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SATA: The Silicic Acid Technology for Aquaculture

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ABSTRACT

Since 2017, research has been conducted into the effects of (mono-)silicic acid (product: AB SiliFish®) on fish and shrimp.

The aim of the present study is to investigate the effects of stabilized silicic (sSA) on the growth, yield and survival of four fish species: Rohu, Catla, Tilapia and Pangasius in 0.5 ha freshwater ponds for 240 to 360 days.

In addition, two forms of applications and two dosages were investigated: a. application of silicic acid to the pondwater and b. mixing the product with fish feed using two dosages.

Water quality was monitored using physico-chemical analyses and the effects on other aquatic organisms, such as phytoplankton and zooplankton, were analysed.

The results showed that growth, survival, feed utilisation and yield of all four fish species increased significantly with both application types, while mixing the product with fish feed at a dosage of 2 ml/kg was higher compared to application in pond water.

Physicochemical parameters were also improved, while plankton abundance increased significantly.

It is concluded that SATA (Silicic Acid Technology for Aquaculture) significantly increased yields of many fish species compared to controls, as well as water quality.

SATA has no negative effects on fish or water quality and is an environmentally friendly technology that reduces the carbon footprint.

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Introduction

Inland aquaculture of fish and shrimp is important because its economic, environmental, and social contributions. Aquafarming plays a crucial role in food security, livelihoods, and sustainable resource management. There is an increasing demand for aquatic products, also because the growing global population, and the demand for protein rich foods like fish and shrimp.

Pond based aquaculture allows for controlled environments where fish and shrimp can be reared efficiently.

Till recently all kinds of products have been used to increase production including antibiotics to prevent or treat diseases. Due to the growing antimicrobial resistance (AMR) in aquaculture, many countries, including the European Union, have restricted or even stopped the use of antibiotics. Therefore, effective, safe and environmentally friendly products to improve the immune status of fish and shrimp and increase production are important.

Recently a new technique has been introduced, which matches with these requirements, SATA, the Silicic Acid Technology in Aquaculture, a patented technology, based on the application of stabilized silicic acid, a silicon compound.

Silicon is the second most common element in the earth's crust (27,2%), after oxygen (46,6%). Silicon concentrations in natural waters typically are reported in terms of SiO2 and usually range from 5 to 25 mg/L in freshwater bodies. The global average for silica in river water is 13.1 mg/L. Normal seawater contains 6.4 mg/L silica.

Until now, the importance of silicic acid for the growth of algae and aquatic plants has been underestimated. The same happened in agriculture, but in the last 2 decades, a lot of research has been published on the effects and benefits of silicon compounds, demonstrating the importance of 'silicon', and in particular silicic acid, for improving plant growth and yield, and its role in mitigating the effects of abiotic and biotic stresses [1].

Silicon (Si) is now recognized as an important, even essential, element for plants (and animals). The application of silicon, as mono-silicic acid, the only biologically available silicon compound, has multiple effects on plant growth and cell function.

In the last decade, silicon has been shown to have similar effects in (micro-)algae and many aquatic plants as in land plants [2]. Therefore, there is growing awareness of the role silicon plays in increasing production levels in aquaculture.

It has been shown that silicon products such as silica or silicates can stimulate the growth of diatoms [3]. The effects of the application of silica/silicates in aquaculture show a higher growth rate of algae and aquatic plants and a (marginal) improvement of the water quality, resulting in a (modest) increase in the growth and yield of fish and shrimp.

In natural water systems, Si is present in various forms, such as mono-silicic acid, polysilicic acid and other silicon compounds. But only mono-silicic acid [$Si(OH)4$] is bioavailable and bioactive to every life form. Sufficient concentrations of mono-silicic acid stimulate the growth and population of diatoms [4]. This increases zooplankton, fish, and other aquatic animals that rely on diatoms for nutrition.

Low concentrations of silicic acid result in a decline in diatom populations, which results in a shift in the composition of phytoplankton communities and favours other types of algae (such as cyanobacteria and dinoflagellates) that do not require silicon [5]. This can cause harmful algal blooms, which produce toxins that are harmful to marine life and disrupt the balance of aquatic ecosystems.

Overall, (mono-)silicic acid plays a vital role in the 'Silicon Cycle', the natural cycle of silicon in aquatic ecosystems and its role in supporting the health and growth of many aquatic organisms.

To increase shrimp and fish production and minimize the environmental impact of aquaculture, maintaining and regulating the growth and composition of plankton communities and nutritional balance are crucial. Mono-silicic acid is an essential nutrient for the growth of diatoms and other aquatic microorganisms.

In pond waters, the concentrations of mono-silicic acid and polysilicic acid decrease significantly (by 35-90%) during shrimp farming [6].

To address this decline in silicic acid concentration, trials have been conducted since 2017 on the application of the only bioavailable and bioactive silicon compound, mono-silicic acid, to evaluate the effects on fish and shrimp growth.

Because silicic acid is a very instable molecule, a technique has been developed to stabilize silicic acid. With this stabilized (mono-)silicic acid (= sSA), product name AB SiliFish®, trials have done in ponds, lakes and tanks to stimulate the growth of all aquatic organisms.

The effects: higher growth rates and yields of fish and shrimp. Plankton is also stimulated due to the increased concentration of sSA, as well as other related phytoplankton organisms and algae, which in turn cause a bloom in organisms that consume them in the food chain [7].

Other important aspects are the effects on water quality, which show a higher growth capacity of shrimp and effects on the genes. Several genes of the shrimp were upregulated, genes that improve digestion, promote an improved growth response and increase disease resistance in shrimp [8].
The economic benefits of using sSA show a positive result, as the application of sSA significantly reduces the cost of feed for profit [7].

SATA, the silicic acid technology for aquaculture, is safe and environmentally friendly and ensures a better and more efficient use of natural resources that are important for the circular economy.

In trials in India, Bangladesh, Vietnam and Malaysia, sSA was applied in natural water systems to evaluate the effects on the growth and health of various fish species such as Rohu, Catla, Tilapia and Pangasius, and the shrimp species L. vannamei and P. monodon. All these studies, investigating the effects of the application of sSA on fish and shrimp, showed similar positive results.

In shrimp (L. vannamei) trials in Thailand (2021/2022), significant effects were observed in achieving optimal pH to reduce alkalinity, stabilization for increased and consistent dissolved oxygen (6.5 ppm), and significant reductions in ammonia from 2.7 to 0.38 ppm. Superior performance in shrimp yield (+20%), average live weight (+13.5%), and a reduction in FCR from 1.68 to 1.41 were recorded during a 135-day rearing period under farm conditions [7].

Research Project
Based on these previous results, on-farm trials were conducted to assess the effects and effectiveness of the application of stabilized mono-silicic acid (product: AB SiliFish®) to freshwater aquaculture of 4 species of fish: 1. Rohu, 2. Catla, 3. Monosex Tilapia and 4. Pangasius, at 4 different fish farms in Gujarat, India.

In previous studies, two different forms of administration were used: a. the administration of monosilicic acid to the pond water and b. the application of sSA to the fish feed (with different concentrations of sSA). The aim of this study was to compare the effectiveness of both administration procedures and to assess the optimal dose of stabilized mono-silicic acid when applying sSA to fish feed to 4 different fish species.

The objectives of the study are to assess in the 4 fish species:
- the effects on growth and yield;
- the survival rate(s);
- the differences in efficacy between administering sSA directly to the pond water or via administration via food;
- the effects of administering high dosages ('overdose') via food;
- the effects on physico-chemical parameters of the water of the ponds;
- the effects on the abundance of plankton in the experimental ponds.

Materials and Methods
Product: in all trials the product SiliFish© was used, a liquid containing stabilized silicic acid (2.5%) with the micronutrients: boron (0.2%), manganese (0.3%) and zinc (1.5%). AB SiliFish© is a concentrated product that must be diluted before use.

Ponds: the average surface area of the fishponds was 0.5 hectares, with a depth of 1.3 – 1.7 m., depending on the fish species. The pond preparations and water quality management were done in accordance with best practice guidelines.

Fish Seeds, Stocking Densities and Duration of the Trials in 20223/2023
High-quality fish seeds from reliable hatcheries were used.
The fingerlings were reared in earthen ponds of 0,5 ha, with a stocking density (= #) and during a period of: Rohu: #3500 / 360 days, Catla: #3500 / 360 days, Monosex Tilapia: #3000 / 360 days and Pangasius: #3000 / 240 days period.

Feed and Feeding Frequency

The formulation of the feed was in accordance with the requirements of the different fish species. The feeding frequency was in accordance with the developmental stages, the fish species and the water temperature. The feeding frequency was reduced during extreme water temperatures (<15°C or >30°C).

Application and Dosage of Stabilized Silicic Acid (AB SiliFish®)

G1: control: no application.

G2: administration to pond water: dosage of sSA: 0.5 L in a pond of 0.5 ha every two weeks. sSA product is diluted 20 times in advance with water and then administered to the pond water, while stirring continuously using a dosage control system.

G3: sSA product is diluted 10 times with water and next mixed with feed pellets at a dosage of 2 ml per kg feed and spread each morning over the pond.

G4 (= 'overdose'): sSA product SiliFish© is diluted 10 times with water and next mixed with feed pellets at a dosage of 4 ml per kg feed and spread each morning over the pond.

Results

The results of the application of dissolved sSA on growth performance, survival rate, feed utilization and yield, are presented in Table 1: Rohu, Table 2: Catla, Table 3: Monosex Tilapia and Table 4: Pangasius.

Results on Rohu (Labeo Rohita)

The results of the administration of sSA to Rohu (Table 1) show a significant increase in growth parameters, survival and feed utilization in the trial arms G2 and G3 compared to control: the fish yield increased in G2 (water application): +19,1% and in G3 (feed application): +26,1%, compared to control (G1). Feed conversion and feed efficiency in trial arms G2 and G3 were improved accordingly. In G4 (trial arm with 'overdose' sSA) the fish yield decreased: -4,3%. Survival increased by + 5,7% in G2 and 8,6% in G3. In G4 ('overdose') the survival rate decreased by -2,3%.

Table 1: Growth Performance, Survival, Feed Utilization and Production Performance of Rohu, 360 Days Rearing Period.

Parameter	G1	G2	G3	G4
Ponds area (ha)	0.5	0.5	0.5	0.5
Stocking density (Nº)	3500	3500	3500	3500
Culture period (days)	360	360	360	360
IBW-gm	10.5	10.5	10.5	10.5
FBW-gm	835	939 = + 12,5%	968 = + 15,9%	818 = - 2%
WG-gm	825	929	958	808
ADG	2.29	2.58	2.66	2.24
IL-mm	91	92	90	91
FL-mm	382	386	396	376
LG-mm	291	294	306	285
FCR	2.3	2.15	1.87	2.4
FER	0.43	0.47	0.53	0.42
SURVIVAL (%)	87	92 = + 5,7%	94.5 = + 8,6%	85 = - 2,3%
Harvested Biomass (Production in gm)	2511	2990 = + 19,1%	3167 = + 26,1%	2402 = - 4,3%

IBW-gm: initial body weight in grams; FBW-gm: final body weight; WG: weight gain in grams;
ADG: average daily gain; IL: initial length; FL: final length; LG-mm: length gain;
FCR: feed conversion rate; FER: feed efficiency rate.

Dosage protocol: G1=Control; G2=1.5 L sSA every 15 days (pond application); G3=2 ml sSA/kg feed (feed application) and G4=4 ml sSA/kg feed (feed application).

Results on Catla (Catla catla)

The results of sSA administration to Catla (Table 2) show equivalent results compared to Rohu: growth parameters (body weight and length) in G2 and G3 increased significantly. The fish yield increased in G2 (water application): +15.9% and in G3 (feed application): +23.9%. Feed conversion and feed efficiency in trial arms G2 and G3 were improved accordingly. In G4 ('overdose') fish yield decreased: -7.7% compared to the control. The survival increased by +9.5% in trial arm G2 and 10.7% in trial arm G3. In G4 ('overdose') the survival rate decreased by -6%.

Table 2: Growth Performance, Survival, Feed Utilization and Production Performance of Catla, 360 Days Rearing Period.

Parameter	G1	G2	G3	G4
Ponds area (ha)	0.5	0.5	0.5	0.5
Stocking density (Nº)	3500	3500	3500	3500
Culture period (days)	360	360	360	360
IBW-gm	11.3	11.2	11.4	11.5
FBW-gm	935	989 = + 5,8%	1045 = + 11,8%	918 = - 1,8%
WG-gm	924	978	1034	907
ADG	2.57	2.72	2.87	2.52
IL-mm	95	97	99	100
FL-mm	387	394	406	386
LG-mm	292	297	307	286
FCR	2.1	1.98	1.76	2.25
FER	0.48	0.51	0.57	0.44
SURVIVAL (%)	84	92 = + 9,5%	93 = + 10,7%	79 = - 6%
Harvested Biomass (Production in gm)	2716	3149 = + 15,9%	3364 = + 23,9%	2506 = - 7,7%

IBW-gm: initial body weight in grams; FBW-gm: final body weight; WG: weight gain in grams;
ADG: average daily gain; IL: initial length; FL: final length; LG-mm: length gain;
FCR: feed conversion rate; FER: feed efficiency rate.
Dosage protocol: **G1**=Control; **G2**=1.5 L sSA every 15 days (pond application); **G3**=2 ml sSA/kg feed (feed application) and **G4**=4 ml sSA/kg feed (feed application).

Results on Tilapia (Monosex Tilapia)

The results of sSA administration to Tilapia (Table 3) show equivalent results compared to Rohu and Catla: growth parameters (body weight and length) increased significantly, and fish yield increased in G2 (water application): +10.6% and in G3 (feed application): +28.9%. Feed conversion and feed efficiency in trial arms G2 and G3 were improved accordingly. In trial arm G4 ('overdose'), fish yield decreased: -4.1% compared to the control. Survival rate increased by +0.5% in trial arm G2 and 6.1% in trial arm G3. In G4 ('overdose') survival rate decreased by -0.9%.

Table 3: Growth Performance, Survival, Feed Utilization and Production Performance of Tilapia After 360 Days Rearing Period.

Parameter	G1	G2	G3	G4
Ponds area (ha)	0.5	0.5	0.5	0.5
Stocking density (Nº)	3000	3000	3000	3000
Culture period (days)	360	360	360	360
IBW-gm	14.3	16.3	15.4	16.6
FBW-gm	625.1	688.5 = + 10,1%	757.33 = + 21,1%	607.33 = - 2,8%
WG-gm	610.7	672.17	741.96	590.73
ADG	1.70	1.87	2.06	1.64
FCR	1.83	1.63	1.52	1.86
FER	0.55	0.61	0.66	0.54
SURVIVAL (%)	91.4	91.9 = + 0,5%	97 = + 6,1%	90.6 = - 0,9%
Harvested Biomass (Production in gm)	1675	1853 = + 10,6	2159 = + 28,9%	1606 = - 4,1%

IBW-gm: initial body weight in grams; FBW-gm: final body weight; WG: weight gain in grams;
ADG: average daily gain; IL: initial length; FL: final length; LG-mm: length gain;
FCR: feed conversion rate; FER: feed efficiency rate.
Dosage protocol: G1=Control; G2=1.5 L sSA every 15 days (pond application); G3=2 ml sSA/kg feed (feed application) and G4=4 ml sSA/kg feed (feed application).

Results on Pangasius (Pangasius pangasius)
The results on Pangasius (Table 4) show equivalent results compared to Rohu, Catla and Tilapia: significant increases of the yields + 24,3% and + 39,1% for G2 and G3 respectively, but not for G4 ('overdose'): -4,7%.
The feed conversion rate and feed efficiency rate in trial arms G2 and G3 were improved accordingly. In G4 ('overdose').
The survival rate increased with + 14,1% in trial arm G2 and 16,7% in trial arm G3. In G4 ('overdose') the survival rate decreased: -2,6%.

Table 4: Growth Performance, Survival, Feed Utilization and Production Performance of Pangasius After 240 Days Rearing Period

Specimen	G1	G2	G3	G4
Ponds area (ha)	0.5	0.5	0.5	0.5
Stocking density (Nº)	3000	3000	3000	3000
Culture period (days)	240	240	240	240
IBW-gm	40	40	40	40
FBW-gm	997	1082 = + 8,5%	1182 = + 18,6%	976 = - 2,1%
WG-gm	956.9	1041.83	1140.65	935.84
ADG	3.99	4.34	4.75	3.90
IL-mm	135	137	139	138
FL-mm	389	414	426	396
LG-mm	254	277	287	258
FCR	2.21	2.1	1.84	2.35
FER	0.45	0.48	0.54	0.43
SURVIVAL (%)	78	89 = + 14,1%	91 = + 16,7%	76 = - 2,6%
Harvested Biomass (Production in gm)	2239	2782 = + 24,3%	3114 = + 39,1%	2134 = - 4,7%

IBW-gm: initial body weight in grams; FBW-gm: final body weight; WG: weight gain in grams;
ADG: average daily gain; IL: initial length; FL: final length; LG-mm: length gain;
FCR: feed conversion rate; FER: feed efficiency rate.
Dosage protocol: G1=Control; G2=1.5 L sSA every 15 days (pond application); G3=2 ml sSA/kg feed (feed application) and G4=4 ml sSA/kg feed (feed application).

Summary on the Overall Effectiveness of Administering Stabilized Mono Silicic Acid to The Ponds
The effects on growth and yield & B. The survival rate(s)
The combined results of the trials (on the 4 fish species) show that sSA, applied directly to the pond water (G2) or via feed (G3), increased growth and yield parameters, as well the survival rates significantly, compared to control G1.
The combined results (on the 4 fish species) on the feed conversion rate and feed efficiency rate show increases as well.

The Differences in Efficacy Between Administering Ssa Directly to the Pond Water or Via Administration Via Feed
The average yield increased in G2 ('water application') by 17.47% and in G3 ('application via feed pallets at 2 ml/L) by 29.67%. Both forms of administration sSA are effective, with the application of sSA via feed
showing the highest efficiency at a concentration of 2 ml/L.

The Effects of Administering High Dosages ('Overdose') Via Feed
The concentration of silicic acid of 4 ml/L in G4 ('overdose') was not effective at all showing that too high dosing led to an adverse effect, such as a decrease in growth rate, lower survival rate and lower yield, compared to control.

The Effects of Silicic Acid on Physico Chemical Parameters
The physico-chemical water quality parameters in fish farm ponds are crucial for maintaining a healthy environment for the growth and development of fish.

During the trials in the 4 different fish species, the physico-chemical parameters showed limited differences. In Table 5 the effects on the parameters are shown in the Rohu ponds. The transparency, total alkalinity, total hardness, and dissolved oxygen concentrations increased, while the ammonia content decreased.

Table 5: Average Physico Chemical Parameters of Experimental Ponds of Rohu Recorded During Experiment (360 Doc).

Parameter	G1	G2	G3	G4
Air temp	30	31	31	30
Water temp	28	29	30	29
Transparency	35	60	54	56
pH	7.8	7.9	7.7	7.8
Total Alkalinity mg/L	115.8	124.4	138.1	128.6
Total hardness mg/L	154.70	172.40	183.55	163
DO-mg/L	6.40	8.5	7.00	7.10
Free Carbon dioxide mg/L	Nil	Nil	Nil	Nil
Ammonia-mg/L	0.29	0.16	0.18	0.17
Phosphate mg/L	0.22	0.34	0.46	0.37

DO: Dissolved Oxygen.
Dose protocol: G1 – Control; **G2** – 1.5 liters of SiliFish every 15 days (pond application);
G3 – 2 ml SiliFish/kg of feed (feed application) and **G4** – 4 ml SiliFish/kg of feed (feed application).

The effects on the ponds with Catla and Pangasius are similar, compared to Rohu, while in the ponds with Tilapia (Table 6) the effects on transparency, Ph and total alkalinity did not show significant differences compared to control.
In all ponds an increase in the dissolved oxygen and a decrease in ammonia level and TAN was monitored. The phosphate concentrations increased compared to control.

Table 6: Average Physico-Chemical Parameters of Experimental Ponds of Monosex Tilapia, Recorded During Experiment (360 Doc).

Parameter	G1	G2	G3	G4
Temp	28.7	29	28.1	29
Transparency-cm	36.24	33.34	34.17	35.25
DO.mg/l	7.11	8.5	7.5	7.7
pH	7.02	6.87	6.88	6.68
Total Alkanity. mg/l	121.12	118.10	120.15	120
TAN.mg/l	0.10	0.01	0.02	0.01

DO: Dissolved Oxygen; TAN: Total Ammonia Nitrogen.

The Effects of Silicic Acid on Plankton Abundance
The effects of the application of sSA on plankton abundance are shown in Table 7. The application of sSA significantly increases the population of phytoplankton and zooplankton by tens of percent compared to control.

The results on phytoplankton show an increase of + 55,8% in G2 and + 31,1% in G3 compared to control. Also, in G4 a positive result of + 18,5% has been recorded although the increase was much lower compared to G2 and G3.

The results on zooplankton show an increase in all trial arms as well, being + 94,7% in G2, + 62,9% in G3 and in G4: + 15,3%.

Table 7: Plankton Abundance of Experimental Ponds Recorded During the Experiments.

Specimen	G1	G2	G3	G4
Phytoplankton (Cells/l)	47.82×105	74.50×105 + 55,8%	62.68×105 + 31,1%	56.67×105 + 18,5%
Zooplankton (Cells/l)	380	740 + 94,7%	619 + 62,9%	438 + 15,3%

Phytoplankton and zooplankton in number/L

Discussion
Over the last 10 years, silicon compounds such as silica, silicates, nano-silica, diatomaceous earth, etc. have been used to influence the growth of plants and animals. Although these silicon compounds are not bioavailable, these compounds can influence the health of the entire ecosystem, such as water systems and soils, which are the environment for aquatic and terrestrial organisms, through indirect mechanisms. Silicates can improve the health of the soil, allowing beneficial microbes to improve the quality of the soil, resulting in higher availability of nutrients for the plant. The same mechanism applies to the aquatic ecosystem.

However, only monosilicic acid is bioavailable and bioactive. Silicic acid is an unstable molecule and until recently not commercially available. Thanks to a stabilizing technology, mono (or ortho) silicic acid became commercially available at the beginning of this millennium. With sSA tests have been done on all kinds of (terrestrial) plants/crops, the 'silicic acid agri technology', which initially met with much scepticism. After 10-15 years, the effectiveness on growth, yield and quality of all kinds of plants was irrefutable. Compared to other silicon compounds, only silicic acid improves root and plant growth, yield and quality, and reduces abiotic and biotic stresses, while other silicon compounds have no direct effect on plant growth and development [9].

For this reason, monosilicic acid was introduced in aquaculture: sSA is absorbed by all aquatic organisms, such as plankton, aquatic plants and aquatic animals, such as fish and shrimps. By adding mSA, the concentration of mSA will be adequate and effective. When mSA is not applied, the concentration will decrease significantly [6].

In this study, the effects of the application of silicic acid, directly on the pond water or mixed with feed, are presented, showing positive effects on growth parameters, survival rate and yield of the four fish species. These results are due to the direct effects of silicic acid on the fish, due to its role in strengthening connective tissues such as skin, scales and bones, its effect on the immune system that provides better protection against diseases and reduces the risk of infections. This can help to reduce or avoid the use of antibiotics in aquaculture.

Furthermore, it has been shown that silicic acid can upregulate genes in response to external factors, a mechanism that also occurs in plants [8].

Silicic acid then has positive effects on plankton, aquatic plants and beneficial microorganisms, which form the basis of the food chain for fish. Silicic acid is an essential nutrient for diatom blooms. This can outcompete harmful algae (HABs) for nutrients, thereby reducing the growth of harmful algal blooms and preventing eutrophication. Algal blooms consume oxygen and are harmful to aquatic life.

Silicic acid stimulates the growth of beneficial bacteria, important for the nitrification process to break down harmful nitrogen compounds such as ammonia into less toxic forms.

In this trial, the sSA application induces a significant increase in plankton growth, both phytoplankton and zooplankton.

The application of sSA to the pond water induces a significant increase in phytoplankton and zooplankton, important for a healthy pond ecosystem. This effect has been documented in the study of all four fish species.

Furthermore, silicic acid has positive effects on aquatic plants, comparable to land plants. By absorbing silicic acid, these plants become more nutritious and resilient food sources for herbivorous aquatic organisms, including fish.

The outcome of this study confirms the results of previous tests and the experiences of aquaculture farmers in India, Vietnam and Bangladesh with the product AB Silifish©.
Compared to the effectiveness of other silicon compounds, such as silica and silicates, sSA is much more effective, as the only biologically absorbable and active silicon compound.

Also, in other animals and humans, mSA induces positive effects on various tissues and organs, including the immune system.

It is important to use the correct concentration range in aquaculture, because this study showed that too high dosage (‘overdose’) of silicic acid has a negative effect on growth and yield. This is consistent with the results of the application of monosilicic acid to plants: too high doses of silicic acid resulted in lower yields on rice [10].

Further research is needed to optimize the effectiveness of the application method of stabilized silicic acid in aquaculture. Direct application of silicic acid to the pond water every two weeks is effective. Further research is needed to investigate a weekly application, or once every 5 days, at an appropriate dose. The combination of both forms of application should also be further investigated, as well as trials on other fish and shrimp species, crustaceans and mollusks. Ongoing results already show an even higher degree of efficacy. The use and application of monosilicic acid in aquaculture is important as it is a kind of missing link, provided the product is used in the correct concentration and dosage form.

Conclusions

The use of stabilized silica in aquaculture provides many benefits, from improving water quality and supporting the growth of beneficial organisms to improving the health and growth of fish.

It is important to monitor the correct dosage to avoid overdosing, which can lead to other imbalances in the ecosystem.

The use of the AB SiliFish© product and good management of aquaculture techniques are key to maximizing the benefits of silica for both water quality and aquaculture productivity on the one hand, and to improving the ecological footprint.

AB SiliFish© is a product with unparalleled positive effects on the growth and yield of fish and shrimp. The health situation will improve, resulting in a lower infection rate and a higher survival rate.

A healthier ecosystem with balanced nutrient levels and a thriving population of microorganisms can prevent the spread of pathogenic organisms in aquaculture systems, important to reduce or eliminate the use of harmful chemicals and antibiotics.

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