

# **Index of contents**

LIST OF FIGURES .....	IV
LIST OF TABLES.....	VI
LIST OF ABBREVIATURES.....	IX
General Introduction.....	1
Justification and objectives .....	37

<b>Chapter 1</b> .....	
Abstract.....	40
1. Introduction.....	41
2. Materials and methods .....	44
3. Results .....	49
4. Discussion .....	55
References .....	61
<b>Chapter 2</b> .....	
Abstract.....	70
Introduction.....	71
Materials and Methods .....	72
Results .....	79
Discussion .....	87
References .....	93
<b>Chapter 3</b> .....	97
Abstract.....	98
Introduction.....	100
Materials and methods .....	103

Results .....	111
Discussion .....	116
References .....	123
<b>Chapter 4 .....</b>	<b>134</b>
Abstract.....	135
Introduction.....	136
Materials and methods .....	138
Results .....	147
Discussion .....	160
References .....	169
<b>General Discussion .....</b>	<b>193</b>
Conclusions .....	199
<b>General References .....</b>	<b>200</b>

## LIST OF FIGURES

Figure 1. Global aquaculture production from 1991 to 2020 .....	2
Figure 2. Contrasting the organic aquaculture volumes by Member States (MS) in 2020 (or the most recent available year) with the data from the EUMOFA survey in 2015-2016, presented in tonnes .....	.6
Figure 3. The historical trend in world production (in tonnes) of seabream ( <i>Sparus aurata</i> ) from 1984 to 2020, encompassing both aquaculture and capture fisheries, as reported by FAO 2022	13
Figure 4. The historical trend in world production (in tonnes) of seabass ( <i>Dicentrarchus labrax</i> ) from 1984 to 2020, encompassing both aquaculture and capture fisheries, as reported by FAO 2022	15
Figure 5. Illustrates the global production trends of fishmeal and fish oil (in tonnes) from 2001 to 2020.....	18
Figure 6. Illustrates the global distribution of fishmeal utilization across different sectors from 2009 to 2019.....	20

### Chapter 1

Figure 1. Evolution of the average body weight of gilthead seabream fed on the experimental diets.....	50
Figure 2. Productive value of essential amino acids (n = 3) for gilthead seabream fed experimental diets.....	53

### Chapter 2

Figure 1. Release results of amino acids that cross the membrane after hydrolyzing from the protein of all experimental diets .....	83
Figure 2. Equations of linear adjustments to the protein hydrolysis dynamics of all experimental diets.....	84
Figure 3. Histological detail of the liver (20×) of the gilthead seabream fed the experimental diet .....	85
Figure 4. Histological detail of the hindgut (10×) of gilthead seabream fed experimental diets .....	87

**Chapter 3**

Figure 1. Evolution of the average weight of the fish during the experiment ..... 111

Figure 2. Release results of amino acids that cross the membrane after hydrolyzing from 391 the protein of all experimental diets... 114

Figure. 3. Histological details of the liver of seabass-fed experimental diets' hindgut 428 (10x) ..... 116

**Chapter 4**

Figure. 1. Evolution of weight along the experiment..... 147

Figure. 2. Activity of digestive enzymes measured in the pyloric cecum of trout fed with experimental diets ..... 152

Figure. 3. Histological detail of the liver (20x) with Hematoxylin-Eosin staining of the trout fed with the experimental diet. .... 154

Figure. 4. Representation of diversity through the Shannon index between the different experimental groups ..... 160

## LIST OF TABLES

### General Introduction

Table 1. Global production and utilization of fisheries and aquaculture resources (million tonnes, live weight) .....1

Table 1. Some effects of plant protein meal dietary inclusion on some farmed fish .....25

Table 3. Some effects of terrestrial byproducts meal dietary inclusion on some farmed fish ..... 31

Table 4. Some effects of aquaculture by products meal dietary inclusion on some farmed fish .....32

Table 5. Some effects of insect meal dietary inclusion on some farmed fish 36

### Chapter 1

Table 1. Ingredients and formulation of the experimental diets.... 45

Table 2. Amino acid composition of experimental diets (g kg<sup>-1</sup> DM) ..... 47

Table 3. Fatty acid composition of the experimental diets (g kg<sup>-1</sup> in DM) ..... 48

Table 4. Overall performance of gilthead seabream fed the organic experimental diets..... 50

Table 5. Biometric indices of gilthead seabream fed the experimental diets..... 51

Table 6. Body composition (% wet weight) and protein efficiency retention of gilthead seabream fed the experimental diets.52

Table 7. Productive values of fatty acids in gilthead seabream fed the experimental diets (g/100 g of wet weight) ..... 54

### Chapter 2

Table 1. Ingredients and nutritional composition of the experimental diet .....74

Table 2. Composition of essential and non-essential amino acids in experimental diets .....76

Table 3. Conditions were carried out in the protein hydrolysis assay

.....	78
Table 4. Growth and nutritional parameters of gilthead seabream fed experimental organic diets.....	80
Table 5. Body composition in dry matter and retention efficiencies of gilthead seabream at the beginning and after feeding with experimental diets (%) .....	80
Table 6. Biometric indices at the end of the experiment .....	81
Table 7. Apparent digestibility coefficients of dry matter and different nutrients of gilthead seabream fed experimental diets.....	82
Table 8. Retention efficiency of essential amino acids from gilthead seabream-fed experimental diets (%).....	82
Table 9. Histological measures of the liver of gilthead seabream fed experimental diets .....	84
Table 10. Effect of the different diets on distal measurements of the gut in gilthead seabreamc	86

### Chapter 3

Table 1. The characteristics of the raw materials. Macronutrient composition of the different ingredients used in the study (% m.s.).	104
Table 2. Ingredients and proximal composition of diets tested in the growth assay.....	104
Table 3. Composition of essential and non-essential amino acids in experimental diets.....	107
Table 4. The specific conditions of the protein hydrolysis assay.	110
Table 5. Growth and nutritional parameters of European seabass fed experimental diets.....	112
Table 6. Body composition and retention efficiencies of seabass at the beginning and after feeding with experimental diets.....	113
Table 7. Apparent digestibility coefficients of dry matter and nutrients of seabass fed experimental diets .....	113
Table 8. Equations of linear adjustments to the protein hydrolysis dynamics of the six experimental diets.....	115
Table 9. Histological measures of the liver of seabass fed experimental diets.....	115



## Chapter 4

Table 1. Ingredients and proximal composition of diets tested in the growth assay.....	139
Table 2. Composition of essential and non-essential amino acids in experimental diets.....	142
Table 3. Fatty acid composition in experimental diets .....	143
Table 4. Growth and Nutritive indices at the end of the experimental trial .....	148
Table 5. Body composition and retention efficiencies of trout at initial and after feeding with experimental diets .....	149
Table 6. Biometric indices at the end of the experiment .....	149
Table 7. Apparent digestibility coefficients of dry matter and different nutrients of rainbow trout fed experimental diets .....	150
Table 8. Retention efficiency of essential amino acids of the rainbow trout fed with the experimental diets.....	150
Table 9. Effect of the experimental diets on blood parameters of the rainbow trout .....	152
Table 10. Histological measures of the liver of trout fed experimental diets .....	153
Table 11. Effect of the different diets on proximal and distal intestine measurements in rainbow trout .....	154
Table 12. Phyla found in microbiota sequencing .....	155
Table 13. Taxonomy and percentage (%) of the bacterial genera detected in the microbiota of hindgut samples (for each experimental group) .....	156
Table 14. Taxonomy and percentage (%) of the bacterial phyla detected in the microbiota of hindgut samples after Mycoplasma filtration .....	157
Table 15. Taxonomy and percentage (%) of the bacterial genera detected in the microbiota of hindgut samples after Mycoplasma filtration (for each experimental group) .....	159
Table 16. cost and economic performance metrics for experimental diets in rainbow trout.....	168