



ONGROWING FEED FOR SENEGAL SOLE (*Solea senegalensis* Kaup)



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Introduction

Sole (*Solea solea* and *Solea senegalensis*) are regarded as promising new flatfish species for European fish farming. Recent advances in the hatchery techniques and the availability of specific weaning diets, will result in more dependable supply and quality of sole fry in the near future (Howell et al., 1997; Dinis et al., 1999). However, the knowledge about ongrowing sole is still very limited, especially with regard to rearing technology and husbandry conditions, feeding behavior, and nutritional requirements. Since specific sole feed is not commercially available, commercial turbot feeds are often used for sole. The present study aimed at the evaluation of a specific sole formulation in comparison with a commercial turbot feed for ongrowing Senegal sole *Solea senegalensis*.

Feeds

A sinking extruded feed (“INVE Sole”) was formulated for sole ongrowing taking into account the specific requirements of sole, i.e. high protein/energy ratio (crude protein/crude fat 55/16), enhanced palatability (using a mixture of selected attractants) and high digestibility (using absolutely fresh raw materials, marine oils with POV<5 and digestibility enhancers). A standard commercial turbot feed (“COMM Turbot”; crude protein/crude fat 52/20) served as a reference. A pellet size of 2 mm was used for both treatments.



EVALUATION AT LABORATORY SCALE

Experimental design

Juvenile sole *S. senegalensis* (13-15 g initial weight) were reared for 8 weeks in rectangular flat-bottom tanks of 0.5 m² tank surface (35 fish per 50 L; triplicate tanks per treatment) in a partial recirculation system using borehole water (800% total water exchange/day; temperature 18.7 ± 0.6 °C; dissolved oxygen 5-7 mg/L; salinity 40 g/L). The fish were fed daily two to three times to apparent satiation which resulted in very similar amounts of feed distributed to both treatments. Fish were group weighed every two weeks.

Experimental setup for the lab scale evaluation (triplicate tanks of 0.5 m² per treatment) (pic 2 a +b)



Results

- Overall performance of the sole in the present growth trial was excellent (Table 1; Fig. 1):
 - no mortality
 - growth rate of 1.6-1.8%/day
 - food conversion around 1
- The specific sole formulation performed significantly better than the turbot feed in terms of growth (12% higher daily growth rate) and food conversion (20% lower FCR). Average daily feed consumption, expressed as % of average body weight per day, was 12% lower for the sole feed.

Table 1: Growth and feed utilization in Senegal sole fed a specific sole formulation (INVE Sole) in comparison with a standard commercial turbot feed (COMM Turbot). Data represent averages of three tanks; different letters denote significant differences (t-test; P < 0.05)

	COMM Turbot feed	INVE Sole feed	% difference INVE/COMM
Survival (%)	100 ± 0	100 ± 0	0
Initial weight (g)	14.1 ± 1.1 a	14.7 ± 0.6 a	+4
Final weight (g)	34.4 ± 2.8 b	39.8 ± 0.7 a	+16
Weight gain/ind (g)	20.3 ± 1.9 b	25.1 ± 1.2 a	+24
Specific growth rate (%/d)	1.56 ± 0.07 b	1.75 ± 0.09 a	+12
Total feed/ind (g)	21.7 ± 0.8 a	21.6 ± 0.3 a	0
Feed intake (%ABW/d)*	1.58 ± 0.08 b	1.39 ± 0.01 a	-12

FCR	1.07 ± 0.06 b	0.86 ± 0.05 a	-20
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- *ABW=average body weight = (initial weight + final weight)/2

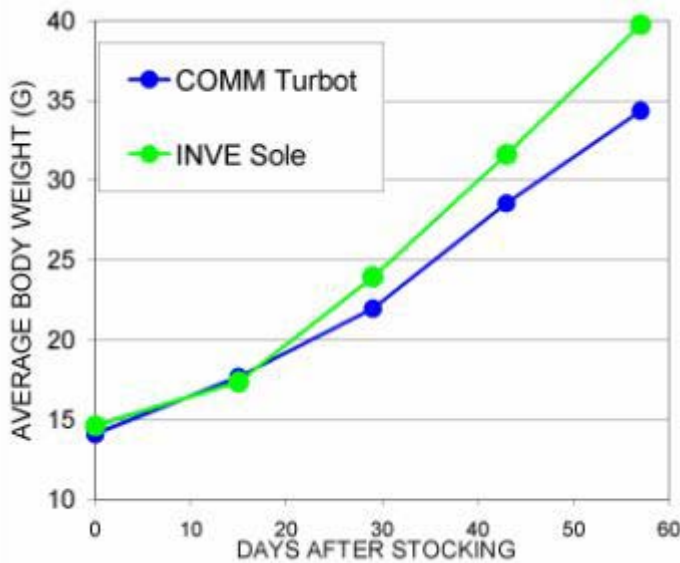


Fig. 1: Growth curves for Senegal sole fed a specific sole formulation (INVE Sole) in comparison with a standard commercial turbot feed (COMM Turbot). Data represent averages of triplicate tanks.

EVALUATION AT PILOT SCALE

Experimental design

Sole *S. senegalensis* (48 g average initial weight) were reared for 8 weeks in a rectangular raceway (500 fish per 1000 L; 5m²) using borehole water (400% water exchange/h; temperature 18.5-19.5°C; dissolved oxygen 6-7 mg/L obtained by a packed column and additional aeration in the tank; salinity 40 g/L). The fish were fed INVE Sole at a daily ration of 1.25% of fish biomass using automatic feeders and under natural photoperiod conditions (12h light). The total fish population was group weighed every two weeks.

Experimental setup for the pilot scale evaluation (5 m² raceway)



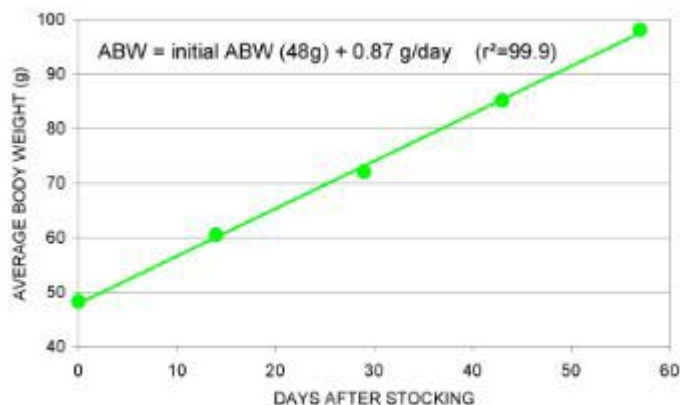
Results

Sole growth in the pilot trial was linear during the 2-month culture period (0.87 g/day from 48 g to 98 g individual body weight, Fig. 2). Food conversion rate was slightly higher than in the lab trial as a result of the automatic feeding (FCR 1.06; Table 2).

Table 1: Growth and feed utilization in Senegal sole fed a specific sole formulation (INVE Sole): comparison of results obtained at lab scale (see Table 1) and pilot scale.

	UPSCALED	LAB-scale
Scale (n° fish/tank surface)	500/5m ²	35/0.5m ²
Duration (weeks)	8	8
Initial-Final density (Kg/m ²)	5-10	1-3
Survival (%)	100	100
Initial weight (g)	48	15
Final weight (g)	98	40
Weight gain/ind (g)	50	25
Total feed/ind (g)	53	22
Feed intake (%ABW/d)	1.27	1.39
Food conversion ratio	1.06	0.86
Specific growth rate (%/d)	1.25	1.75
Daily weight gain/ind (g/d)	0.87	0.45

Fig. 2: Growth curve for Senegal sole fed a specific sole formulation (INVE Sole) in pilot scale evaluation (5-10 kg/m²; 5 m² tank).



Conclusions

- Juvenile sole *S. senegalensis* (15-40 g body weight; 1-3 kg/m² culture density) exhibited an excellent growth performance (1.56-1.75 %/day) and food utilization efficiency (FCR 0.86-1.07) in a growth trial at laboratory scale.
- A standard commercial turbot feed was not fully adequate to satisfy the nutritional requirements of *S. senegalensis*. Improved growth (increase of daily growth rate with 12%) and food conversion (with 20%) was obtained using a specific sole formulation instead of a standard turbot feed in a laboratory trial.
- The preliminary pilot scale trial (48-98 g body weight; 5-10 kg/m² culture density) confirmed the interesting growth potential of *S. senegalensis* fed the specific sole formulation in tank culture (growth 0.87 g/day; FCR 1.06)

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