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Effects of two food extruded on the growth performance of trout Rainbow (*Oncorhynchus mykiss*) and their environmental impact

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Abstract: The present work concerns a comparative study of two effects extruded foods on the growth performances of trout rainbow (Oncorhynchus mykiss) and their impacts on the environment. Two diets are used: an extruded imported food "Gouessant" (47 % of gross proteins and 20 % of fats) and another extruded food premises "Happy Fish" (45 % of gross proteins and 24 % of fats). For each of both studied food, we used 900 fishes stemming from the same prize of eggs, with average initial weight of 60 g, distributed in 6 conical ponds in fiberglass, fed with fresh water, in open circuit in triplicate. The food is twice brought a day during two months. The best performances of growth and food efficiency are registered at the local extruded food with low ratio PD/ED. Besides the local food HAPPY FISH presents less negative effect on the environment in comparison with to the imported food.

Index terms—: trout Rainbow, growth, efficiency food, environmental impact.

I. INTRODUCTION

Fish are among the group's fauna which have undergone large number of introduction in the wild worldwide [1]. The rainbow trout (*Oncorhynchus mykiss*) is a salmonid native to the West coast of the North American [2,3]. Its physiological plasticity to environmental conditions allowed his introduction in more than 80 countries [4, 5, 6] which Morocco in 1925 [7.8]. Over the last decade, scientific research in the heart of an environmentally sustainable truticole industry has undertaken several studies on the rearing of trout [9]. To the Morocco trout farming is essential for the restocking of rivers and of water bodies where sport fishing is exercised. This activity has a significant impact, both in terms of the protection of the natural environment and socio-economically by fishing tourism development and induced jobs. The quality of the food has a significant impact on production. The choice of the food must be perfectly adapted to the specific conditions of each breeding, the stability of vitamins, the traceability of the components, the absence of toxic products (e.g. heavy metals), the weight gain and feed conversion. This account holding of fish waste (quantity, composition and subsequent treatments). Despite its ecological and socio-economic interest, the rainbow trout remains among the least studied fish in Morocco [10].

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Aware of the economic interest of the Morocco continental fish farming and the importance of fish to the breast of Lake Ecosystems, we were interested in this study to improve fish production both quantitatively and qualitatively. We thus tested the effect of two types of food on the rate of growth in trout Rainbow, on feed conversion and the impact on the environment. We then aimed the proper intervention regarding the optimum restocking of continental aquatic ecosystems and the development of sport fishing.

II. MATERIAL AND METHODS

2.1. Experimental devise

The experiment was conducted in station fish farming of Azrou (Morocco). The trial was conducted in six circular trays of 1 m^3 of volume at open circuit with an initial load of

10 Kg fed by spring water at a constant temperature around 14 ° C and a flow rate of 30 m 3/h, providing a rate of greater than 80% saturation of oxygen. The average content of dissolved oxygen in output of the basins is 7.1ppm. We used 900 individuals of average weight of 60 g, from the same batch of eggs, divided in six circular pools.

The fish are fed manually with two meals per day (morning and afternoon) for two months, according to the feeding table given by the provider of food In order to estimate the size of fish weight averages, a sampling of 33 fish of each batch is used.

Fish are anesthetized and measures their weight and their sizes are carried out individually. Quantities of food distributed each week are estimated and weighed according to the density of each basin

2.2 Experimental foods

To inquire about the evolution of the individual weight of the fish, we used a type of pellets corresponding to their development cycle and magnification (with 3.5 mm in diameter)

2.2.1. Composition of the feed

The composition of the food is given in the table below:

Table 1: comparative composition of the two tested food (Gouessant and Happy Fish)

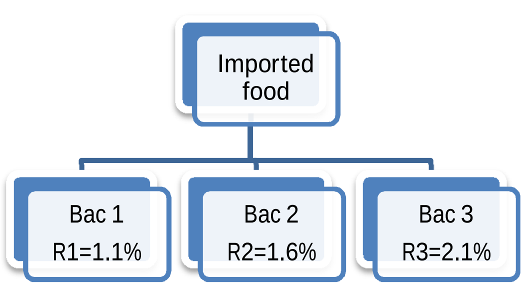
Ingredients	rate (Gouessant)	rate (Happy Fish)
Protein %	47	45
Lipids %	20	24
Cellulose %	1	1.8
Ash %	8	12
Phosphorus %	1.7	1.2
ED (MJ/Kg)	19	20
PD/ED (g/MJ)	21.30	20.5
Vitamin A -(UI/KG)	10000	7500
Vitamin D3-(UI/KG)	1750	1500
Vitamin E-(mg/Kg)	200	270
Vitamin C -(mg/Kg)	100	150

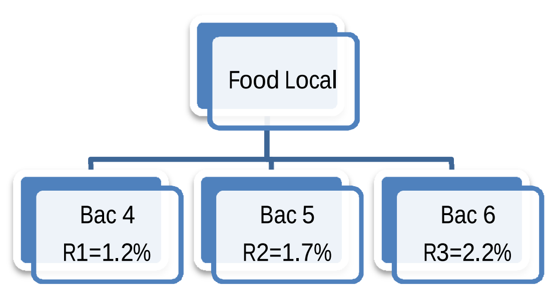
2.2.2. The rate of feeding

To compare the different parameters, the quantity of food distributed respects the conformity of the feeding of the two food tables established by providers. The rate of rationing is relative to the site about 14 ° C temperatures. Thus, the quantitative relationship is:

- Quantity of the imported extruded food (Gouessant)=1.6%
- Amount of the local extruded food (Happy Fish) =1.7%

Each food feeding rates are framed by the value 0.5 %. The experimental protocol of the trial is described as follow:





2.2.3 zoo-technical performance and growth index

To ensure the best conditions for breeding, we followed in situ temperature, pH and dissolved oxygen measurements.

The parameters measured and the equipment used are detailed in table 2:

Table 2: Conduite de l'étude de la qualité de l'eau

Parameters	Frequency	Place	Equipment	Unit
temperature	Every day	Basin	Thermometer type ODEON	Degree Celsius
pH	Every day	Basin	pH meter type ODEON	PH unit
Dissolved oxygen	Every day	Basin	Oximeter type ODEON	Mg/l

Studied zootechnical indices are presented in table 3.

Table 3: the zootechnical indexes studied

Parameters	Formulas
Weight gain (GP)	G.P =Poidsmoyen final(g) – Poidsmoyen initial
Survival rates (TS)	TS(%) = Final number of fish x 100/ Initial number of fish
Index of consumption (IC)	IC = Amount of ingested dry food / Body mass gain
Daily individual growth (CIJ)	CIJ (g/j) = [final weight (g)- initial weight (g)]/ duration of breeding
Specific growth rate (TCS)	TCS (%j)= (ln (final weight)-ln (initial weight))x 100/ Duration of the experiment
Relationship length - weight:	$M = a L^b$ p: mass of fish in g,L : fish in mm length b: rate of allometry, a: constant
Condition factor (k)	$K=10^5$x P/L3

2.3. Analysis of fish releases

The parameters analyzed at the level of the waters of fish releases are: material in suspension, ammonium, nitrite, nitrate, total nitrogen and total phosphate.

2.4. Statistical tools

The variability of the zoo-technical parameters of the two foods is evaluated by analysis of variance (ANOVA) single-factor of each of these variables: weight gain, feed efficiency, survival rate, daily individual growth, the specific growth rate and condition factor. Statistical analysis is performed by program SYSTAT 12, comparison of test (t) previously carried out each time that it is a significant effect of the studied factors. For results that come in the form of percentage, we used a data transformation to meet the conditions of normality of the distributions and equality of variances (according to the following formula: Y = 2ArcSin√x/100).

III. RESULTS

3.1. Parameter for breeding

The daily monitoring of dissolved oxygen, pH and the temperature of tanks led to the results which averages are summarized in table 4.

Table 4: Average measurements of physicochemical parameters of livestock

Parameters	Food block *"Gouessant"*	Food block *"Happy Fish"*	Optimum
Temperature	13,8° - 14,2°	13,8° - 14,2°	10° - 21°
Dissolved oxygen (mg/L)	6,9 - 7,1	6,9 - 7	> 6
pH	6,9 - 7,2	6,9 - 7,2	6 - 8

Daily measurements of physic-chemical parameters of livestock results demonstrate that, during the test, the trout were under optimal conditions.

3.2. Weight growth

3.2.1. Growth with both types of food

The graphic representation of the evolution of the average weight of the trout Rainbow fed by two types of extruded food was reflected in the figure below.

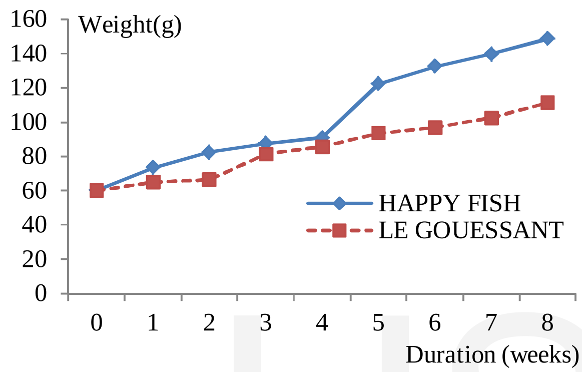


Figure 1: Growth of trout fed by two types of extruded food

The graphical representation of the weight increase, in function of time, of consignments of trout fed by the local food HAPPY FISH and imported food Gillespie show almost the same look.

These results emphasized that trout fed by the local extruded food record good growth during the experimental test performance. Indeed, the comparison of weight gains accused by consignments of trout fed by HAPPY FISH and Gillespie showed a highly significant difference (p< 0,001).

3.2.2 Growth with "Gillespie" food at different feeding rates

The evolution of the average weight of the rainbow trout fed with these different feeding rates is represented in the figure below.

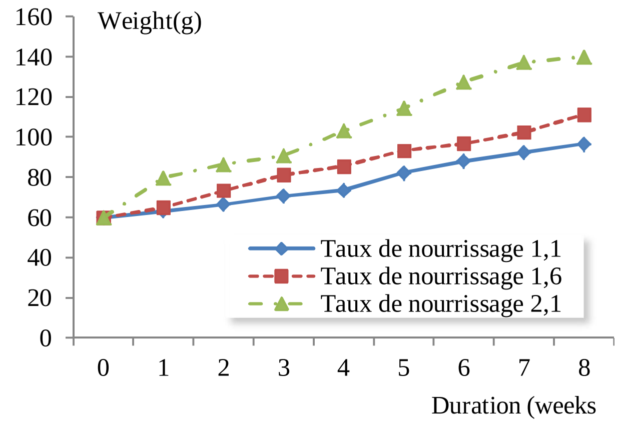


Figure 2: Growth of trout fed by Gillespie to different rations

The analysis of these results shows that curves almost have the same allure. The increase in weight during investigational testing varies depending on the feeding rate. These results indicate that the rate of feeding 2.1 produces good growth performance and that the variance between different feeding rates, according to the ANOVA test is significant (p < 0, 05).

3.2.3 Growth with the HAPPY FISH food at different feeding rates:

Figure 3 shows the evolution of the average weight of the rainbow trout fed with different rates of feeding during the experiment.

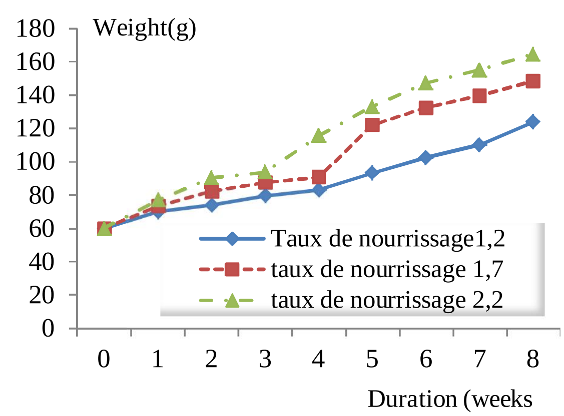


Figure 3: Growth of trout fed by HAPPY FISH at different rations

These results indicate that with the feeding rate 2.2 good growth performances have been obtained.

3.2.4 Growth indices

The difference in weight growth between the three lots is significant ANOVA p < 0, 05).

Table 4: Growth parameters of the batch fed with different feeding rates

Parameters	GOUESSANT			HAPPY FISH		
	R_1=1,1	R_2=1,6	R_3=2,1	R_1=1,2	R_2=1,7	R_3=2,2
Initial weightl (g)	60.00	60.00	60.00	60.00	60.00	60.00
Final weight (g)	96,67	111,34	140,66	124,12	148,67	164,59
Average weight gain (g)	36.67	51.34	80.66	64.12	88.67	104.59
Specific growth rate (%j)	0,79	1,03	1,42	1,21	1,51	1,68
Daily individual growth (g/j)	0,61	0,85	1,34	1,06	1,47	1,74
Index of consomption	1,48	1,66	1,79	1,08	1,31	1,68

The results (table 4) show a difference between growth indices of consignments of trout Rainbow fed the same food and those receiving different foods.

3.3 weight/length relationship

This relationship is a power. The rate of allometry 'b' expresses how the weight varies depending on length of [11]. Its value depends on individuels over weight.

3.3.1. *For imported food "GOUESSANT"*

Couples length-weight trout with imported food "Gillespie" are represented by figures 4, 5 and 6.

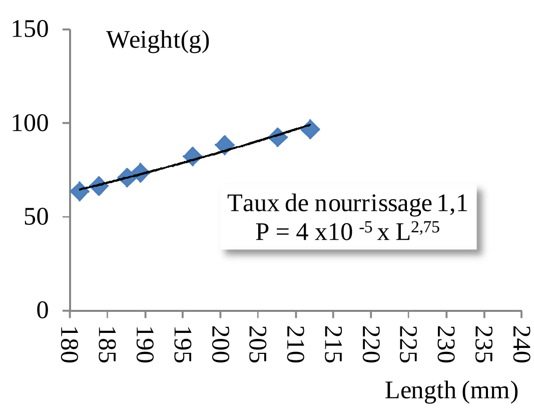


Figure 4: Length-weight relationship of trout fed by a feeding rate 1.1

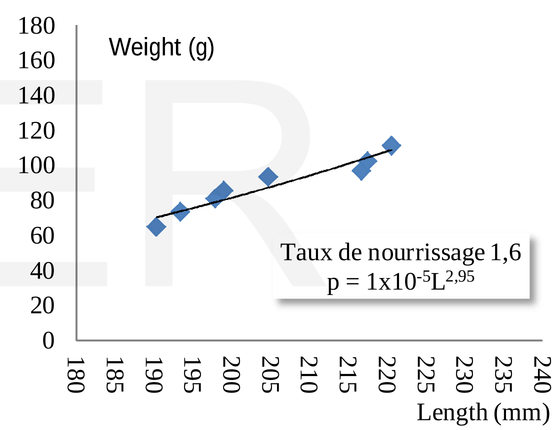


Figure 5: Length-weight relationship of trout fed by a feeding rate 1.6.

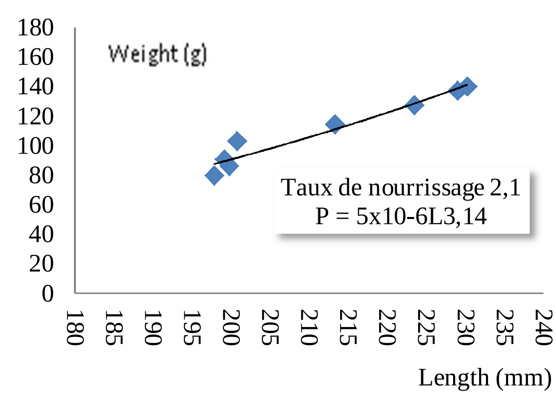


Figure 6: Length-weight relationship of trout fed by a feeding rate 2.1

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These allometric rates show an increase with the rate of feeding.

3.3.2. For local food "*HAPPY FISH*":
Couples length-weight trout with local food HAPPY FISH are represented by the figures7, 8 and 9.

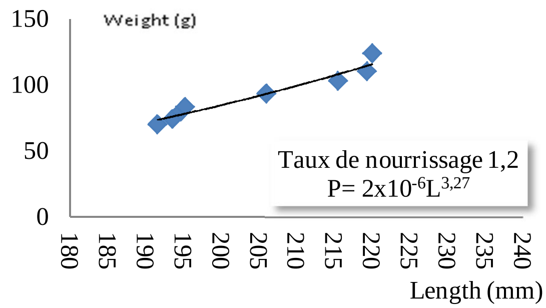

Figure7: Length-weight relationship of trout fed by a feeding rate 1.2

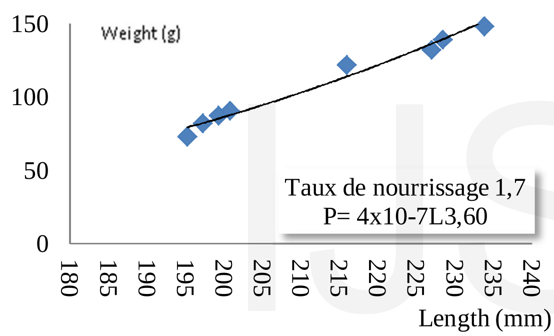

Figure 8: Length-weight relationship of trout fed by a feeding rate 1.7

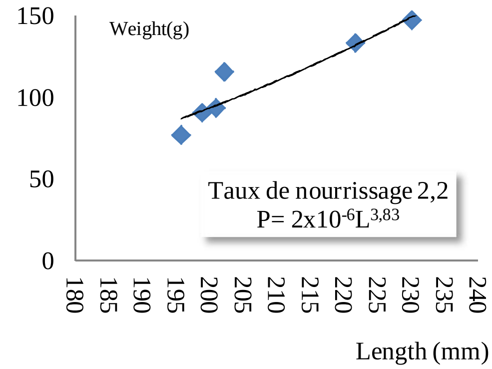

Figure 9: Length-weight relationship of trout fed by a feeding rate 2.2

These results indicate that the rate of allometry for lots of fish fed with the local food at different feeding rates is all superior to the value 3. We have taken note of a significant difference between the different rates of allometry (ANOVA, p ; 0, 05)

3.3 condition factor (k)
This factor allows assessing the impact of diet on productivity of fish.

3.3.1. For food "GOUESSANT"
Table 5 shows the values of the coefficient of average condition (K) trout Rainbow living under the same conditions and with different feeding rates.

Table 5: Coefficient of fed trout average condition (K) by *GOUESSANT*

Parameters	***GOUESSANT***								
	Feeding rate 1,1			Feeding rate 1,6			Feeding rate 2,1		
	Weight	Size	K1	Weight	Size	K2	Weight	Size	K3
Average condition factor	1,06			1,02			1,14		

3.3.2. For local food "HAPPY FISH"
Table 6 shows the values of the coefficient of average condition (K) of the live rainbow trout under the same conditions and with different feeding rates.

Table 6: Coefficient average condition (K) of trout fed by HAPPY FISH

Parameters	**HAPPY FISH**								
	Feeding rate 1,2			Feeding rate 1,7			Feeding rate 2,2		
	Weight	Size	K1	Weight	Size	K2	Weight	Size	K3
Average condition factor	1,06			1,11			1,20		

These results show that the condition factor K decreases as the length increases and the ANOVA statistical test confirms that this decrease is significant (p < 0,05).

3.4 Survival rates :

Table 7 shows the results obtained for the survival rate.

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Table 7: Rate of survival of trout with a different diet

	GUESSANT			HAPPY FISH		
	Feeding rate 1,1	Feeding rate 1,6	Feeding rate 2,1	Feeding rate 1,2	Feeding rate 1,7	Feeding rate 2,2
Survival rates	95	95	96	96	97	97

From the results obtained, it was noted that survival rates were 95.3% for the imported food (the GUESSANT) and 96.6% for the local food (HAPPY FISH). This difference between the two groups were not statistically significant (ANOVA, p > 0.05).

3.4. Environnement Impact

The parameters studied are the solids (TSS), total nitrogen and total Phosphate, the results obtained are summarized in the table below.

Table 8: Impact of tested food

Parameters	GOUESSANT			HAPPY FISH		
	R1=1,1	R2=1,6	R3=2,1	R1=1,2	R2=1,7	R3=2,2
MES (mg/L)	1,24	3,68	10,72	2,56	4,76	13,16
Pt (Total phosphate)	0,14	0,18	0,21	0,11	0,13	0,16
Nt (Total nitrogen)	1.12	1,26	1.34	0.91	0,98	1.1

With respect to releases of trout, it turns out according to the results obtained (table-8), fish fed with local food to reject more than my than any food, and the amount increases the rate of feeding of each plan, then for total phosphate and total nitrogen, it was recorded low discharges from the local food that the food imported.

IV. DISCUSSION ET CONCLUSION

Trout were reared under optimal conditions, because the values of the various parameters: temperature, dissolved oxygen and pH, meet the standards of these fish [12].
The weak growth performance recorded in consignments of fish fed with imported food (Gillespie) could be explained by their different levels of lipids and carbohydrates.
Numerous studies have highlight, the beneficial effect of a diet of high energy on the growth and feed efficiency of proteins from food of fish [13; 14; 15]. However, supplementation with fat rather than carbohydrates, as a source of nonprotein energy, is usually more effective to increase the energy level because lipids are easily metabolized, especially by carnivorous fish, trout Rainbow [16].
Our results confirm the existence of a feed efficiency, where better growth recorded for the local food (HAPPY FISH) that translates by 64.12 g, 88.67 g weight gain and 104.59 g respectively for feeding rates 1.2%, 1.7% and 2.2%.
For the specific growth rate (TCS%: from 0.7 to 1.6) the values obtained are indicative of the good growth in rainbow trout and our results are similar to those reported by [17]. In addition, the same results are obtained by other authors [18, 19].
The investigational test shows that the local regime HAPPY FISH the best indicator of consumption (1.31) compared to the IC of the food imported the GUESSANT (1.66). These results are consistent to those obtained by the experimental tests of [20] and show similar to those obtenux by [21] whose study is focused on the wolf fish.
Survival rates, with regard to obtained values, it is clear that we have not registered major

problems at the level of mortality, the percentage of survival above 95% for both diets. The few individuals dead counted during the experiment do not appear to be linked to food. Because the death occurred one, two or three days after the manipulation (anesthesia). Therefore, mortality would be similarly, due to the stress of handling. We have noted no significant difference (P > 0.05), in relation to the survivals of animals fed with different regimes. Therefore, we consider that our results are within the accepted standard.

Condition factor is an index of the State of health of the fish and an indicator of growth [12].

We noticed that the K-factor is important for local extruded regime HAPPY FISH greater than 3 expressed as a rate of allometry (b), which explains that fish undergoing this regime have grown better, as well, by weight and length; While for any extruded regime, we recorded a rate of allometry less than 3, reflecting that fish have had a performance in size and this cannot be explained only by the richness of this regime imported phosphorus on the one hand, and the low-energy on the other hand, where a strong protein catabolism and later development of the bone of fish [23] frame.

While contributing to food, aquaculture activity must also, in the context of sustainable development, respect the environment by minimization of releases from fish effluent. The impact of discharges of fish on the environment were studied in several species of fish, nmfm gilthead seabream "Sparusaurata" [24] .the bar "Dicentrarchuslabrax" [25] and salmonids [26, 27]. By gills, nitrogenous waste excretion is mainly dependent on protein intake and metabolic efficiency of the fish, which is specific to this case [28]. It is well known that an excess of amino acids in the food, will result in the catabolism of amino acids, with the ammonia excretion associated with a loss of energy [29]

The excess of phosphorus in the diet of fish generates higher levels of excreted phosphate, which is the main cause of eutrophisation of aquatic environments and consequently the alteration of the quality of water [30]. With the overall aim of reducing the pollution of waters, the minimization of excretion of phosphate by the fish became imperative [31] generally, fish with stomach, such as trout, assimilate more phosphorous than fish without stomach, like carp [32].

The phosphate excretion is proportional to the content of P in the food, where our results indicate that the intake of the HAPPY FISH food creates a low excretion of phosphate from the other any plan. These results are concordant with those of many authors [33; 34; 35; 36; 37; 38; 39; 40; 41].

Suspended solids released by trout fed by the two regimes40; extruded local and imported, show that our local food creates more than the my imported food, and among the factors that have caused this increase in physical quality, by the presence of fine particles and dust due to a defect in manufacture of food [41, 42]. It seems that the two regimes have made benefit trout in all tanks of optimal growth and welfare conditions, since they meet the predicted standards of salmonid which showed that trout have less tolerance for the values of my greater than 80 mg/l. In addition, our results are consistent with those obtained by [43] who got a rejection for the 14 mg/l, then [44] received 12 mg/l. This can be explained by the high digestibility of food with which we fed trout, while for [42], they got a value that reaches 62 mg/l due to the low digestibility of diets.

Of all the results obtained, we concluded that the water that feeds the pisciculture – CNHP room is a physic-chemical quality for better conditions for rearing of rainbow trout and that local food HAPPY FISH increases the growth of trout Rainbow compared to the imported food GOUESSANT According to the parameters calculated (weight gain, TSC, condition factor). On the other hand the local food HAPPY FISH has less harmful effect on the environment which would encourage its use for trout breeding.

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