The use of acidifiers in tropical and non-tropical fish and shrimp culture

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The promotion of environmentally sound practices in all fields of fish and shrimp production is a relevant point for the aquaculture industry if sustainability is to be achieved (Williams *et al*., 2000). However, in the field of aquaculture it is well established so far that the inclusion of antibiotics into the diets of fish (Ahmad and Matty, 1989) can promote growth and feed conversion. But the use of low levels of these antibiotics in animal feeds possesses the possibility to transfer bacterial immunity to species pathogenic in animals and humans (Liem, 2004). Due to the above mentioned facts alternatives needed to be found.

Since the use of fish silage from preserved fish and fish viscera included the acid preservation (Gildbert and Raa, 1977; Åsgård and Austreng, 1981) in-feed acidifier came into scientific observation too, since it was interesting to investigate the effects of these short-chain acids onto the fish directly. First with carnivore species, like Rainbow trout *Oncorhynchus mykiss*, Atlantic salmon *Salmo salar* and Artic charr *Salvelinus alpinus*, but also with herbivorous filter feeders, like tilapia, and also shrimp (Lückstädt, 2006).

Ringø (1991) fed Arctic charr on commercial diets with or without the supplementation of the sodium salts of lactic and propionic acid in brackishwater at 8°C. Inclusion rate of the sodium salts was 10 kg / t of feed. Fish fed the diet with added Na-lactate increased their weight from around 310 g to about 630 g within 84 days of the experiment, while the difference to the negative control group (final weight of fish: 520 g) was significantly ($p<0.05$). The inclusion of Na-propionate however had a growth depressing effect compared to the control. The gut content from Arctic charr fed the sodium-lactate supplemented diet contained significantly ($p<0.05$) lower amounts of water, energy, lipid, protein and free amino acids.

It has been observed that charr feeding on high doses of commercial feeds, as it often appears under aquaculture conditions, have a tendency for diarrhoea. When charr was feeding on Na-lactate no nutritive diarrhoea appeared, probably because of much lower amounts of remaining nutrients and water in the gut. Furthermore, it was proposed that the growth promoting effect of dietary lactate in Arctic charr is caused by the relatively slow gastric emptying rate (Gislason *et al.*, 1996). An increased holding time in the stomach augments the antibacterial potential of the lactic acid salt and can have therefore a larger inhibition effect against possible pathogenic bacteria (Sissons, 1989). The improved growth of the Artic charr did not affect the chemical composition of the fish (Ringø *et al*., 1994).

Feeding Na-lactate to Atlantic salmon juveniles (15 kg / t) however did not show such a prolonged effect (Ringø, 1994; Gislason *et al.*, 1996) compared to charr. Ringø found slightly increased survival rates in salmon feeding on lactate (84.8% compared to 80.1%), while Gislason *et al.* determined a higher specific growth rate SGR ((ln final weight – ln initial weight) x 100 / days of culture period). However, none of those differences were statistically significant.

These findings may suggest that the influence of lactate is a result of some differences in digestive physiology between the two fish species, for instance a longer retention time of lactate in the stomach in charr. But lower bacterial challenge, due to the use of the organic acid salt, may have lead to the tendency of higher survival rates.

Recently, a trial with organic acid salts was also carried out with Rainbow trout *Oncorhynchus mykiss* (de Wet, 2005). This study aimed to evaluate an organic acid blend (5 – 15 kg / t), mainly consisting of formate and sorbate, for its use in trout nutrition to improve performance parameters and compared it with some commonly used antibiotic growth promoters (40 ppm Flavomycin). Rainbow trout fingerlings feeding on 10 and 15 kg acidifier per ton of feed had significantly higher final weights compared to the negative control group after three months of feeding (three times a day to apparent satiety), while there was no difference to the group treated with AGP. Feed conversion ratio tended to be lower with increasing dosages of the acid blend, even if compared to the AGP group.

The results of this study showed that the application of the acidifier at 15 kg / t improved weight gain and feed conversion ratio in trout compared to a negative control by 20.1% and 14.8% respectively and was furthermore an alternative in the use of the AGP.

The use of organic acids however was not only tested in Salmoniformes, but also in tropical warm-water species, like tilapia or catfish. Ramli *et al.* (2005) tested the use of potassium-diformate as a non-antibiotic growth promoter in tilapia grow-out in Indonesia. In this study fish were fed over a period of 85 days 6 times a day different concentrations of potassium-diformate (0, 2, 3 and 5 kg / t feed). Furthermore, fish were challenged orally starting day 10 of the culture period with *Vibrio anguillarum* at 10^5 CFU per day over a period of 20 days.

Table 2: Effects of potassium-diformate on growth performance in tilapia challenged with *V. anguillarum*; data from Ramli *et al.* (2005)

Parameter	Control	2 kg / t acidifier	3 kg / t acidifier	5 kg / t acidifier
Initial weight (g)	16.7	16.7	16.7	16.7
Final weight (g)	218^{a}	258^{c}	246^{b}	252^{bc}
FCR	1.34^{a}	1.23^{b}	1.25^{b}	1.22^{b}
Mortality (%), day 10-85	33.0^{a}	20.8^{b}	18.4^{b}	11.0^{c}

^{abc}within rows, means without common superscripts are significantly different ($p<0.05$)

Over the whole feeding period from day 1 to day 85 potassium-diformate significantly increased the weight gain and feed efficiency in fed tilapia. Survival rates of fish after the challenge with *V. anguillarum* on day 10 were also significantly higher compared to the negative control and the effect was furthermore dose dependent.

The 2 kg / t inclusion of the potassium salt of the formic acid lead to an improvement in weight gain and feed conversion ratio in tilapia by 18.6% and 8.2% respectively and indicate furthermore that the chosen acidifier is able to counteract bacterial infections in tilapia.

Owen *et al.* (2006) tested the sodium salt of butyric acid as a feed additive in the omnivorous tropical catfish *Clarias gariepinus* at 2 kg / t in a fish meal based diet and in a defatted soya concentrates diet. No significant differences were found while supplying sodium butyrate if compared with the negative control. However, especially in the catfish fed on fish meal diet the SGR was seen to be slightly higher in the supplemented fish (% body weight gain 131.3% and 141.4% for control group and Na-butyrate group

respectively) with a concomitant reduction in the FCR of the supplemented fish. Subjectively sodium butyrate supplementation did appear to increase the proportion of gram positive bacteria in the hindgut of *C. gariepinus*, even though this increase was not statistically.

The beneficial application of organic acid salts was also proven by Tung *et al.* (2006) who used 5 kg / t Na-citrate next to inactivated Lactobacilla to boost the growth of the Kuruma shrimp *Masurpenaeus japonicus*.
Finally, a recent report (Lückstädt, unpublished data) suggests that a dosage of 2.5 kg / t Ca-formate can also enhance the survival rates in brackishwater shrimp grow-out in Taiwan. However, those achieved results must be evaluated in more than just one grow-out season.

Out of the above mentioned studies and trials can be concluded that the use of organic acid salts or acid blends is an interesting option to promote the performance of a wide variety of aquaculture species worldwide. It is furthermore suggested, that the impact of bacterial infections can be reduced which might lead to higher survival rates. The use of acidifier in aquaculture can be therefore an efficient tool to achieve a sustainable and economical fish and shrimp production.

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