Growth performance and nutrient utilization in gilthead seabream

EXPERIMENTAL DESIGN

- 6 diets tested in quadruplicate tanks
- Initial mean body weight: 47 g
- 45 fish per 1000 L tank
- Average water temperature was 20.7 ± 0.4ºC
- Salinity 35.6 ± 0.4 ppt and dissolved oxygen levels kept above 6.0 mg/L.
- 95 days of experimental feeding

Table 1. Rationale of dietary treatments

CTRL	**Mimicking a common commercial bream diet in the Mediterranean region** It contains 6% SPC and 16% corn gluten meal (CGM) On a digestible basis it contains 37% digestible protein and 16.8 MJ/kg digestible energy On this diet the SPC+CGM accounts for 13.5% digestible protein
Corn protein concentrate	**Corn protein concentrate was used to replace 50% of the digestible protein input from SPC+CGM** The 13.76% level of TSR represents an input of 6.75% digestible protein (from previously generated ADC data)
Corn protein concentrate	**Corn protein concentrate was used to replace 100% of the digestible protein input from SPC+CGM** The 27.54% level of TSR represents an input of 13.5% digestible protein (from previously generated ADC data)
Barley protein concentrate	**Barley protein concentrate was used to replace 50% of the digestible protein input from SPC+CGM** The 11.41% level of BPC represents an input of 6.75% digestible protein (from previously generated ADC data)
Barley protein concentrate	**Barley protein concentrate was used to replace 100% of the digestible protein input from SPC+CGM** The 22.82% level of BPC represents an input of 13.5% digestible protein (from previously generated ADC data)
TSR+Barley protein concentrate	**Corn protein concentrate and Barley protein concentrate were used to replace 100% of the digestible protein input from SPC+CGM** The 13.76% level of TSR + 11.41% level of BPC represents an input of 13.5% digestible protein

Table 2. Formulation of experimental diets.

Ingredients, %	CTRL	Corn protein concentrate	Corn protein concentrate	Barley protein concentrate	Barley protein concentrate	TSR+Barley protein concentrate
Fishmeal	15.00	15.00	15.00	15.00	15.00	15.00
Poultry meal	10.00	10.00	10.00	10.00	10.00	10.00
Soy protein concentrate	6.00	3.00	-	3.00	-	-
Corn gluten meal	16.00	8.00	-	8.00	-	-
Corn protein concentrate (PANNONIA)	-	13.76	27.54	-	-	13.76
Barley protein concentrate (PANNONIA)	-	-	-	11.41	22.82	11.41
Soybean meal 44	12.00	12.00	12.00	12.00	12.00	12.00
Rapeseed meal	4.50	4.50	4.50	4.50	4.50	4.50
Sunflower meal 40	5.50	6.10	6.20	5.80	5.64	6.10
Wheat meal	9.98	8.07	6.69	9.57	9.57	7.96
Whole peas	4.40	4.40	4.40	4.40	4.40	4.40
Vit & Min Premix	1.00	1.00	1.00	1.00	1.00	1.00
Antioxidant	0.10	0.10	0.10	0.10	0.10	0.10
Monocalcium phosphate	1.40	1.25	1.05	1.40	1.45	1.25
L-Lysine HCl 99%	0.20	0.20	0.20	0.20	0.20	0.20
Yttrium oxide	0.02	0.02	0.02	0.02	0.02	0.02
Fish oil	5.00	5.00	5.00	5.00	5.00	5.00
Rapeseed oil	8.90	7.60	6.30	8.60	8.30	7.30

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Table 3. Growth performance after 95 days of feeding.

Ingredients, %	CTRL	Corn protein concentrate	Corn protein concentrate	Barley protein concentrate	Barley protein concentrate	Corn+Barley protein concentrate	P-value
Survival, %	99.4 ± 1.1	99.4 ± 1.1	99.4 ± 1.1	99.4 ± 1.1	98.9 ± 1.3	100.0 ± 0.0	0.808
IBW, g	47.3 ± 0.2	47.3 ± 0.3	47.2 ± 0.4	47.2 ± 0.5	47.4 ± 0.2	47.2 ± 0.1	0.820
FBW, g	166.1 ± 2.2^{a}	173.1 ± 4.9^{b}	175.1 ± 2.6^{b}	170.2 ± 2.3^{ab}	169.2 ± 3.2^{ab}	173.6 ± 3.3b	**0.010**
SGR, %/d	1.32 ± 0.01^{a}	1.37 ± 0.03^{b}	1.38 ± 0.01^{b}	1.35 ± 0.02^{ab}	1.34 ± 0.02^{ab}	1.37 ± 0.02b	**0.008**
FCR	1.28 ± 0.02	1.25 ± 0.03	1.28 ± 0.03	1.27 ± 0.05	1.30 ± 0.02	1.28 ± 0.02	0.426
FI, %ABW/d	1.51 ± 0.02	1.51 ± 0.02	1.55 ± 0.04	1.52 ± 0.07	1.54 ± 0.04	1.54 ± 0.03	0.401
PER	1.85 ± 0.03	1.88 ± 0.04	1.84 ± 0.04	1.86 ± 0.07	1.81 ± 0.03	1.83 ± 0.03	0.370

Values are means ± standard deviation (n=4).
Absence of different superscripts within a row, denote the absence of statistical differences (P<0.05).

- The final body weight (FBW) ranged between 166 and 175 grams. Fish from the control treatment (CTRL) showed a 3.5-fold increase of their initial body weight (IBW). At this stage, fish fed diet corn protein concentrate, corn protein concentrate and corn protein concentrate+barley protein concentrate showed a significantly higher FBW than those fed the CTRL diet (P<0.05).
- The specific growth rate (SGR) varied between 1.32 and 1.38 %/day. Again, fish fed diets corn protein concentrate, corn protein concentrate and corn protein concentrate+barley protein concentrate showed a significantly higher SGR than those fed the CTRL diet (P<0.05).
- The feed conversion ratio (FCR) varied between 1.25 and 1.30, which can be considered as adequate for the fish size range and water temperature profile. Dietary treatments had no significant effect on FCR (P>0.05).
- Feed intake (FI) varied between 1.51 and 1.55 %ABW per day, and was not significantly affected by dietary treatments (P>0.05).
- Protein efficiency ratio (PER) varied between 1.81 and 1.88, and was not significantly affected by dietary treatments (P>0.05).
- After 95 days of experimental feeding, a total of 6 fish died. However, this overall mortality can be considered as residual (0.56%) and was not associated to dietary treatments (P>0.05).

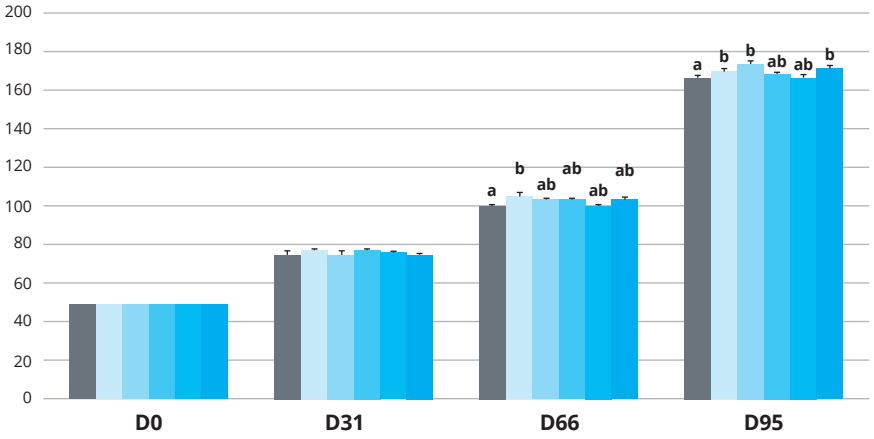

Figure 1. Changes on body weight (BW) throughout the trial

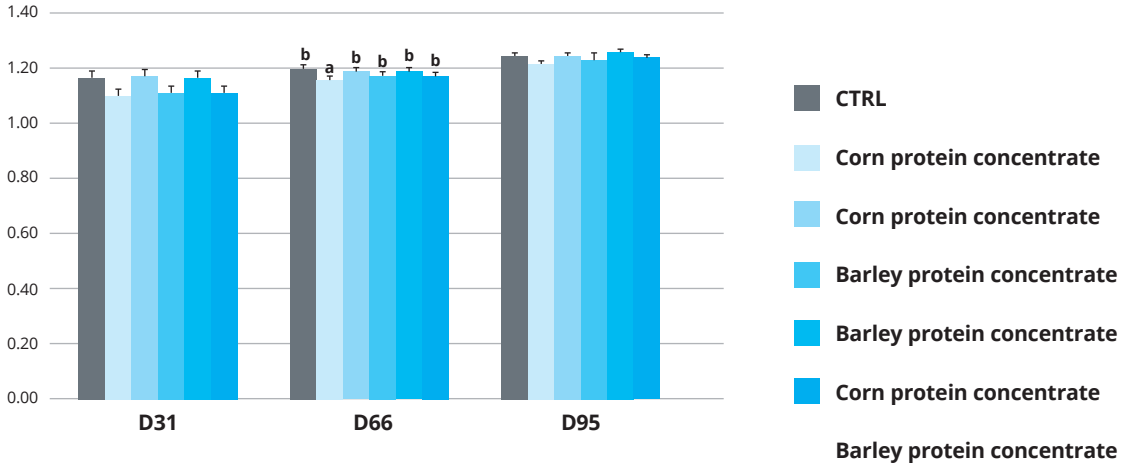

Figure 2. Changes on FCR throughout the trial

After 95 days of feeding and when compared to the control treatment, the replacement at 50 and 100% of the digestible protein supply of soy protein concentrate and corn gluten by corn protein concentrate, or its combination with barley protein concentrate, resulted on a significant enhancement of weight gain performance criteria (FBW and SGR), without affecting feed utilization criteria (FI, FCR, PER). Barley protein concentrate containing diets sustained an overall performance equivalent to that of CTRL and corn protein concentrate diets.

Growth performance and nutrient utilization in rainbow trout

EXPERIMENTAL DESIGN

- 6 diets tested in quadruplicate tanks
- Initial mean body weight: 30 g
- 40 fish per 350 L tank
- 97 days of experimental feeding
- Average water temperature was 13.5 ± 0.5ºC
- Dissolved oxygen levels were kept above 7.3 mg/L.

Table 1. Rationale of dietary treatments

CTRL	**Mimicking a common commercial trout diet in Europe** It contains 18% SPC and 8% corn gluten meal (CGM) On a digestible basis it contains 37% digestible protein and 23.4 MJ/kg digestible energy On this diet the SPC+CGM accounts for 15.7% digestible protein
Corn protein concentrate	**Corn protein concentrate was used to replace 50% of the digestible protein input from SPC+CGM** The 15.25% level of TSR represents an input of 7.86% digestible protein (from previously generated ADC data)
Corn protein concentrate	**Corn protein concentrate was used to replace 100% of the digestible protein input from SPC+CGM** The 30.5% level of TSR represents an input of 15.7% digestible protein (from previously generated ADC data)
Barley protein concentrate	**Barley protein concentrate was used to replace 50% of the digestible protein input from SPC+CGM** The 12.94% level of BPC represents an input of 7.86% digestible protein (from previously generated ADC data)
Barley protein concentrate	**Barley protein concentrate was used to replace 100% of the digestible protein input from SPC+CGM** The 25.91% level of BPC represents an input of 15.7% digestible protein (from previously generated ADC data)
TSR+Barley protein concentrate	**Corn protein concentrate and Barley protein concentrate were used to replace 100% of the digestible protein input from SPC+CGM** The 15.25% level of TSR + 12.94% level of BPC represents an input of 15.7% digestible protein

Table 2. Formulation of experimental diets.

Ingredients, %	CTRL	Corn protein concentrate	Corn protein concentrate	Barley protein concentrate	Barley protein concentrate	TSR+Barley protein concentrate
Fishmeal Super Prime	10.000	10.000	10.000	10.000	10.000	10.000
Fish protein hydrolysate	2.500	2.500	2.500	2.500	2.500	2.500
Corn protein concentrate (PANNONIA)	-	15.250	30.500	-	-	15.250
Barley protein concentrate (PANNONIA)	-	-	-	12.940	25.910	12.940
Soy protein concentrate	18.000	9.000	0.000	9.000	0.000	0.000
Pea protein concentrate 72	3.000	3.000	3.000	3.000	3.000	3.000
Wheat gluten	12.500	12.530	12.680	12.200	11.900	12.400
Corn gluten meal	8.000	4.000	0.000	4.000	0.000	0.000
Wheat meal	10.500	10.000	9.500	11.335	12.070	10.640
Dehulled faba beans (low tannins)	6.000	6.000	6.000	6.000	6.000	6.000
Vitamin and mineral premix	1.000	1.000	1.000	1.000	1.000	1.000
Antioxidant	0.200	0.200	0.200	0.200	0.200	0.200
Monoammonium phosphate	1.880	1.780	1.650	1.950	2.050	1.850
L-Lysine HCl 99%	0.600	0.600	0.600	0.600	0.600	0.600
L-Tryptophan	-	0.020	0.050	0.055	0.150	0.100
Yttrium oxide	0.020	0.020	0.020	0.020	0.020	0.020
Rapeseed lecithin	0.200	0.200	0.200	0.200	0.200	0.200
Fish oil	9.000	9.000	9.000	9.000	9.000	9.000
Rapeseed oil	16.600	14.900	13.100	16.000	15.400	14.300

Growth performance and nutrient utilization in gilthead seabream // Zootechnical results

Table 3. Growth performance after 97 days of feeding.

Ingredients, %	CTRL	Corn protein concentrate	Corn protein concentrate	Barley protein concentrate	Barley protein concentrate	Corn+Barley protein concentrate	P-value
Survival, %	100.0 ± 0.0	99.4 ± 1.3	100.0 ± 0.0	100.0 ± 0.0	100.0 ± 0.0	99.4 ± 1.3	0.564
IBW, g	30.6 ± 0.2	30.5 ± 0.3	30.6 ± 0.3	30.6 ± 0.1	30.5 ± 0.2	30.6 ± 0.3	0.948
FBW, g	123.1 ± 2.2^{a}	132.2 ± 2.7^{b}	125.8 ± 1.5^{a}	123.0 ± 2.7^{a}	122.8 ± 1.9^{a}	124.2 ± 1.1^{a}	**<0.001**
SGR, %/d	1.44 ± 0.02^{a}	1.51 ± 0.03^{b}	1.46 ± 0.02^{a}	1.43 ± 0.02^{a}	1.43 ± 0.02^{a}	1.44 ± 0.01^{a}	**<0.001**
FCR	1.07 ± 0.04^{b}	0.94 ± 0.02^{a}	1.04 ± 0.03^{b}	0.96 ± 0.02^{a}	1.05 ± 0.01^{b}	1.05 ± 0.01^{b}	**<0.001**
FI, %ABW/d	1.33 ± 0.04^{b}	1.21 ± 0.01^{a}	1.30 ± 0.03^{b}	1.19 ± 0.02^{a}	1.31 ± 0.02^{b}	1.31 ± 0.01^{b}	**<0.001**
PER	2.28 ± 0.09^{a}	2.63 ± 0.05^{b}	2.37 ± 0.06^{a}	2.56 ± 0.06^{b}	2.32 ± 0.03^{a}	2.32 ± 0.03^{a}	**<0.001**

Values are means ± standard deviation (n=4).
Absence of different superscripts within a row, denote the absence of statistical differences (P<0.05).

- The final body weight (FBW) ranged between 122.8 and 132.2 grams. Fish from the control treatment (CTRL) showed a 4-fold increase of their initial body weight (IBW). Fish fed diet corn protein concentrate showed a significantly higher FBW than those fed all other diets (P<0.05).
- The specific growth rate (SGR) varied between 1.43 and 1.51 %/day. Fish fed diet corn protein concentrate showed a significantly higher SGR than those fed all other diets (P<0.05).
- The feed conversion ratio (FCR) varied between 0.94 and 1.07, suggesting adequate feeding practices. Fish fed the corn protein concentrate and Barley protein concentrate diets showed a significantly lower FCR than those fed the CTRL, corn protein concentrate, Barley protein concentrate and Corn protein concentrate+Barley protein concentrate diets (P<0.05).
- Feed intake (FI) varied between 1.19 and 1.33 %ABW per day. Fish fed diets corn protein concentrate and Barley protein concentrate showed a significantly lower FI than those fed the CTRL, corn protein concentrate, Barley protein concentrate and Corn protein concentrate+Barley protein concentrate diets (P<0.05).
- Protein efficiency ratio (PER) varied between 2.32 and 2.63. Fish fed the Corn protein concentrate and Barley protein concentrate diets showed a significantly higher PER than those fed the CTRL, Corn protein concentrate, Barley protein concentrate and Corn protein concentrate+Barley protein concentrate diets (P<0.05).

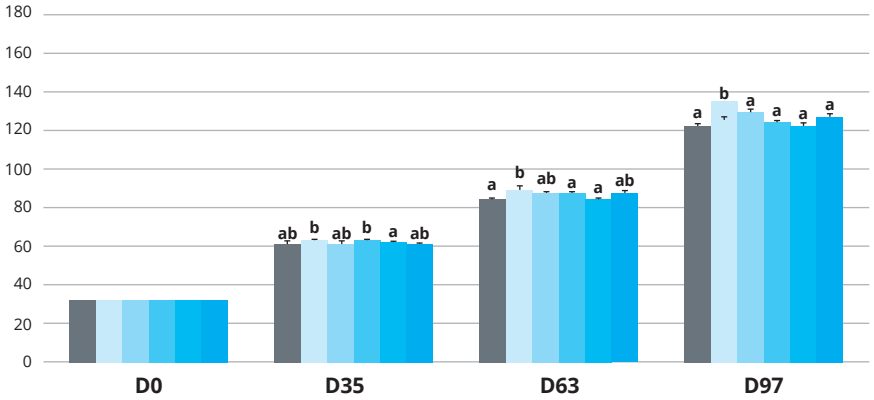

Figure 1. Changes on body weight (BW) throughout the trial

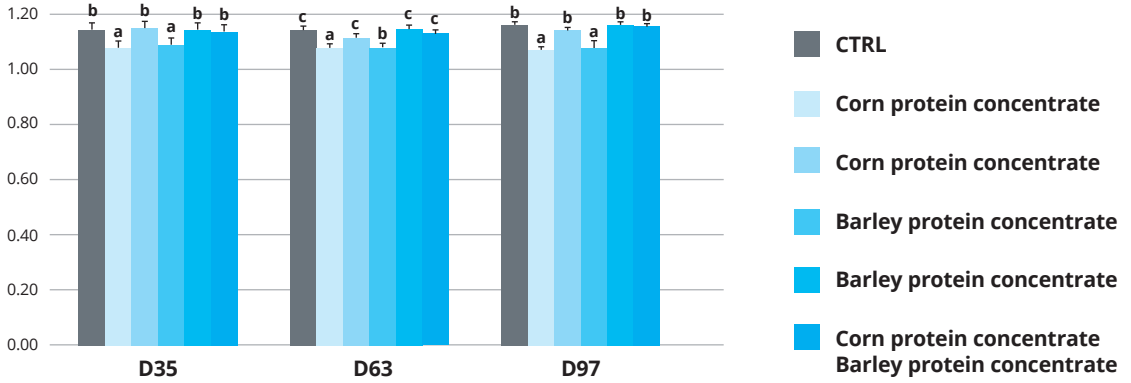

Figure 2. Changes on FCR throughout the trial

After 97 days of feeding and when compared to the control treatment, the replacement at 50% of the digestible protein supply of soy protein concentrate and corn gluten by Corn protein concentrate, resulted in a significant enhancement of overall growth performance criteria. This same level of replacement (50%) by Barley protein concentrate, although without a significant effect on weight gain (FBW and SGR), resulted in a significant improvement of feed utilization criteria (FCR and PER). All other diets, targeting a 100% replacement of the digestible protein supply of soy protein concentrate and corn gluten by Corn protein concentrate and BPC alone or in conjunction, sustained an overall performance equivalent to that of CTRL diet. Following the 3 months feeding period, subsequent colour observations showed no change in coloration away from the control. There were no visible impacts to flesh pigmentation which was also well below the initial tone of the SalmoFan graduation.