

## Research concerning the feed digestibility and the digestive utilization coefficient in grass carp (*Ctenopharyngodon idella*)

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**Abstract.** The experiment was organized to investigate the recovery of additional food (fodder and terrestrial vegetation) given to fish, *Ctenopharyngodon idella*, in particular through the study of nutrient digestibility. Studied forage digestibility was determined through laboratory experiments, conducted between June 20 to 30, 2009, using 10 individuals of the species *Ctenopharyngodon idella* from fish farm Movileni, Iași. There were formed two experimental groups, each of five individuals per group, differentiation between the two groups was the type of feed used, respectively specific fodder and green clover green mass harvested in bud's phase. To determine organic matter digestibility from feed we used the direct method, which consists in weighing all feed ingested, scrap feed and faeces removed. For this purpose in each aquarium was placed one fish, after which the tanks were covered with netting and set with oxygenation of the water pump. Statistical analysis of the data obtained from the experiment shows that the average values of the coefficients of digestibility of nutrients from fodder and green clover have been very significant differences. If we compare the mean values of digestibility coefficients of organic substances in the two types of forage (green clover and fodder) we can say that the fodder is digested and assimilated better than clover. Thus, in fodder at a protein content of 378.7 g / kg DM (dry matter), there was a digestibility coefficient of 92%, while at a lower protein content of 312.5 g / kg DM, in the case of green clover, the digestibility coefficient was 69%.

**Keywords:** fish, digestion, food, nutrients, enzymes.

**Rezumat.** Experimentul a fost organizat cu scopul de a urmări modul de valorificare a hranei suplimentare (nutreț combinat și vegetație terestră) administrată materialului piscicol, reprezentat de *Ctenopharyngodon idella*, în mod special prin studiul digestibilității substanțelor nutritive. Digestibilitatea nutrețurilor studiate s-a determinat prin experiențe de laborator, desfășurate în perioada 20 - 30 iunie 2009, utilizându-se ca material piscicol 10 indivizi din specia *Ctenopharyngodon idella* proveniți din ferma piscicolă Movileni, județul Iași. Au fost constituite două loturi experimentale, a câte 5 indivizi/lot; diferențierea între cele 2 loturi a constat în tipul de hrană utilizat, respectiv nutreț combinat specific și trifoi masă verde recoltat la îmbobocire. Pentru determinarea digestibilității substanțelor organice din hrana administrată s-a folosit metoda directă, care constă în cântărirea întregului nutreț ingerat, a resturilor de nutreț și a fecalelor eliminate ce corespund hranei administrate. În acest scop în fiecare acvariu a fost introdus câte un exemplar, după care acvariile au fost acoperite cu plasă și prevăzute cu pompă de oxigenare a apei. Prelucrarea statistică a datelor obținute din experiment arată că între valorile medii ale coeficienților de digestibilitate ale substanțelor nutritive din nutrețul combinat și trifoi masă verde s-au înregistrat diferențe foarte semnificative. Dacă comparăm valorile medii ale coeficienților de digestibilitate privind substanțele organice la cele două nutrețuri administrate în hrana peștilor (trifoi și nutreț combinat), putem afirma că nutrețul combinat este mult mai bine digerat și asimilat comparativ cu trifoiul. Astfel, în cazul nutrețului combinat la un conținut proteic în hrană de 378,7g/kg substanță uscată, s-a înregistrat un coeficient de digestibilitate de 92%, pe când la un conținut mai scăzut în proteină de 312,5 g/kg substanță uscată, la trifoi, coeficientul de digestibilitate a fost de 69%.

**Cuvinte cheie:** pește, digestie, hrană, nutrienți, enzime.

**Introduction.** Managed fishes husbandry is an old occupation, but with an actual high significance, knowing that providing the required food quantities for human populations is yet an unsolved problem and that  $\frac{3}{4}$  of Earth surface is covered by water. In several countries, cyprinids serves as primary source of cheap proteins used to fight against malnutrition, the derived products containing those essential amino acids which frequently lack from vegetal protein substitutes. It was also found that cyprinids better convert feed than ruminants, poultry or even than swine. Some cyprinids species consume those microorganisms that could not be directly used by humans, while other

species act like real sanitary agents, consuming even the detritus.

*Ctenopharyngodon idella* (grass carp) is a cyprinid which converts aquatic macroflora into valuable meat, easy to assimilate and rich in proteins (Bura et al 1995, 1997). *Ctenopharyngodon idella*, grace to its multiple qualities, imposes to be reared within carp pools, increasing thus the economical efficiency into the cyprinids farms, mainly through the valorisation of the aquatic macroflora. *Ctenopharyngodon idella* is reared across the entire world, in many countries (China, Austria, Germany, Taiwan, Malaysia, Hong Kong, Sweden, Canada, USA, France, Romania, Israel, Egypt, Finland, United Kingdom), proving thus the economical significance of this species. Valuable information has been acquired during scientific literature studies, mainly concerning the intake and the valorisation of the aquatic vegetation by *Ctenopharyngodon idella*, species used in the own experiments, as well as various data referring to the chemical and nutritional features of the plants used as feed (Giraud 1993; Manea 1985). Some arguments stand for the interest of extending the rearing of this species: it consumes and valorises the macrophyte vegetal biomass which is not used by other fishes; fights against undesired aquatic vegetation without any equipments and fuel expenses; contributes to the increasing of the life conditions level for other species reared in policulture system, mainly through the improvement of the oxygen status and through the multiplying of the biogenic substances, of the planktonic and benthonic biomass (Macovei & Leonte 2006).

The experiment was organized to investiate the recovery of additional food (fodder and terrestrial vegetation) given to fish in particular through the study of nutrient digestibility. During the experiment have been collected and interpreted the following data:

- the amount of food given in experiment and the quantity of uneaten food
- the amount of faeces collected
- the chemical composition of feeds used
- the chemical composition of faeces collected
- the value of digestibility coefficients of nutrients from fodder studied.

**Material and Methods.** Studied forage digestibility was determined through laboratory experiments, conducted between 20 to 30 June 2009, using biological material *Ctenopharyngodon idella* from fish farm Movileni, Iași county. In order to achieve the experiments, ten aquariums of glass were used, with a glass thickness of 6 mm, having the following dimensions 60 cm long, 42 cm height, 30 cm wide, respectively with a capacity of 60 liters per tank; every aquarium being populated with one carp of two years old. Aquariums were filled with filtered water (no natural food).

There were formed two experimental groups, each of five individuals per group, differentiation between the two groups was the type of feed used, respectively specific fodder and green clover harvested in bud phase.

Determination of nutrient digestibility of feed is possible only through digestibility experiments "in vivo" or by using laboratory methods for assessing the digestibility "in vitro". We conducted "in vivo" experiments with a single control period, held in individual aquarium. Biological material used consisted of ten specimens of grass carpo f two years age; the average weight of fish at the beginning of the experimental period was on average 500 g, batches were homogeneous in this regard.

To determine organic matter digestibility from feed we used the direct method, which consists in weighing all feed ingested, scrap feed and faeces removed from the tank. For this purpose in each aquarium was placed one fish, after which the tanks were covered with nets and set with oxygenation of the water pump. Throughout the experiments it was intended to provide the necessary oxygen (5 mg/L of water) and ensuring water temperature averages of 20° C.

Duration of digestibility experiments was held for 5 days, of which the first four days were a pre-experimental period and the last day a proper experimental period, in accordance with the methodology found in the literature (Cărăușu 1962; Halver 1972; Guillaume et al 1999; Oprea & Georgescu 2000). Thus, the first day of pre-experimental

period was not given food to fish and the next three pre-experimental days, fish were fed with studied types of food, adapting the fish to food and other experimental conditions.

The amount of food given daily was established as representing about 4.5% by weight fish, respectively 20 g of feed / fish. Fish received food once a day, in the morning at 9 o'clock. Fodder was given at forage's table under the hydrolyzed form and green clover was simply introduced into the water.

On day 5, the proper experimental period, after changing the water, fish received the same amount of food; after 6 hours were harvested scrap's feed and after another 4 hours (respectively 10 hours after taking food) were collected faeces removed. The scrap of feed and clover was collected by siphoning. Determinations were made of gross chemical composition for fodder and scrap's feed.

We determined the amount of organic matter intake (ingestion), as the difference between the total amount of feed and the quantity of scrap uneaten feed, separately for crude protein (PB), crude fat (GB), crude fiber (CB), extractive substances without nitrogen (SEN) and for total organic matter (SO).

Faeces collection was made by dissection and gathering of water by siphoning and separation of food waste. For every fish was performed an abdominal dissection, after that the intestine was separated, and faeces were collected by pressing the rectum. They were weighed in analytical scales, separately for each fish. From the total amount of faeces were collected samples for analysis to determine the average chemical composition.

Based on the amount of faeces removed and its chemical composition, we calculated the amount of organic matter eliminated through faeces (egesta). The difference between ingested nutrients and those eliminated in the faeces is the amount of digested nutrients (digestion). Quantity digested percentage was reported to the intake, resulting digestibility coefficients calculated for organic substances from studied fodder.

**Results on the digestive utilization coefficient.** In fishery, the digestibility studies aimed at better understanding of nutrient use, optimization of quality food and a reduction of food waste to protect the environment in general and water in particular.

In assessing the quality of feed, this should be given to its origin, animal or vegetal. To find out the degree of digestibility and digestive assimilation of fodder and clover, coefficients of digestibility of organic matter in each feed for each individual were calculated. The analysis of the average coefficients of digestibility of organic matter from green clover (Table 1) results that extractive substances without nitrogen presents the highest digestibility coefficient (77%), while the lowest crude fat (57%). Note that the values obtained from tests concerning the chemical composition of the green clover, scrap's trefoil, faeces collected from individuals fed with green clover, which were the basis for the calculation of digestibility coefficients of organic substances are similar to those described in literature (Burlacu 1985, 1991).

As regards the fodder, the results of calculating the mean's digestibility coefficients of organic substances showed the highest values for extractive substances without nitrogen (94%) and lowest values were obtained for crude fat (57%) (see Tables 1-2, Figs 1-2).

Table 1

Mean digestibility coefficients of the organic matters in  
fodder and fresh clover

<i>Organic substances</i>	<i>Mean digestibility coefficients (%)</i>	
	Fodder	Green clover
Crude protein (P.B.)	92	69
Crude fat (G.B.)	91	57
Crude fiber (C.B.)	60	65
Substances without nitrogen (S.E.N.)	94	77
Total organic matter (S.O.)	91	71.2

Table 2

## Mean and variability of indicators studied

Indicator	<i>n</i>	$\bar{X}$	$\pm s_x$	<i>s</i>	<i>V%</i>	Minimum	Maximum
PB1	5	92	0.707	1.581	1.719	90	94
GB1	5	91	0.707	1.581	1.738	89	93
CB1	5	60	0.707	1.581	2.635	58	62
SEN1	5	94	0.316	0.707	0.752	93	95
TOTAL SO1	5	91	1.049	2.345	2.577	87	93
PB2	5	69	0.707	1.581	2.292	67	71
GB2	5	57	0.707	1.581	2.774	55	59
CB2	5	65	0.447	1	1.538	64	66
SEN2	5	77	0.707	1.581	2.053	75	79
TOTAL SO2	5	71.2	0.583	1.304	1.831	70	73

\* PB<sub>1</sub>, GB<sub>1</sub>, CB<sub>1</sub>, SEN<sub>1</sub>, Total SO<sub>1</sub> – values for fodder

\* PB<sub>2</sub>, GB<sub>2</sub>, CB<sub>2</sub>, SEN<sub>2</sub>, Total SO<sub>2</sub> – values for green clover

By comparing the average values of digestibility coefficients of organic substances in the two forage given in feed fish (clover and fodder), we can say that the fodder is digested and assimilated better than clover (Tables 1-2, Figure 3).

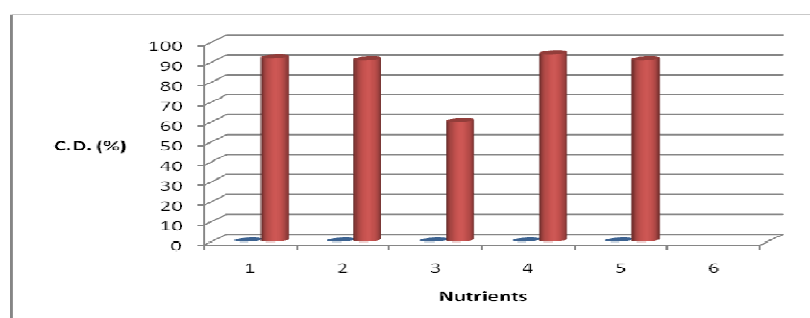


Figure 1. Average coefficients of digestibility of nutrients in fodder

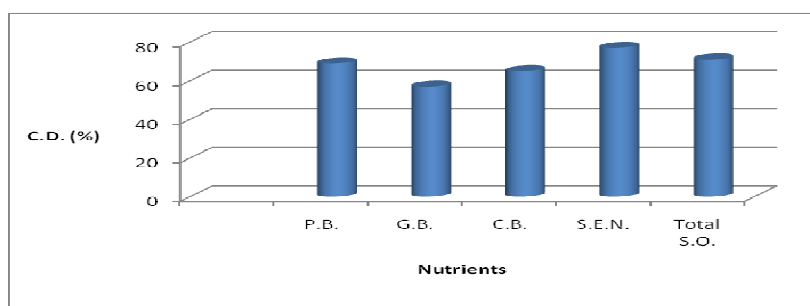


Figure 2. Average coefficients of digestibility of nutrients in green clover

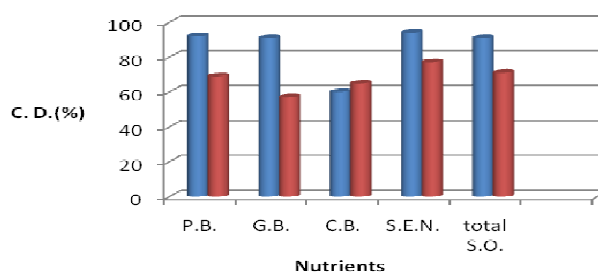


Figure 3. Average coefficients of digestibility of nutrients in fodder and green clover

The results show that both digestibility and fodder capitalization in *Ctenopharyngodon idella* is better because of the specific enzyme, which allows a better digestion and assimilation of organic substances of fodder to those of green clover.

**Indicator P.B.<sub>2</sub>**

Fisher's test

529.000 (F) > F<sub>0.001</sub> (1 ; 8) 25.42 \*\*\* (very sign.)

Tukey's test

Indicator 1	Indicator 2	Mean's difference	Q1	Q2	W1	W2	Significant's difference	Significant's level
P.B. <sub>2</sub>	P.B. <sub>1</sub>	23.00	3.26	4.74	2.41	3.35	Significant	0.01

**Indicator G.B.<sub>2</sub>**

Fisher's test

1156.00 (F) > F<sub>0.001</sub> (1 ; 8) 25.32 \*\*\* (very sign.)

Tukey's test

Indicator 1	Indicator 2	Mean's difference	Q1	Q2	W1	W2	Significant's difference	Significant's level
G.B. <sub>2</sub>	G.B. <sub>1</sub>	34.00	3.26	4.74	2.31	3.35	Significant	0.01

**Indicator C.B.<sub>2</sub>**

Fisher's test

35.7143 (F) > F<sub>0.001</sub> (1 ; 8) 25.42 \*\*\* (very sign.)

Tukey's test

Indicator 1	Indicator 2	Mean's difference	Q1	Q2	W1	W2	Significant's difference	Significant's level
C.B. <sub>2</sub>	C.B. <sub>1</sub>	5.00	3.26	4.74	1.93	2.80	Significant	0.01

**Indicator S.E.N.<sub>2</sub>**

Fisher's test

481.667 (F) > F<sub>0.001</sub> (1 ; 8) 25.42 \*\*\* (very sign.)

Tukey's test

Indicator 1	Indicator 2	Mean's difference	Q1	Q2	W1	W2	Significant's difference	Significant's level
S.E.N. <sub>2</sub>	S.E.N. <sub>1</sub>	17.00	3.26	4.74	1.79	2.60	Significant	0.01

**Indicator TOTAL S.O.<sub>2</sub>**

Fisher's test

272.250 (F) > F<sub>0.001</sub> (1 ; 8) 25.42 \*\*\* (very sign.)

Tukey's test

Indicator 1	Indicator 2	Mean's difference	Q1	Q2	W1	W2	Significant's difference	Significant's level
TOTAL S.O. <sub>2</sub>	TOTAL S.O. <sub>1</sub>	19.80	3.26	4.74	2.77	4.02	Significant	0.01

According to Fischer test between the values of digestibility coefficients of nutrients of fodder versus green clover were recorded very significant differences.

Also, according to Tukey test, the values of digestibility coefficients of nutrients of fodder and green clover showed significant differences.

**Conclusions**

- Comparative analysis of the coefficient of digestibility of organic matter for two types of feed distributed to grass carp allows us to affirm that the fodder is digested better than clover.

- The average coefficient of digestibility for mixed fodder was higher with 23 percentage points for protein, 34 percentage points for fat, 17 percentage points for extractive substances without nitrogen and smaller with 5 percentage points for crude fiber than the average digestibility's coefficient of organic matter in green clover.
- We can afford to say that the composition of forage had some influence on its digestibility and protein digestibility implicitly. These will be better with the higher protein content. Thus, for the fodder at a protein content of 378.7 g / kg D.M., there was a digestibility's coefficient of 92%, while at a lower protein content of 312.5 g / kg D.M. in clover, digestibility's coefficient was 69%.
- As a main conclusion, at grass carp of two years old was found a better digestibility of nutrients from fodder than the nutrients from green clover, due to the chemical composition of fodder and the enzyme's equipment specific of omnivorous fish.

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