



FIELD TRIAL DATA AND STUDIES

Aquasta[®] naturally-sourced astaxanthin has been proven as effective as synthetic astaxanthin through various feed manufacturing processes, production timelines and storage temperatures in commercial field trials involving fresh, frozen or smoked Atlantic salmon, Coho salmon and Rainbow trout.

FIELD STUDIES

This field study was conducted in Chile with the first group of fish pigmented with naturally-sourced Aquasta[®] and the control with a synthetic pigment. Approximately 85,500 fish were divided into 3 cages for this study. Each field trial used standardized groups of fish from the same species, stock and initial weight, both for Aquasta[®] and the control cages. Each study included no less than 2 cages per study, located at the same site, which ensured identical water conditions, currents and/or wind. Each group of fish in the same site was fed with the same diet composition, and same level of pure astaxanthin, differing only in the pigment source.



SAMPLING

Each cage was sampled, mainly on a monthly basis, until the fish group reached its harvest weight. All samples were sent to a lab for astaxanthin analysis to determine the color expression and overall pigment content in the fish flesh. Production information was collected for each sample, along with the weight and length of the whole fish. A color box was used to calculate a color score for each filet sample using a standardized light source.

FREEZING STUDY

To determine the possible losses of color in fish flesh during freezing, a three-month freezing study was conducted as soon as the fish were harvested. Identical filets were obtained from each fish, considering no less than 50 fish per treatment for the freezing study. Samplings were taken every 30 days and the filets were compared with their "copies" from each sampling.



ATLANTIC SALMON

Atlantic salmon is the main species farmed in Chile, and is mainly exported to the United States as fresh salmon. Although Japan has increased its consumption of Atlantic Salmon, the target color is higher, which has caused an increase in pigment consumption in the Chilean market.

A normal production cycle for Atlantic salmon lasts between 10 to 16 months in seawater to reach an average mean weight of 3.5 to 4.5 kilos. Pigmentation levels in Chile range from 60 ppm to 80 ppm astaxanthin for the whole production cycle, although it is necessary to conduct a follow-up program to determine the effectiveness of a given pigmentation strategy on color expression and astaxanthin content in the flesh. Diet composition is very similar, in terms of the protein/fat ratio among the feed suppliers, with high-energy diets being used more often.

Good retention and pigment level in the fish were obtained for both naturally-sourced Aquasta[®] and synthetic astaxanthin pigment sources in the feed. No significant difference was detected for pigment content and Color Card for both groups, with the common data trend indicating equal performance.

Freezing studies were also performed to demonstrate the stability of astaxanthin in the muscle. After the field trials concluded, samples were frozen and stored under normal freezing conditions, showing variation in pigment content and color after as many as 60 days.

Fig. 1: Astaxanthin in flesh and mean weight relationship in Atlantic salmon samples

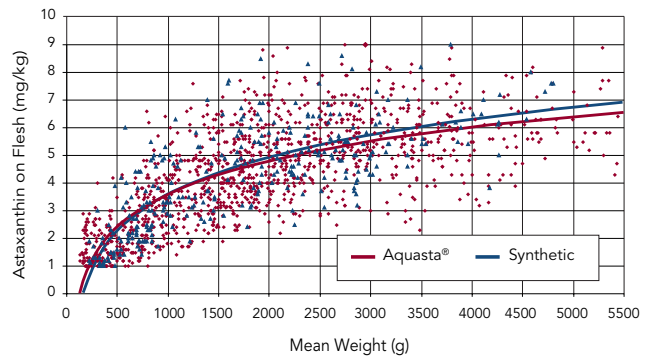


Fig. 2: Visual color and mean weight relationship in Atlantic salmon samples

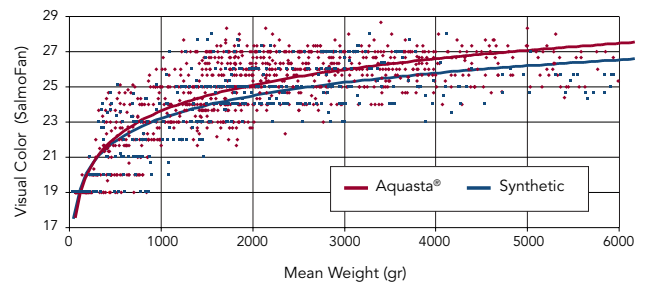
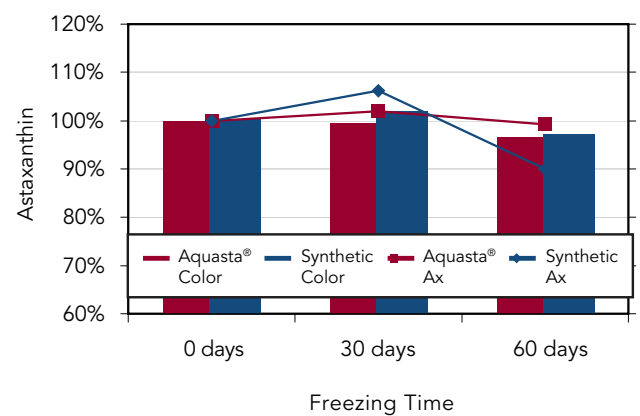


Fig. 3: Color percentage and astaxanthin level losses in Atlantic salmon samples



RAINBOW TROUT

Rainbow trout is the main salmon species exported to Japan from the Chilean market and the color score is the main quality parameter. Because of the great distance, all the fish must be frozen, therefore, the stability of astaxanthin during the freezing stage is a critical point.

A normal production cycle in the sea for Rainbow trout lasts from 6 to 11 months in Chile. In most farms, pigmentation strategies with high astaxanthin levels are required, which is necessary to meet the color requirements of the Japanese market. Pigment levels range between 70 ppm to 90 ppm astaxanthin for the whole production cycle.

Results showed no significant difference between naturally-sourced Aquasta[®] and synthetic astaxanthin, both for pigment content in the muscle and color at the harvest weight, with the data from each fish sampling following the same trend for astaxanthin content and color score.

Freezing studies were also performed on a group of fish pigmented with astaxanthin to demonstrate the stability of naturally-sourced Aquasta[®] and synthetic astaxanthin. The results clearly demonstrate that there was no significant loss in filet color and/or pigment content in the flesh for Rainbow trout stored for 135 days at minus 18 °C.

Fig. 4: Astaxanthin in flesh and mean weight relationship in Rainbow trout samples

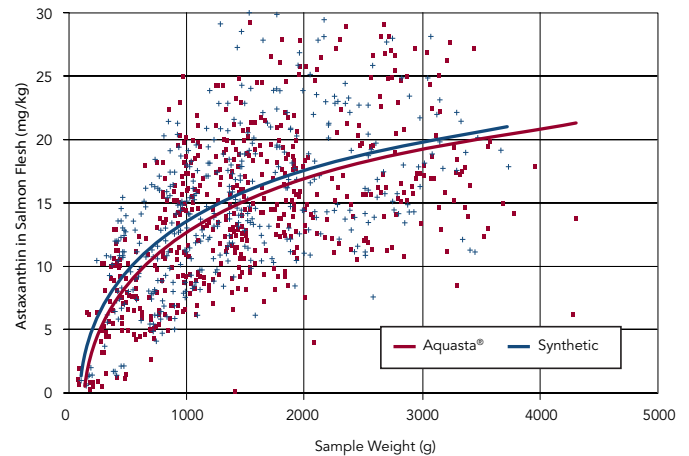


Fig. 5: Visual color and mean weight relationship in Rainbow trout samples

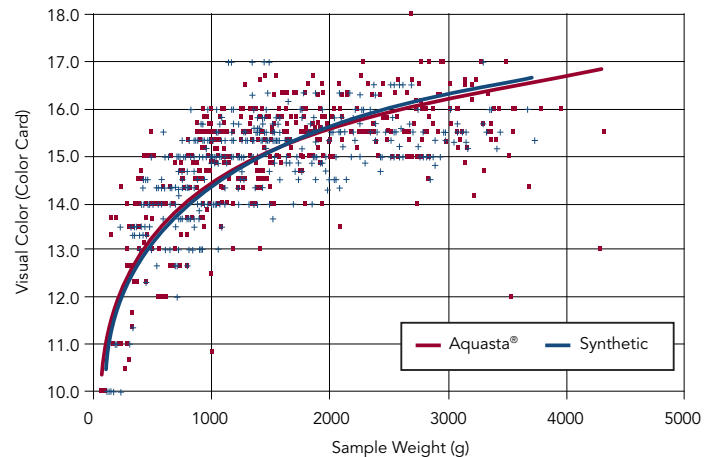
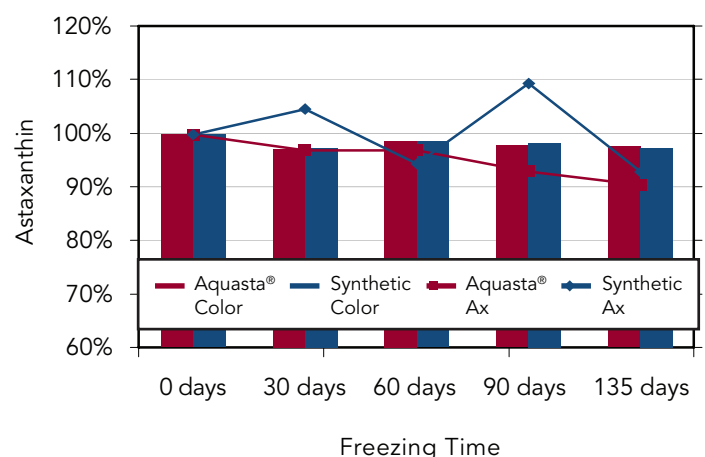


Fig. 6: Color percentage and astaxanthin level losses in Rainbow trout samples



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COHO SALMON

All Coho salmon produced in Chile is exported to Japan where color is the main indicator of high quality. High demands for pigments and pigmentation strategies are therefore the main focus for this species. Coho salmon has a very high retention percentage and very similar production cycles every year, making overall production easier. Since the introduction of smolt vaccination, survival rates have increased. Pigmentation strategies differed at each fish farming company, with the pigment level in the feed varying as much as 40 ppm to 80 ppm, even for the whole cycle. Retention was found to be very different among the participating companies throughout the study.

The study compares how naturally-sourced Aquasta® and synthetic astaxanthin are absorbed in the muscle along with a comparison of pigment level in the muscle. The pigment level is determined in this case, according to Color Card (11-18) and shows no difference between the two pigments.

The first graph shows all data for the astaxanthin level in the fish muscle at different fish sizes. The second graph shows a comparison of naturally-sourced Aquasta® and synthetic astaxanthin at different weights.

Fig. 7: Astaxanthin in flesh and mean weight relationship in Coho salmon samples

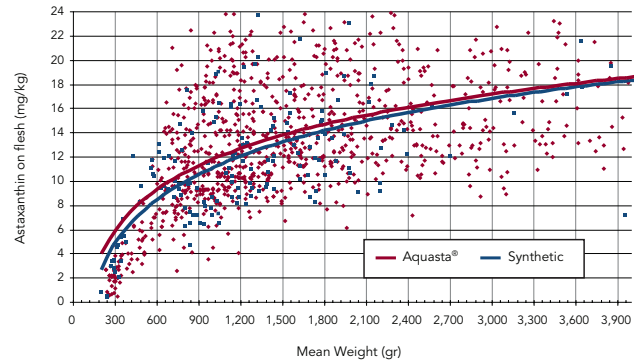
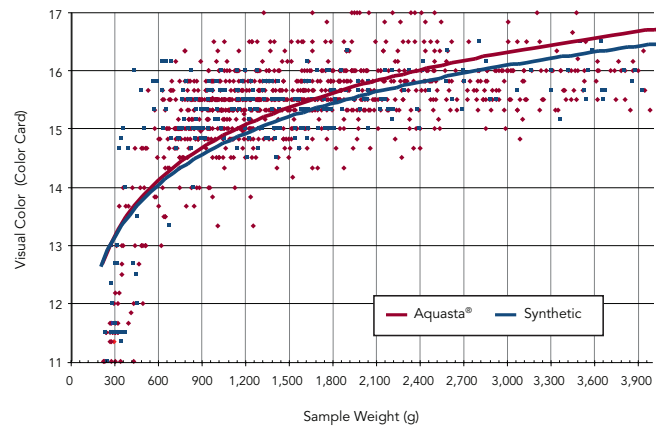


Fig. 8: Visual color and mean weight relationship in Coho salmon samples



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