Improved astaxanthin utilization in Atlantic salmon fed sulphuric acid extracted fish bone compounds

Albrektsen, Sissel; Østbye, Tone-Kari; Pedersen, Mona; Ytteborg, Elisabeth; Ruyter, Bente and Ytrestøy, Trine
Nofima AS, Kjerringdalen 16, N-5341 Fyllingsdalen, Norway. E-mail: sissel.albrektsen@nofima.no

In Atlantic salmon, digestive and absorptive processes, and metabolic turnover of astaxanthin (Ax), influence the utilization and flesh deposition of carotenoids. Usually, less than 10 % of ingested Ax is retained in the flesh of Atlantic salmon. In salmon 0+ smolt fed sulphuric acid extracted fish bone compounds, significantly increased plasma, liver and whole body concentrations were observed. A high Ax deposition rate in the flesh may be a result of increased Ax uptake in the intestine, decreased metabolic turnover of digested Ax or increased Ax uptake in the tissues. All of these potential altered Ax uptake and distribution mechanisms were studied in large salmon (1.7 kg), and the results used to understand the physiological impacts of sulphuric acid extracted fish bone compounds on Ax utilization.

Materials and Methods
Atlantic salmon (1.7 kg) were reared in 12 net-pens and fed a practical formulated control diet (D1), experimental diets added sulphuric acid (H2SO4) extracted fish bone hydrolysate (FBH) at respectively 2.1 % (D2) and 4.2 % (D3), and a diet added K2SO4 to study potential impacts of the chemicals used for mineral extraction, for a feeding period of 78 days. All diets were balanced to meet dietary phosphorus (P) requirement (8 g kg-1P). An in vitro cell culture study with hepatocytes collected from salmon (600 g) was performed to evaluate effects of the FBH ingredient on hepatic Ax uptake.

Results
The body weights increased from 1.7 to 2.5 kg and mean specific growth rate (SGR) was 0.52 ± 0.03 % for all diets. The FBH ingredient significantly increased specific Ax retention in muscle by 35 % in fish fed D3 (P < 0.05), as compared to fish fed D1 (Fig. 1 C). A tendency towards improved Ax digestibility (Fig. 1 A), and increased plasma and tissue Ax deposition (ns) was found in fish fed D3 (Fig. 1 B), compared to fish fed D1. Reduced metabolic turnover of Ax was indicated, with about 10 % more of absorbed Ax retained in the flesh of fish fed D3. The in vitro study showed no significant impacts of the fish bone compounds on hepatic Ax uptake (P > 0.05), Table 1.

Improved tissue Ax deposition in A. salmon 0+- smolt
Preliminary results in A. salmon 0+-smolt showed significant improved tissue Ax deposition in fish fed H2SO4 extracted fish bone compounds. The fish were fed a control diet with inadequate available P (D1: 0.33 g kg-1), adequate available P from inorganic P (D2: 7 g kg-1) or from HCl (D3: 6 g kg-1 diet) and from H2SO4 (D4: 7 g kg-1 diet) extracted fish bones. The growth was significantly highest in fish fed D2 and D4 (P < 0.05). Diet D4 increased Ax in plasma and liver with 55 and 29 % (P < 0.05), and in whole body with 22 % (ns), as compared to Diet 2. Diet 4, Diets D1 and D3 resulted in low plasma and tissue Ax deposition.

Summary and conclusion
- Sulphuric acid (H2SO4) extracted fish bone compounds significantly increased muscle Ax retention by 35 % in Atlantic salmon (2.5 kg), possibly explained by a tendency towards improved Ax digestibility followed by increased circulating Ax and tissue Ax deposition.
- Slightly reduced metabolic turnover of Ax was indicated in vivo, while no effect of H2SO4 extracted fish bone compounds on hepatic Ax uptake was found in vitro.
- Results obtained in Atlantic salmon reared at different life stages indicate that dietary addition of H2SO4 extracted fish bone compounds may improve Ax utilization.

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