Algae and clay association to improve digestive performance in aquaculture species

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With the current trend of finding fishmeal replacements in terrestrial plants a lot of attention is being given to finding a balanced mix of ingredients to fulfil the nutritional requirements of the target species. However the bioavailability of nutrients from this mix of ingredients is equally important. Carnivorous species more so than herbivorous or omnivorous species are more difficult to satisfy with ingredients other than fishmeal.

Fishmeal fulfil the nutritional requirements for any species and in particular carnivorous species. It is also highly digestible making all the nutrients available to meet these requirements.

Nevertheless all groups of species need to find a balance between a limited resource and the increasing use of new raw materials in the ever growing aquaculture segment. Wild catch has reached a maximum while aquaculture has continued to grow at a rapid pace. In order to continue growing alternative ingredients have to be included in increasing amounts to meet the demand for quality aqua feeds without negatively affecting performance.

Technological advancements and understanding of nutritional requirements have allowed for the optimization of the use of alternative ingredients, such as from plant sources. However, the digestive process can also be optimized to get the most out of the aqua feeds, when using ingredients other than the favoured fishmeal.

Olmix has combined algae and clay, two natural raw materials, and created a digestive enhancer through patented technology which has improved feed performance by means of better digestion of feeds and thus making more nutrients available to fill the growing needs of various aquaculture species.

CLAY-ENZYME COMPLEXES

Reichardt (2008) and Habold et al (2009) both report the ability of clays to favour the contact between enzymes and nutrients, and thereby improving the rate of digestion of feed. Indeed, digestive enzymes need to be in contact with their substrate in order for hydrolysis to occur. The physio-chemical interactions of enzymes with clay particles seem to enhance the contact between digestive enzymes and feed. This makes clay a good supporting matrix for enzymes and acts as a meeting point for enzymes to be in contact with their substrate. Cabezas et al (1991) demonstrated that clay-enzyme complexes are formed at enteric pH values. These active stable complexes are resistant to proteolysis and increase the amount of active digestive enzymes in the intestine, thus improving nutrient digestibility. In the same way, Habold et al (2009) observed higher pancreatic lipase activity in rats supplemented with Kaolinite; Xia et al (2004) showed an increase in small intestinal digestive enzymes activities on broilers supplemented with Montmorillonite; and Paolo et al (1999) observed an increase in protein and energy retention coefficients for growing pigs supplemented with clay. Some studies also suggest that the increased activity of enzymes in contact with clay, not only comes from their stabilisation, but also from the presence of cofactors in the clay (Reichardt, 2008; Habold et al, 2009). Cofactors are defined as thermostable non-protein compounds that form the active portion of an enzyme system. In other words, cofactors are helper molecules required for enzymes to be active. They can be organic or inorganic, most commonly vitamins in the first case and metallic ions in the latter. Clays are layered mineral materials, composed of a succession of aluminium and silicon based sheets, which vary according to the type of clay. In montmorillonite, several metallic ions

replace some aluminium and silicon ions in the structure. Known as the substitution phenomenon, this event provides montmorillonite part of its physiochemical reactivity. Moreover, the presence of metallic ions may contribute to the activation of some enzymes, through their action as cofactors (Niederhoffer, 2000). Ions present in these complexes such as copper is known to activate lipase and phospholipase A (Jondreville et al, 2002) and zinc is a required cofactor of carboxypetidase (Williams, 1960), to mention only a few examples.

Table 1. Growth performance in Atlantic salmon.

Parameters	Control	MFeed+	Variation[1]
Initial mean weight (g)	45.2	42.6	-2.6
Final mean weight (g)	70.4	77.7	+7.3
Feed per fish (g)	37.5	44.3	+6.8
SGR	0.29	0.39	+35%*
GF3[2]	0.71	0.95	+34%†
FCR	1.48	1.29	-13%

*[1]Analysis of variance: *P<0.05, †P<0.10*
[2]GF3, or thermal growth coefficient, is an assessment of growth performance which accounts for the effect of temperature.

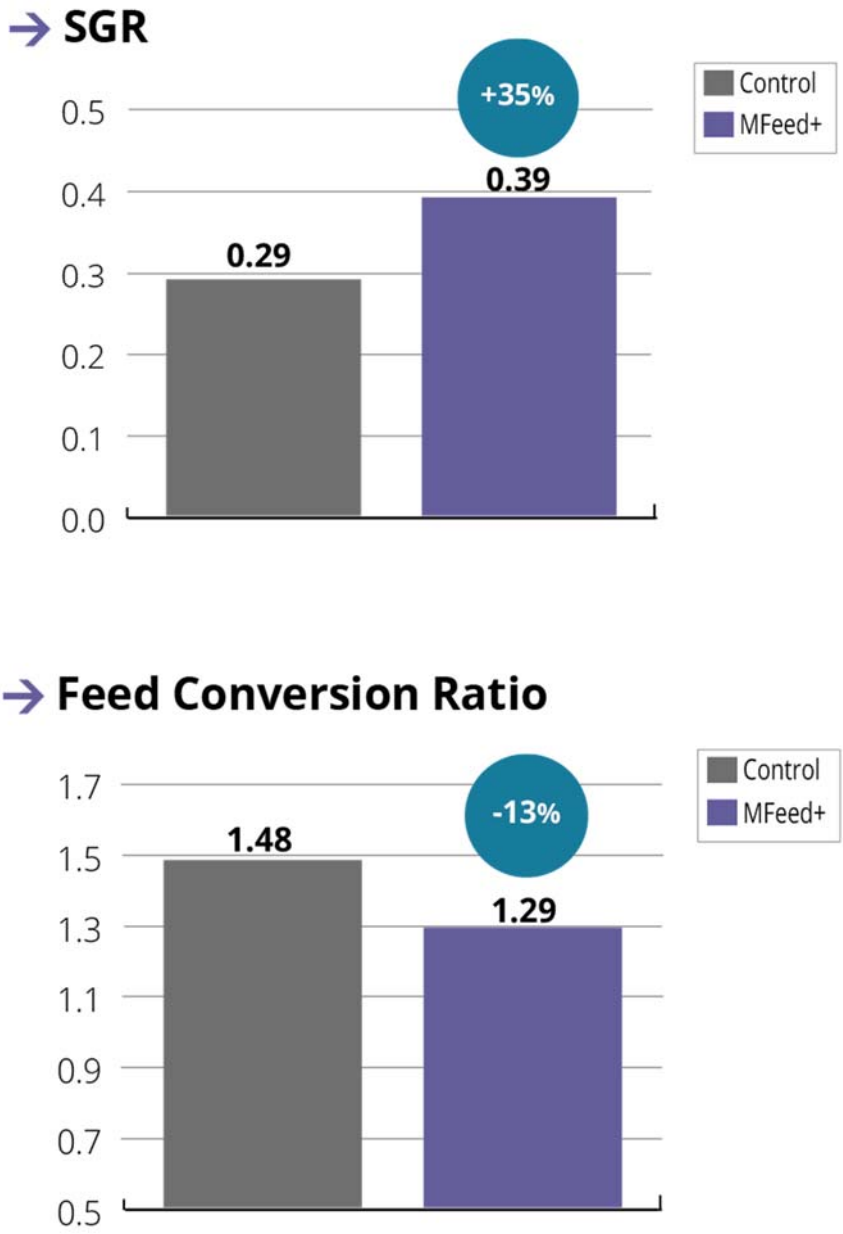
COMBINATION WITH SEAWEEDS

The matrix support provided by the clay and the cofactor effect coming from the metallic ions present in the clay structure can be referred to as biocatalysis: the improvement of performance of a biochemical reaction through the action of an external compound, a biocatalyst. Due to a large variety of clay minerals, one can imagine that not all clays have the same potential for biocatalysis. This depends mainly on their type, their purity, their place of origin or their treatment. For example, clay structure can be modified and associated with other materials in order to increase its biocatalytic properties. This association of materials to improve digestive capacity is the innovative technology that has been developed by Olmix group (France) in the framework of its research programme conducted on seaweeds and clays. The micronized form allows a fine dispersion of the product in the intestine, providing many sites of reaction of enzymatic digestion with easily accessible metal ion cofactors. Moreover, there is beneficial synergy between clay and seaweeds increasing biocatalysis, as seaweeds bring in a vast diversity of metallic ions, sometimes absent in feed, which are required cofactors for the activation of several enzymes. This unique combination of

seaweeds and clay makes it a unique tool to boost enzyme activity, through the action of biocatalysis, and therefore digestive performance.

The product (MFeed+) resulting from the association of seaweed and clay was trialled on various aquaculture species with consistent results. Following excellent results with *L. vannamei* (results showing significant improvement of growth rate, FCR and gut health published in Aqua Feed, December 2014 issue, p 15-19), a new trial was set up with Atlantic Salmon. A commercial fresh water facility producing Atlantic salmon smolts tested MFeed+ for five months, under winter conditions from November to April, on pre-smolts prior to transfer to salt water conditions. 97,000 pre-smolts were distributed over 6 tanks (3 control replicates and 3 treatment replicates) and standard farm protocols were followed. After five months results showed a significant 7% increase in growth performance for the group fed with the algo-clay supplement. A strong 13% decrease in food conversion rate also suggest an improved feed utilization and improved digestive performance (Table 1). Finally this being a commercial trial, a sea lice treatment was given through the feed. All measurements showed there was no negative effect on the uptake of the sea lice treatment.

In this follow up trial yet another aquaculture species has shown significantly improved performance when MFeed+ is supplemented to the feed.



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