AQUACULTURE update

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Pacific Biological Station

Growout and harvest quality of Atlantic salmon in a SEA System IIä floating bag

The SEA System II™ bag was developed by Future SEA Technologies Inc. (FST) to create a controlled environment for finfish culture. The enclosure is supplied with pumped water that can be drawn from varying depths to control quality, current speed and temperature. Previous tests of the technology (see Aquaculture Updates #79, 81 and 84) were conducted jointly by FST and Fisheries & Oceans Canada at facilities in Departure Bay, Nanaimo, BC. The subject of this Update is a group of Atlantic salmon which remained as downgrades following a harvest from a previous trial. These fish were further cultured in a Sea System II™ bag and an adjacent netpen under conditions of minimal intervention for data-gathering. The test ran from July 17, 1999 to February 2, 2000. Table 1 summarizes the initial conditions in the test.

Table 1. Bag and netpen starting conditions.

	Bag	Netpen
Volume, m3	1450	324
No. fish stocked	3140	161
Fish mean weight, g	1572	1674
Condition factor (footnote 1)	1.18	1.21
Stocking density, kg/m3	3.89*	0.8

* as of August 11, 1999

The fish in the bag were transferred from the original 12-m diameter bag to a 15-m diameter bag on August 11, while the netpen fish remained in the original netpen from July 17 onward. No further interventions occurred until harvest. They were fed to satiation on a commercial diet by the same personnel.

Fish were measured at beginning and end of the test by direct sample, and once interim by video (VICASS™ System). Although the netpen fish were larger at the outset, those in the bag were larger at the intermediate point (November 1999), and had significantly greater length, weight and condition factor at harvest (Table 2).

Table 2. Growth performance indicators at end of trial.

	Bag	Netpen
Mean wt, g	4016.6	3607.1
Condition factor	1.49	1.43
Density, kg/m3	7.60	1.27
Mortality, %	11.56	13.04
Growth coeff.	2.06	1.54
Simple FCR	1.44	2.65
Matures, %	0	24.0

The differences occurred despite lower degree-day (ATU) totals in the bag (2066 vs. 2245) (Figure 1).

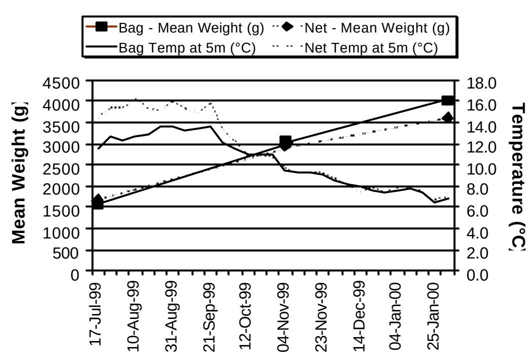

Figure 1. Growth of Atlantic salmon versus water temperature.

Growth coefficients, which take body size and water temperatures into consideration (Iwama & Tautz 1981) and other variables also were higher in the bag (Table 2).

Maturing fish with darker color and developing gonads were present in the netpen at harvest, but not in the bag (these were excluded from tables and data analyses where they influenced the outcomes). Mean current speeds measured in the areas of the bag frequented by the fish were typically from 16 to 24 cm/sec throughout the test. Current speeds were not measured in the netpen, but appeared considerably lower at most times. The majority of fish harvested went directly to commercial processing, while a range of tests and data were collected from research samples prepared and dressed by commercial plant workers.

Parasites: both commercially important parasites of Atlantic salmon were found in both culture systems at harvest (*Lepeophtheirus salmonis, Kudoa thyrsites*). In salmon from the bag, 23/25 fish carried sealice, 17/25 carried *Kudoa.* In salmon from the pen, 25/25 fish carried sealice, 5/25 carried *Kudoa*. We have noted differences in sealice burden between bag and pen fish in previous studies (see Aquaculture Update #86), but *Kudoa* was not previously present. In all instances to date, the presence of either parasite was light and considered to have no potential impact on marketability (the fish were processed commercially in every instance). We have not identified any causes for these differences, however it is noteworthy that both parasites spread via very small planktonic infective stages whose abundance may vary throughout the watercolumn. Placement of a netpen, or the intake for a SEA System™, could thus have potential bearing on the number of infective stages to which a stock of fish are exposed. Further studies are in progress to clarify whether intake depth plays a role in parasite burden in cultured Atlantic salmon.

Carcass attributes: Mucous cell counts, which have been reported to increase in fish at higher longterm swimming speeds and stocking densities, did not differ between bag and netpen in this test, nor did dressing loss (viscera and gills) during processing. However, visceral fat deposit, ranked independently by 2 observers, was higher in netpen fish, as was drip loss after 48 hrs refrigerated storage of fillets. Flesh color measured with a Roche SalmoFan™ under daylight spectrum lighting was deeper in the bag fish. Fin erosion (length) was assessed in relation to body length for both pectoral and both pelvic fins as well as the dorsal fin. No difference was found between bag and netpen salmon (Table 3).

Table 3. Carcass attributes (25 fish sampled from each source, matures dropped from tests where they affected outcomes).

	BAG	PEN	p level
Mucous cells/cm^2 (a)	605	626	NSD
Mucous cells/cm^2 (b)	518	675	NSD
Visceral Fat Index (footnote 2)	2.48	2.74	0.041
Dressing loss	13.72	14.43	NSD
Drip loss, %	1.51	2.53	0.001
Roche color, left side	28.80	27.21	0.000
Roche color, rt. side	28.76	27.21	0.000

Note a, b: Mucous cells were sampled at 2 sites on each fish

Fillet texture: Prepared fresh fillet samples were evaluated for firmness to the touch by a panel of judges using a recognized multiple-comparison food science testing procedure. No difference in texture was found, as variation within each source exceeded that between sources, and testers found differences between sample-pairs consistent and moderate.

Proximate and fatty-acid content: none of the gross body constituents or the gross energy content differed between bag and netpen fish (fillets) at harvest. Omega-3 (unsaturated) fatty acids were examined due to their widely accepted dietary value in maintaining circulatory system health in human consumers. While no difference was found in the fatty acid 'DPA', total omega-3 or omega-3 highly-unsaturated fatty acids, a difference was found in the fatty acid 'EPA', which was significantly higher in fish from the bag (Table 4).

Table 4. Proximate and fatty acid composition (25 fish sampled from each source, proximate values as % wet wt. basis except Gross energy, specific fatty acids as % of all fatty acids. Matures excluded from data analyses).

	BAG	PEN	p level
Moisture	65.88	66.88	NSD
Ash	2.36	2.53	NSD
Lipid	12.50	11.60	NSD
Protein	20.78	20.75	NSD
Gross energy, MJ/kg	9.86	9.49	NSD
EPA (20:5ω3)	9.96	9.40	0.022
DPA (22:6ω3)	14.18	14.28	NSD
Total ω3	30.71	30.20	NSD
ω3 HUFA*	24.14	23.67	NSD

* Highly unsaturated fatty acids

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Note to Tables: where a 'p level' is given for a comparison, this estimates by statistical test the probability that the difference between the 2 values arises by chance alone. Biological significance is usually assigned to differences with p values smaller than 0.05 (5%). NSD indicates 'no significant difference'.

Footnote 1: Condition factor is calculated by 100 X Wt (g) / Len^3 (cm)

Footnote 2: Visceral fat index is a ranking of the extent of visible fat deposits on the body's internal wall and organs, 0, 1 (sparse), 2 (moderate), 3 (abundant)

References

Iwama, G.K. and A. Tautz. 1981. A simple growth model for salmonids in hatcheries. Can. J. Fish. Aquat. Sci. 38:649-656.