fat and 20 MJ / Kg and food C with 40% protein, 26 fat and 19 MJ / Kg. The initial trout weight was ± 40 g bred in six freshwater basins with twice-per-hour renewal.

Fish were raised under the same conditions of breeding at a density of 1.58 kg / m³ and a load of 1.04 m³ / h. Each group was fed twice a day after 222 days of experimentation. The final weight of three foods A, B and C was 803.14g, 1043.9g and 942.1g.

Results showed that the best performances of growth are obtained by food B with a final weight of 1043.9g.

The biochemical composition, the origin of the raw material used in the feed and the formulation of the three extruded feeds had an influence on the growth performance of the rainbow trout. Outlet water from magnification basins does not show any pollution of the aquatic environment.

Keywords— Foods, Biochemical composition, Performances, Rainbow trout, Environment, Morocco.

I. INTRODUCTION

Recently, fish food took an important place in the world market. It's one of the most desired foods in human

alimentation. In this case and to ensure a sustainable control of the production phase of salmonids, it becomes necessary to optimize the nutrition of this species and to maintain a high quality of the final product in order to meet the customers' requirements.

In fish farms, it's possible to control the breeding parameters for the enhancement of aquaculture production. Such as environmental conditions (temperature, water flow, quality of the environment, etc.), biochemical composition of food (protein, lipids, carbohydrates, etc.) and water quality (ammoniacal nitrogen, phosphorus, suspended matter).

Feeding represents 40 to 60% of the production costs of farmed fish. Its composition must contain high levels of fish meal as the main source of protein, an essential component of artificial fish feeding (NRC, 1993). Foods must be rich in protein (47 to 50% protein). As main ingredient, Fish meal contains 70% of protein. This composition is ideal to cover the fish needs.

Lipids present an important nutrient for rainbow trout (Médale et al. 1991). It requires high levels of lipids in foods without affecting their digestibility (Refsstie and Austreng 1981; Choubert et al. 1991; Berge and Storebakken 1991).

In contrast, the introduction of carbohydrates into trout diet induces prolonged hyperglycemia and decreased growth (ANR, 2008).

The objective of this study is to compare the effect of three extruded foods on the growth performance of rainbow trout. This will allow determining the food that

has a positive effect on the growth performances of rainbow trout. Additionally, it will permit to evaluate the digestibility of this specie in order to limit and optimize fish releases and to adopt a sustainable aquaculture that respects the environment.

For economic and ecological reasons, this comparative test of three foods made it possible to remember that the food B had a better zootechnical and low performance with fewer fish releases (Ouaisa et al. 2007).

II. MATERIAL AND METHODS

a. Experimental study

The experiment was carried out on June 15, 2015 at the Oum Er Rbia Fish Farm (Morocco). Growth basins are fed by spring water at 14°C renewed every half hour (48 times /days) with high level of oxygen (more than 90 % saturation).

4574 Trout, of average weight of 40 g, were sampled from the same batch of eggs and divided randomly into

six tanks. The test was carried out in monoculture and the fish were fed manually with a determined daily ration.

Every 15 days, 90 fish (according to Student's law) are captured from each basin, being fasted for 24 hours and then anesthetized to measure the size and the weight of each fish, weight gain (WG), feed conversion ratio (FCR), specific growth ratio (SGR) and factor condition (K). The distributed foods were weighted to estimate the consumption by the fish between two successive sampling.

b. Experimental foods

To investigate about the evolution of the individual weight of the fish, we used three types of foods corresponding to their development cycle and magnification (with 3, 4.5 and 7 mm in diameter).

c. Composition of three foods extruded

Table.1 bellow shows the biochemical composition of the three studied foods (A, B and C) in (%).

Table 1. The biochemical composition of the three studied foods (the different food diameters).

Type of foods	A			B			C		
	3mm	4.5mm	7mm	3mm	4.5mm	7mm	3mm	4.5mm	7mm
Food diameter	3mm	4.5mm	7mm	3mm	4.5mm	7mm	3mm	4.5mm	7mm
Protein (%)	40	39	39	45	43	41	46	45	40
Lipid (%)	23	27	27	20	22	24	20	24	26
NFE (%)	21	18.2	18.2	20	20.7	20.5	15	14	13
Cellulose (%)	2.25	1.86	1.8	1.9	1.9	2.3	1	1	1
Ash (%)	7.20	6.77	6	8.1	7.4	7.2	10	10	10
Phosphorus (%)	1.05	0.98	0.9	1	1	1	1.5	1.5	1.40
Digestible energy(Mj/kg)	19.2	20.2	20.2	20	20.3	20.6	19	19.90	20.50
Digestible protein/Digestible energy (g/MJ)	19	17.5	17.5	-	-	-	22.30	22.30	17.60
Vitamin A (UI.kg)	10000	10000	10000	10000	10000	10000	10000	10000	10000
Vitamin D3 (UI.kg)	1750	1750	1750	1000	1000	1000	1850	1850	1850
Vitamin E (UI.kg)	200	200	200	200	200	200	200	200	200
Vitamin C (UI.kg)	150	150	150	-	-	-	180	180	180

Table .2 show the zootechnical performances studied for the growth of the rainbow trout

Table.2: Parameters of zoo-technical performances studies

Parameters	Formulas	Unit
Weight gain. (Cren ,1947)	$WG = \text{final body weight(g)} - \text{initial body weight(g)}$	(g)
Specific Growth Rate. (Brett et al., 1969)	$SGR = \frac{\{\ln(\text{Final weight}) - \ln(\text{Initial Weight})\} * 100}{\text{Duration of experience}}$	(%)
Feed Conversion Rate (Bellet ,1977)	$FCR = \frac{\text{Amount of food ingested}}{\text{Weight gain}}$	Without unit
Condition Factor (k) (Tesch ,1971)	$K = \frac{10^5 * \text{Weight}}{\text{Size}^3}$	Without unit

d. Analysis of fish releases

Physical and chemical parameters of water

To estimate the outflows of nitrogen (NH₄⁺), phosphorus (PO₄³⁻) and suspended matter at the inlet and the outlet of basins, water samples are taken twice per month consecutively. Samples are transported, in a cooler at 4°C and analyzed in the laboratory of the Oum Er-Rbia hydraulic basin agency in Beni-Mellal.

According to AFNOR (1983), Ammonia nitrogen was measured by the acidimetric method after distillation

(NFT90-015) ; orthophosphates by spectrophotometry after mineralization followed by acid hydrolysis (NFT 90-013) and suspended matter by filtration method on fiberglass filter disc (NFT 90-105).

III. RESULTS

The following table presents the zootechnical performances of the three foods (A, B and C) in the three stages of rearing fed by the different food diameters (3mm, 4.5mm and 7mm) obtained during this test.

Table.3: Zootechnical performances of rainbow trout fed with extruded food during the three growth stages.

Settings	A			B			C		
	3mm	4,5mm	7mm	3mm	4,5mm	7mm	3mm	4,5mm	7mm
Initial weight(g)	41.05	192.31	428.4	41.15	192.15	501.1	44.65	180.55	48.95
Final weight(g)	143.28	366.66	803.14	147.22	421,1	1043.9	132.68	402.5	942.1
Specific growth rate (%)	1.7	1.1	1.1	1.7	1,2	1.2	1.6	1.3	1.4
Conversion index	0.8	1.0	1.1	0.8	0.9	0.9	0.9	0.8	0.8
Condition factor	1.2	1.22	1.27	1.27	1.45	1.61	1.08	1.28	1.03

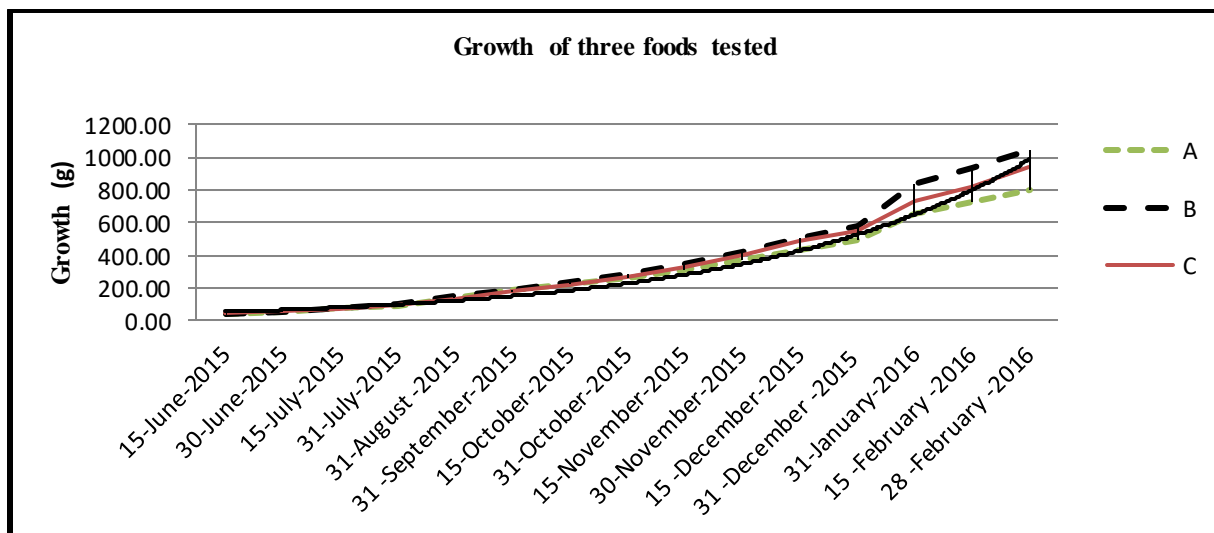


Fig.1: Growth of rainbow trout with the three foods (A, B and C)

During the experiment, the test was carried out under the same conditions of breeding for the three tested foods A, B and C (temperature, oxygen and water flow). Table 3 shows the growth performance of rainbow trout during the experimental period. food B is still the most efficient (weight gain, specific growth rate and daily individual growth). It gives greater growth and better performance compared to the other two tested foods (A and C).

Weight growth has a major impact on production. It reflects the effectiveness of the food in mass production.

For this reason, a regular trout weight measurement was carried out throughout the experimental test.

The graphical representation of the evolution of the average weight of rainbow trout fed by three types of iso-energetic food of different biochemical compositions is shown in table 1.

In term of growth, the results reveal that food B is the most efficient food. Its growth has recorded 1043.9 g compared to foods A (803.14g) and C (942.1g) even if its lipid content is lower than the other two foods A and C.

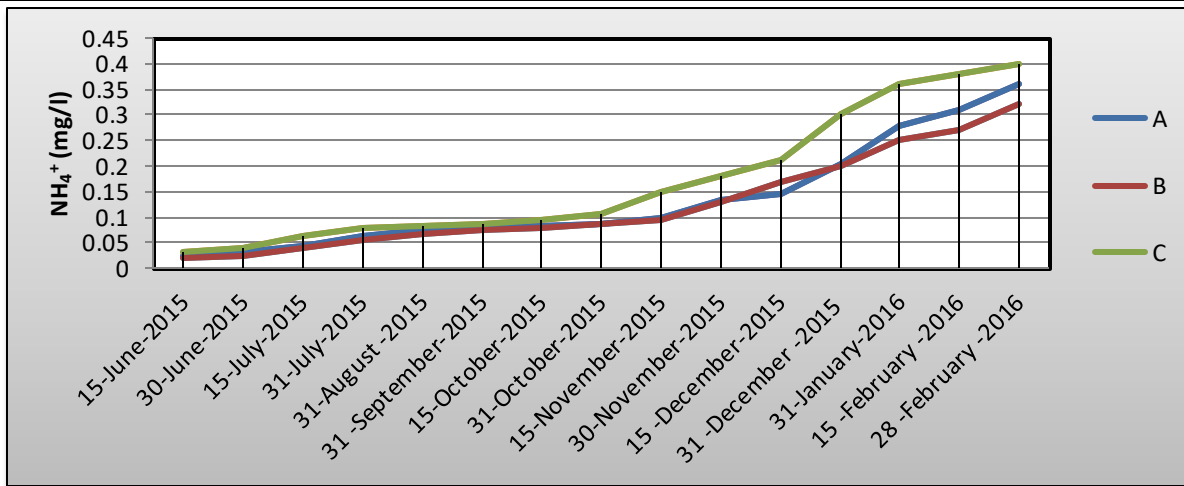


Fig.2: The evolution of rates of nitrogen discharges.

Figure 2 show that the amount of nitrogen discharges increases with exponential production. This is due to the fact that the release of nitrogen is proportional to the quantities of food distributed. However, releases from fish for the three foods tested remain below the 0.5 mg/L standards.

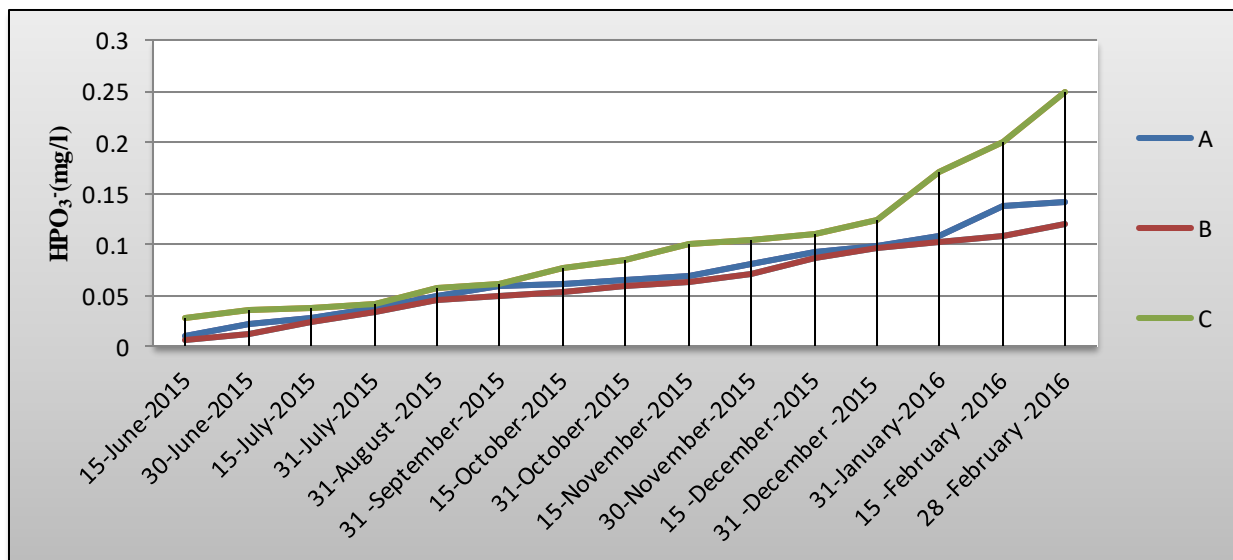


Fig.3: The evolution of rate of phosphorus discharges.

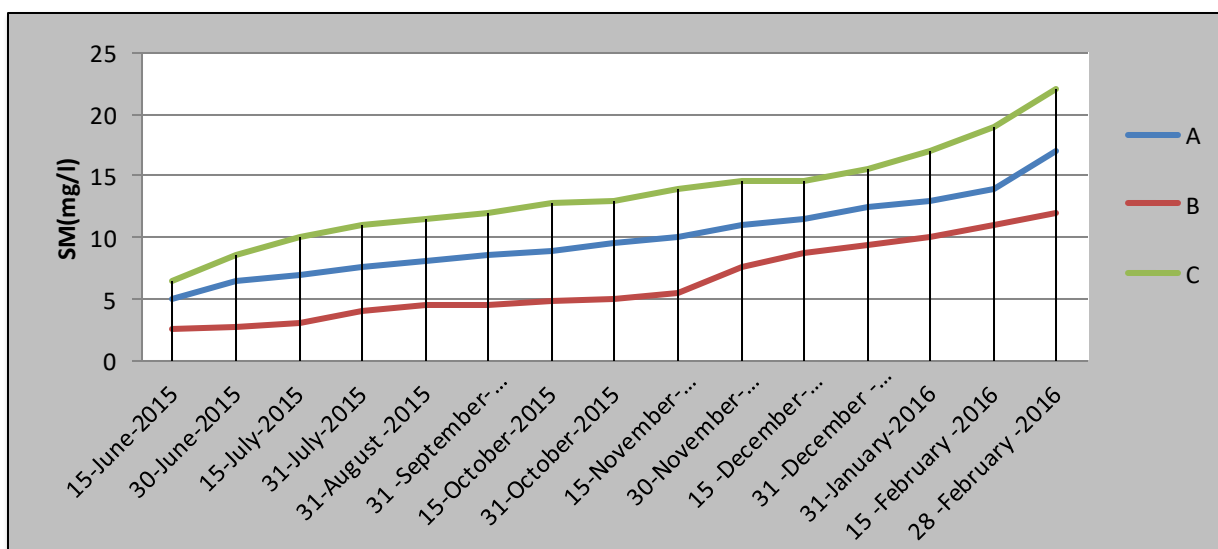


Fig.4: Evolution of suspended matter solids rate.

Figures 2, 3 and 4 presents the results of water analysis at the outlet (Einen and al. 1997) on the bar "*Dicentrarchus labrax*" of basins with the three extruded foods tested. Fish fed with food C and salmonids (Young and al. 1998 ; Dosdat et al. 2003). discharged more nitrogen and phosphate than food A and B.

IV. DISCUSSION

The rainbow trout fish were kept under optimal conditions throughout the trial period, the values obtained for temperature, dissolved oxygen and pH meeting the standards for breeding these fish (Wedemeyer, 1996).

According to this comparative study, the results show that feed B ensures a significant growth of trout fish compared to food A and C. the final weight for food B was 1043.9g, compared to 883.1g for food A and 942.1g for food C.

The extruded food B provided better growth performance compared to food A and C. The highest final average weight values of daily growth rates and feed conversion efficiencies were obtained using diet B.

It was found that growth was also increased by increasing lipid levels in diet C. The final weight of the fish fed by the food B is higher than food C even if they have almost the same protein content (B = 39 % and C = 40%) but with a different lipid content in both diets. Our results are similar to those obtained by (Luquet, 1971) and defined by the preliminary saving.

The results confirm the existence of a feed efficiency; the better growth was recorded for food B (1043.9 g). At the magnification stage, food B contains low fats (24%) compared to food A and C that contain 27% and 26% of lipids, respectively. These results are contradictory to those found by (Chaiyapechara, 2003).

The conversion indexes recorded in this study was $\{CI_b=0.86\}$ and they are comparable to those obtained by (Erika et al. 2007) and those reported by (Brauge et al. 1994) and (Azevedo et al. 2004), whose experiments concern the study of the effect of two extruded foods on the rainbow trout' performances and that reveals a good growth and an efficient food conversion (0.88).

Our results show also that the factor condition (K) is very high in diet B by $\{K_b=1.61\}$, which shows the excellent health status of the fish. This factor explains why the fish undergoing this diet have better growth performances in term of weight and length ratio. On the other hand, for the diet C, the fish had a size performance higher than the weight performances. This can be explained by the richness of the food C by the phosphorus which leads to an important development of skeleton fish fed by food B (Kaushik, 2005).

In the context of sustainable development and the preservation of water resources, aquaculture by their turn acts directly on the environment and preserves water resources. Several studies have been interested on determining the effect of aquaculture on the environment

In open fish farms, nitrogen releases were estimated using the linear relationship between nitrogen in food and nitrogen excreted.

Since the excretion of dissolved substances is linked to the fish metabolism, excretion within the same species remains the same irrespective of the considered breeding (cages, ponds or rearing in recycled water (Pagand, 1999). According to the work of (Kaushik, 1998), it has been observed that as long as the diet is rich in protein, the excretion of ammonia is important. This is not in accord with our results because the food B, which is rich in protein, presents a low concentration of nitrogen in the fish releases.

All the phosphorus required for fish comes from their diet. The phosphorus produced will, therefore, depends on the amount present in the food. Phosphorus can be of animal origin (fish meal), vegetable or mineral. The digestibility of phosphorus varies depending on the species and the origin of the phosphorus.

Based on the results obtained and shown in the figures {1,2 and 3}, it can be said that the extruded food B allows a reduction of fish releases compared to foods A and C, knowing that the food B contains 41% of protein content in the composition (39%) and normally have more releases than the load B at a rate of 0.31 mg / L compared to the nitrogen concentration released by the food B (0.32 mg / L).

Additionally, food C has a high content of suspended solids compared to food A and B, due to the high level of phosphate and nitrogen excreted by fish in test basins.

V. CONCLUSION

This study shows that extruded food is characterized by its energy content, its high digestibility, its best energy digestible / digestible protein ratio and its non-protein energy determining level. This food offers the best growth performance of rainbow trout.

The price of food production is the main factor of production in intensive fish farming. Using extruded diets despite their high price can be justified by their important advantages like:

- Savings resulting from their food efficiency,
- The best feed conversion,
- The reduction of discards,
- The contribution to sustainable aquaculture.

All this requires technical and professional efficiency in the control of food formulation.

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval "This article does not contain any studies with animals performed by any of the authors."

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