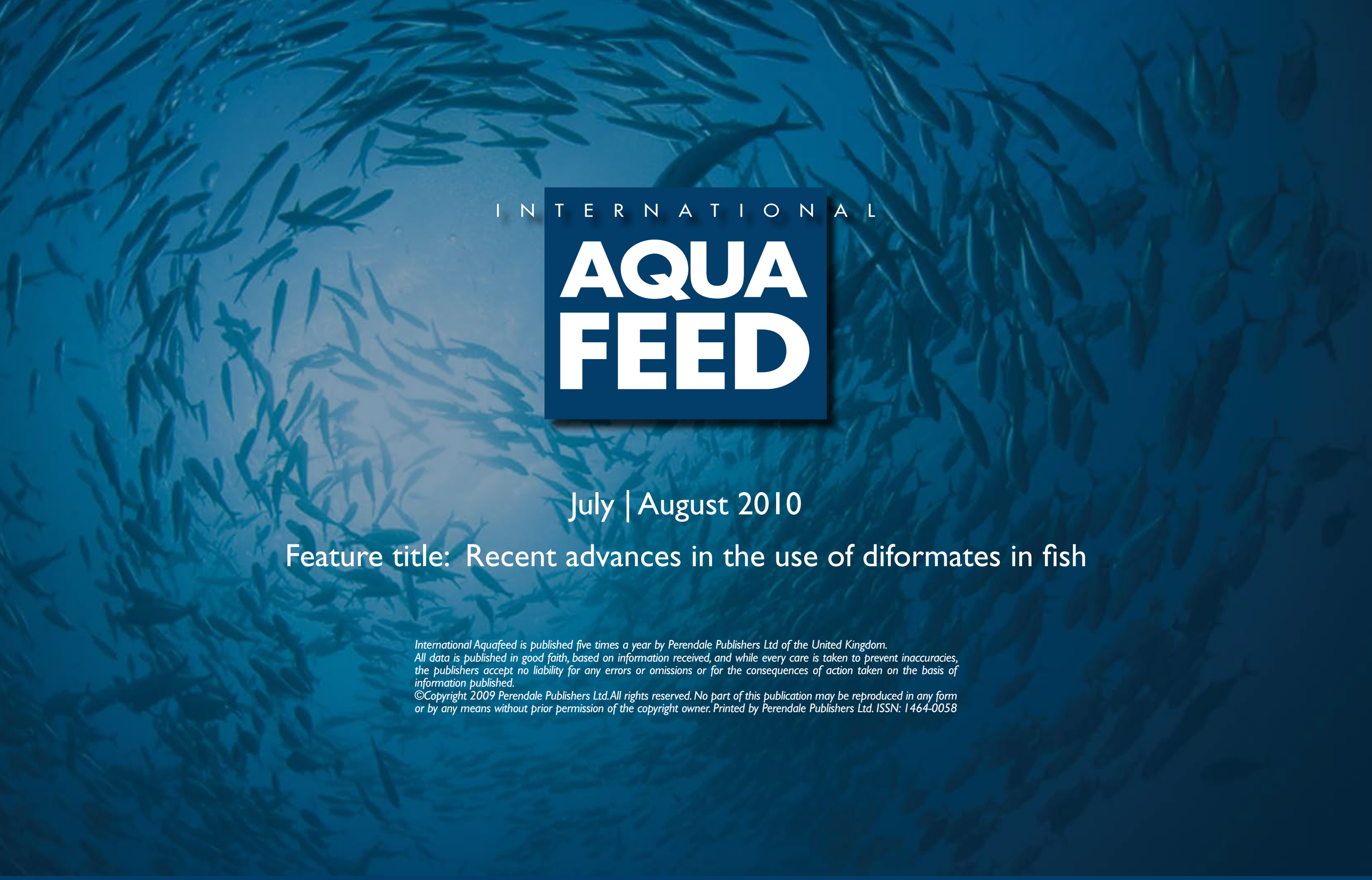

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Feature title: Recent advances in the use of diformates in fish

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Recent advances in the use of diformates in fish

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A summary of latest findings in respect to the effectiveness of diformates in fish nutrition

The use of acidifiers in aquaculture is currently gaining more interest among researchers as well as practitioners. A wide range of different organic acids and salts have been tested so far (Lückstädt, 2008). The mode of action of acidifiers in fish diets have been extensively described in Int. Aquafeed – Vol. 12, No. 2 in 2009. Diformates in particular have been used very regularly in tropical, as well as cold-water aquaculture, because of their high load of active ingredients on the one hand and their stability and handling properties in extruded feeds on the other.

Ramli et al. (2005) tested potassium diformate (potassium salt of formic acid) as a growth promoter in tilapia grow-out in Indonesia (see Table 1).

In this study, fish were fed over a period of 85 days, six times a day, diets containing different concentrations of potassium diformate (0%, 0.2%, 0.3% and 0.5%). The diets contained 32 percent crude protein, 25 percent carbohydrates, six percent lipids and 10 percent fibre. The fish were challenged orally starting day 10 of the culture period with Vibrio anguillarum at 105 CFU per day over a period of 20 days.

Over the entire feeding period from day one to 85, KDF significantly increased feed intake (P<0.01) and weight gain (P<0.01) as well as improved the feed conversion ratio significantly (P<0.01).

Furthermore, protein efficiency ratio was also significantly improved due to the addition of the formic acid double-salt (P<0.05). The improvement was best with 0.2 percent and 0.5 percent addition of the diformate. 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 dose dependent (P<0.01).

The authors concluded that the application of potassium diformate at 0.2 percent is an efficient tool to control bacterial infections in tropical tilapia culture.

Similar results were achieved by Zhou et al. (2008), who tested hybrid tilapia (Oreochromis niloticus x Oreochromis aureus) fingerlings (2.7 g initial weight) in a dose response study with potassium diformate (0%, 0.3%, 0.6%, 0.9% and 1.2%), while also comparing the results with an antibiotic growth promoter (8mg/kg Flavomycin).

During the 56-day trial period, tilapia fed all the potassium diformate enriched diets grew faster than the negative control (an increase of up to 11.6%), while fish fed 0.3 percent and 0.6 percent KDF achieved even better weight gain than the fish in the positive control group.

Table 1: Effects of potassium diformate (KDF) supplementation in diets on performance of tilapia challenged with V. anguillarum (modified from Ramli et al. 2005)

	Potassium diformate inclusion in diet (%)			
	0	0.2	0.3	0.5
Initial weight (g)	16.7	16.7	16.7	16.7
Final weight (g)	218a	258c	246b	252bc
FCR	1.34a	1.23b	1.25b	1.22b
Mortality (%), day 10-85	33.0a	20.8b	18.4b	11.0c

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

The authors speculated that dietary potassium diformate could stimulate a beneficial bacterial colonization of the intestine.

Dietary organic acids

A subsequent study with this highly effective substance was carried out in Malaysia (Ng et al. 2009). There, a 14-week feeding trial was conducted to determine the effect of dietary organic acids.

The experimental diet was added with 0.2 percent KDF and fed to triplicate groups of red hybrid tilapia.

Upon completion, tilapias were challenged with Streptococcus agalactiae.

Results clearly showed that total bacteria per gram of faeces were significantly reduced in diets containing potassium diformate. The number of adherent gut bacteria tended to be lower as well.

Furthermore, apparent digestibility of phosphorous was improved too – by nearly 11 percent in acidified diets.

Finally, cumulative mortality of fish fed no organic acids (58.3%) was higher compared with fish fed the potassium diformate supplemented diet (16.6%) at 16 days post challenge.

The Malaysian data showed that the inclusion of this acidifier can exert strong antimicrobial effects and have the potential to exert beneficial effects on nutrient utilization as well as disease resistance in tilapia. Organic acid salt may be therefore especially during the grow-out period of high importance for tilapia culture (Lückstädt 2008).

More work carried out

Recently, research groups in the Philippines as well as in Germany have concentrated their work again on the use of diformates in tilapia. Researchers from the Southeast Asian Fisheries Development Center – Aquaculture Department in Binangonan, Philippines (Cuvin-Aralar et al. 2010) looked at the effect of potassium diformate (KDF).

Table 2: Growth performance of tilapia after 42 days fed with or without sodium diformate NDF

	Control	NDF (0.3%)	P-level
Number of fish	160	160	-
Initial weight (g)	34.0	33.9	n.d.*
Final weight (g)	70.9	75.5	n.d.
Weight gain (g)	36.9	41.6	0.098
FCR	1.46	1.29	0.007

**n.d. – not determined*

Twenty-five male Nile tilapias with a mean weight of 7.84±0.90 g were stocked in eight 240-litre polyethylene tanks in a static-renewal system. Fish were reared for 74 days. Proximate composition of the commercial feed was 31.4 percent crude protein, 6.9 percent crude fat, 8.6 percent crude fibre, 52.3 percent NFE and 0.8 percent ash as well as a gross energy of 17.3 kJ g-1. The fish in both the control and KDF treatment were given the appropriate feed with a daily ration equivalent to 5 percent of their body weight. Feed was dispensed thrice a day at 0800h, 1200h and 1600h. Water parameter as well as growth performance of fish were monitored regularly.

Diet supplemented with KDF yielded improved growth data, based on daily growth rate as well as specific growth rate (P<0.01). Tilapia in the control group reached a mean body weight of 45.5±1.1 g, while the fish fed with potassium diformate reached an average weight of 51.4±2.2 g. Likewise, feed conversion ratio was improved significantly (P<0.05).

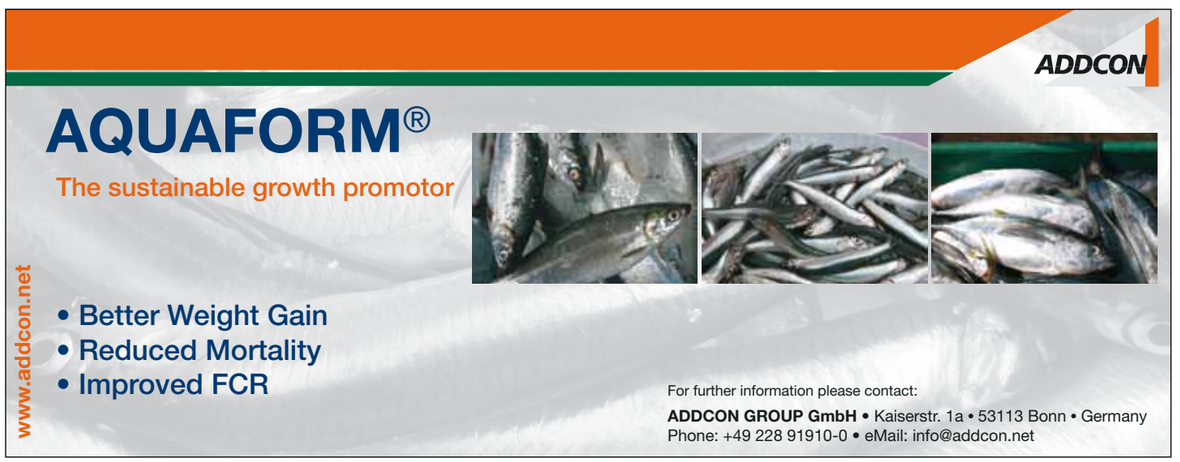
The results show that addition of 0.3 percent KDF in the diets of Nile tilapia can help to improve its growth performance and thus, can achieve a more economic and sustainable tilapia production.

Furthermore, the additive optimizes feed efficiency, which is in full agreement with previously reported improved digestibility parameters after the inclusion of KDF in fish feeds.

Double salt feed additive

Researchers from the Göttingen University in Germany (Liebert et al. 2010) focused on the most recently developed double salt feed additive – sodium diformate, which is also produced at Addcon's production site in Norway.

Preliminary data from a semi-closed re-circulating system showed promising



results on the use of sodium diformate (NDF) at 0.3 percent inclusion rate in tilapia fingerling rearing (see Table 2).

This new additive caught the interest of researchers from the APC in As, Norway. Morken et al. (2010) showed two studies during the ISFNF in China in June 2010 which included NDF in fish feed, especially for trout.

Results from the first study, entitled "Sodium diformate and extruder temperature affects physical quality of barley protein concentrate-based fish feed" highlighted that the physical quality (hardness, water stability index) of BPC-based fish diets could be improved by optimizing extruder temperature and by adding NDF.

Table 3: Growth performance of milkfish fed with or without potassium diformate KDF

	Control	KDF (0.3%)	P-level
Initial body weight [g]	12	24	n.d.*
Final body weight [g]	307	311	n.d.
Culture period [d]	193	175	n.d.
ADG [g]	1.60	1.81	0.08
FCR	2.52	2.26	0.06
Survival [%]	91.4	90.6	0.37

n.d. – not determined

The second study, entitled "Effect of sodium diformate and extruder temperature on nutrient digestibility in rainbow trout fed barley protein concentrate-based diets" lead to significant improvements in apparent digestibility of crude protein and crude fat, as well as essential amino acids in Rainbow trout.

Latest results from Auburn University, USA (Lim et al. 2010) are in full agreement with the above mentioned tilapia trials, since tilapia fed with increasing dosages of KDF (from 0.25% to 1.00%) showed increased weight gains.

Addcon recently announced the successful test of its acidifier range, based on the diformate technology, in yet another fish species (see Table 3).

A commercial scaled trial in milkfish marine cage culture was recently completed.

First results showed clear tendencies ($P<0.1$) of KDF on growth (13% surplus in weight gain) and feeding efficiency (FCR improved by more than 10%) at inclusion rates of 0.3 percent.

Conclusion

In general the authors concluded that data achieved under high hygienic conditions at laboratory scale will lead to even more pronounced effects of diformates in the field. It is therefore highly recommended to include organic acid salts, like diformates, in the ration of growing fish under tropical conditions.

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