Novel Nanotechnology as Biostimulant

The culmination of decades of research in nanotechnology

invati

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01 > Who we are

Our long-standing goal has been finding right solution for the farming community through our competency in invention and innovation. Poultry farming goes through continuous external challenges, and we don’t pretend to have all the answers. What we do have are goals to strive for, and utilise our expertise in R&D to best possible way. Our recent foray into poultry healthcare space stems from tremendous success in agriculture and human health. We are deeply committed to work closely with poultry farmers, veterinarians, and professionals for improving farm productivity towards sustainability.

A glimpse of Invati

At Invati, we have great land for research & development (R&D) of metals, polymers and basic elements to develop various molecules and nanotech solutions for addressing challenges in life-science verticals

What fuels the trajectory of growth at Invati

Invention and innovation has been our greatest strength that fuels the growth trajectory at Invati. We have been granted numerous patents in the field of nano-technology, chemical synthesis, new molecular entity, and microbial growth. In addition, our proprietary fermentation technology and certified organic products (NPOP) drives the engine of new product development.

14
Novel pipeline for animal health, aquahealth, agriculture, and human medicine

56
International and national patents

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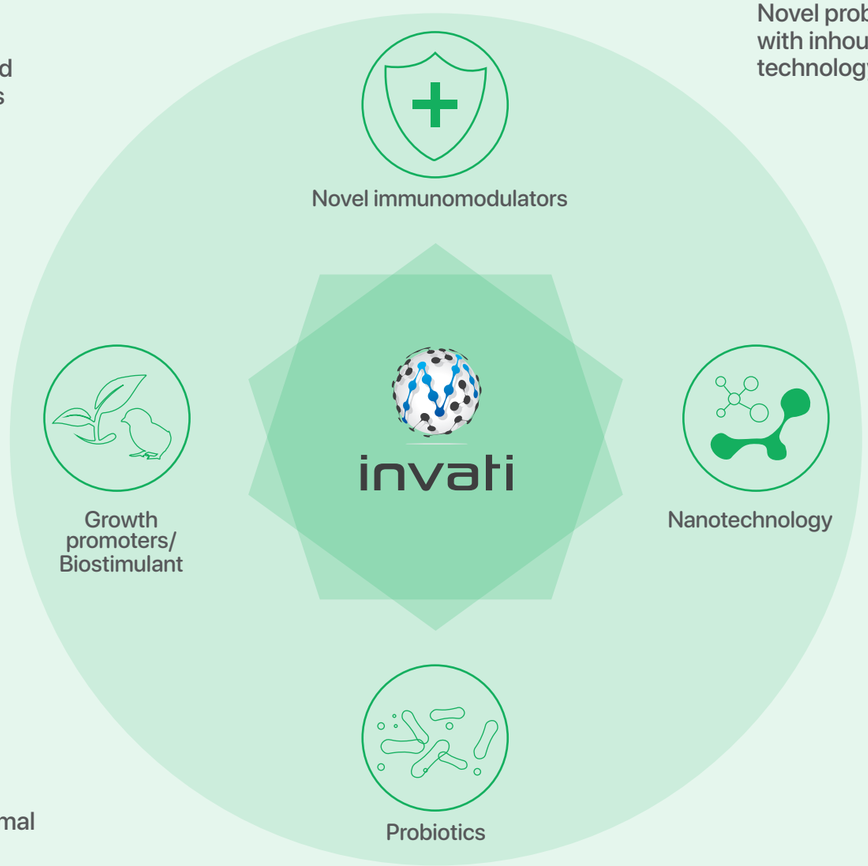
Novel probiotic strains with inhouse fermentation technology



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Novel products launched in Animal Health Industry

Improving lives through invention and innovation

02 > We and Nanotechnology

Invati and Nanotechnology is inseparable. The inception of Invati is routed through decades of research in the field of nanotechnology. In these years, we have developed proprietary (patented) process of generating stable nano-scaled metals with significantly enhanced biological activity. We have found wide range of application of these nano-scaled metals in agriculture, animal, and human health for improving lives and productivity.

How it started

The course of invention, innovation, and to products

2012
Invention of noble synthesis method of metal nanoparticles (International patent filed)

2014
Invention of nutrient nanoparticle synthesis (Patented)

2016
Zero valent metal nanoparticle synthesis scale up

2018
Nutrients and metal nanoparticles size and stability standardization

2019
HydroNano M™, first in the category, plant nutrient nanoparticles launched in agriculture

2020
Random field trials in poultry and aqua with nutrient and mineral nano-particle formulations

2021
HyGroNano™, first in the category, zerovalent nano-scaled minerals for poultry launched

#1
Customer satisfaction recorded by HydroNano M™ in agriculture

Changing lives

HydroNano M™

The launch of HydroNano M™ in agriculture had revolutionised crop yield and productivity, since its inception in 2019. Besides productivity, the disease resistance, crop quality, foliage volume, root growth were enhanced significantly. It gives immense pleasure to have millions of happy farmers benefited by our innovation in nanotechnology

15 – 25%

increase in yield were recorded depending on the crop type after application of HydroNano M™

Customer feedback

Horticulture department, Govt of Sikkim

We are happy with the performance of HydroNano M™. It is ecofriendly and good source of minerals for plants. We have recorded upto 25% increase in crop yield as compared to control.

Pan seeds Pvt Ltd., Kolkata

We have recorded 22% yield advantage with HydroNano M™ in Ranjana seed production.

Tomato production, Gujarat

We have recorded 25% increase in crop yield and higher stress tolerance with HydroNano M™ application.

Apple production, Kashmir

We have recorded 20% weight increase of apple, enhanced lustre, and early ripening advantage with HydroNano M™ application.

03 > HydroNano M™ in agriculture

Nano-technology is an emerging technology with tremendous potential and diverse applications in human health, agriculture, and animal nutrition. It also offers potential advantages in supporting research in many areas of life sciences. Nano-technology has many vital biological applications as living systems depend on many nano-scale objects like proteins, DNA, and enzymes. Trace minerals are normally used in very minute quantity in animal nutrition but issues like lower bioavailability, antagonism, and higher excretion rates from body limit their efficiency.

What is HydroNano M™

HydroNano M™ is a nano particle-based plant nutrient which is a good source of water-soluble forms of all essential minerals for plant growth. It is an eco-friendly agrochemical which not only reduce the application of plant protection products, but also minimises the nutrient loss due to fertilization and cope up the plant to fight against various biotic and abiotic stress. It is a safe, non-toxic, and ecofriendly biostimulant.

HydroNano M™ is derived from patented technology of producing mineral nanoparticles (NPs) and coating the mineral NPs with essential nutrients or precursors thereof.

How it works

- Plant nutrients are of two types viz, macronutrients (Ca, Mg, etc) — required in larger quantities and present in about 0.2 – 4.0% by dry matter weight of plant tissue, and micronutrients (Fe, Zn, B, etc) — required in smaller quantities and may range from about 5 – 200 ppm or less than 0.2% dry weight of plant tissue.

- There are 3 fundamental ways plant uptake nutrients —
  - **Simple diffusion** — without protein carrier and no energy required
  - **Facilitated diffusion** — with protein carrier and no energy required
  - **Active transport** — Require ATP pump (energy required)

- Certain nutrient like Boron (B) is immobile and requires polyol compounds for cellular uptake. The availability of polyol compound is limited and restricts cellular uptake of boron.

- Unwanted interactions of charged mineral ions often undergo poor cellular uptake and require spending of energy (active transport) for mobility.

- HydroNano™ M featuring nutrient coated Ca, Mg, B, Fe, and Zn nanoparticles ensure rapid mobility/cellular uptake of nutrient and essential minerals without any unwanted interactions and losses thereof.

- It signicantly improves growth and productivity of plants and crops.

Field Trials

Trial crops

Field crops	Vegetables	Fruits	Garden crops
Rice	Palwal	Mango	Tea
Potato	Bitter gourd	Orange	Coffee
Sesame	Chilli	Apple	
Mustard	Capsicum	Kiwie	
Guar	Cauliflower	Sweet lime	
Sugarcane	Cabbage	Guava	
Cotton	Cucumber		
	Onion		
	Garlic		
	Mustard		

Trials in various agro-climatic zones of India

- West Bengal
- Gujarat
- Telengana
- Sikkim
- Jammu & Kashmir
- Haryana
- Karnataka
- Chhattisgarh
- Assam

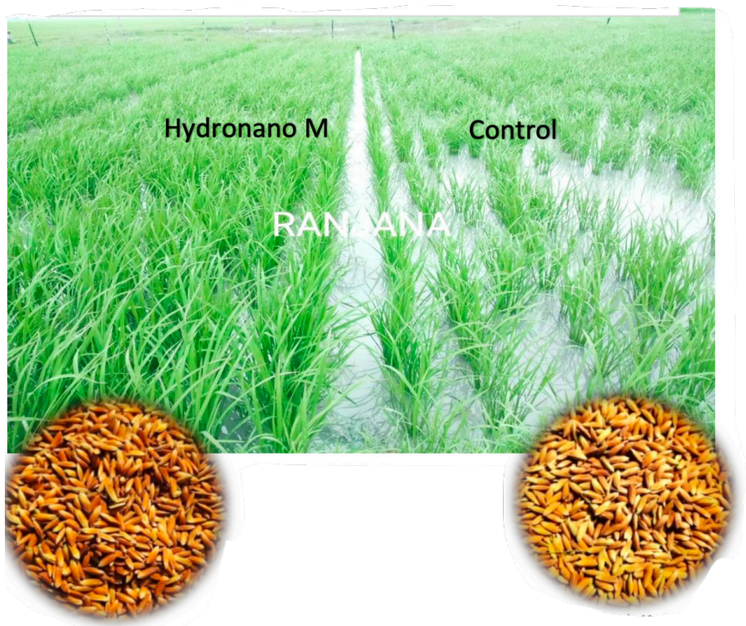
In all trials at different agroclimatic conditions, HydroNano™ M improved the crop yield by 15 – 25%, while maximun yield improvement was 40%. Additionally, the disease resistance, and lustre of crops were significantly improved.

Toxicological trial of HydroNano™ M done on plants, rat, rabbit, fish, bird, honey bee, and earthworm have been show to safe at 100X of recommended dose

Field Trials

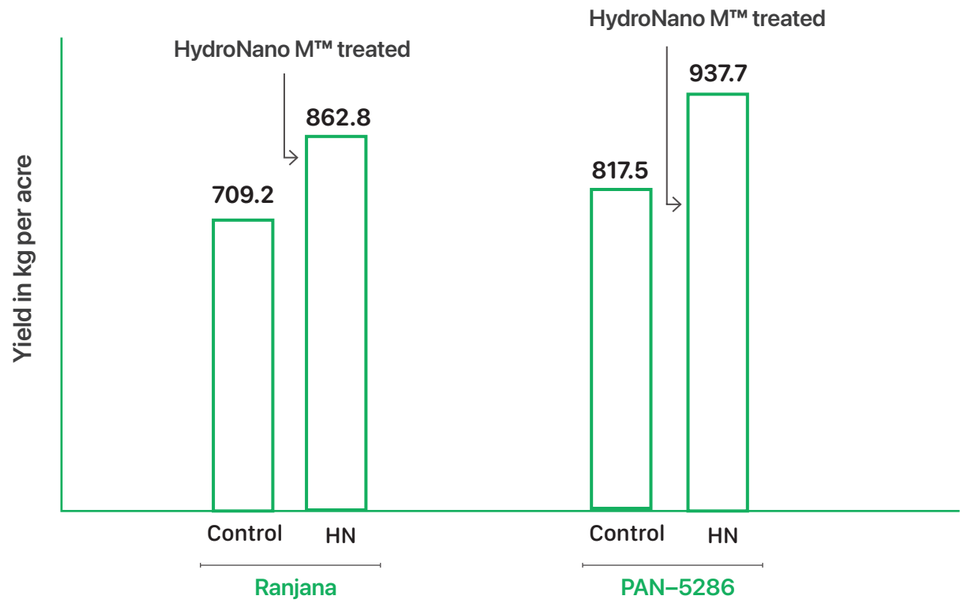
Experiment design

Season	Kharif – 2020
Crop	Ranjana (140-145 days), PAN-5286 (145-150 days), PAN-5265 (110-115 days)
Dose	5 ml per liter
Time of application	10 days before transplanting, Active tillering stage, and Panicle initiation stage



Ranjana seedlings age 22 days. Effect of HydroNano™ M observed after 5 days of spraying

Yield difference based on averge of 25 plants per replcate (n=75) in 0.25 acre experimental plot



Trial of HydroNano M™ on Ranjana crop and PAN–5286 crop shown 22% and 15% improvement in yield, respectively.

Field Trials

Glimpse of HydroNano™ M field trials on Ranjana and AN-5286 crops

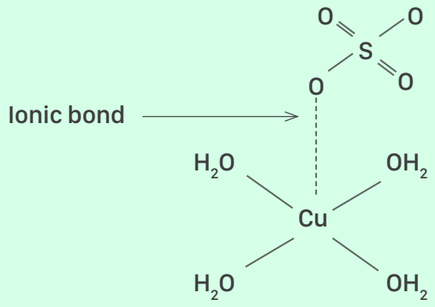
04 > Nanotechnology in aquaculture

Nano-technology is an emerging technology with tremendous potential and diverse applications in human health, agriculture, animal, and fish nutrition. It also offers potential advantages in supporting research in many areas of life sciences. Nano-technology has many vital biological applications as living systems depend on many nano-scale objects like proteins, DNA, and enzymes. Trace minerals are normally used in very minute quantity in animal, plant and fish nutrition but issues like lower bioavailability, antagonism, and higher excretion rates from body limit their efficiency.

Conventional trace and macro minerals

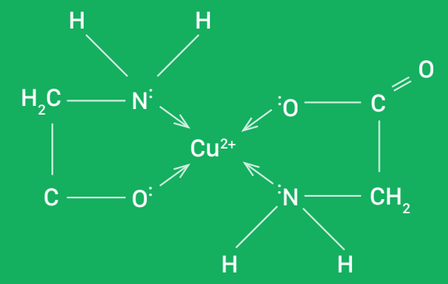
Trace minerals like Copper, Iron, Manganese, Zinc, Selenium, and Chromium are available in organic (amino acid/analogue chelate or proteinate)**, and inorganic** (oxide or sulfates) **forms with varying bioavailabilities, while chickens derive macrominerals like Calcium and Phosphorus, mostly from inorganic sources** (Limestone, DCP[1], MCP[2], etc)

Inorganic minerals (e.g. sulphate)



A specific metal bound to a non–carbon containing ligand. Developed in the 1930's

Organic minerals (e.g. amino acid chelate)



A specific metal bound to a carbon/nitrogen containing ligand. Developed in the 1970's

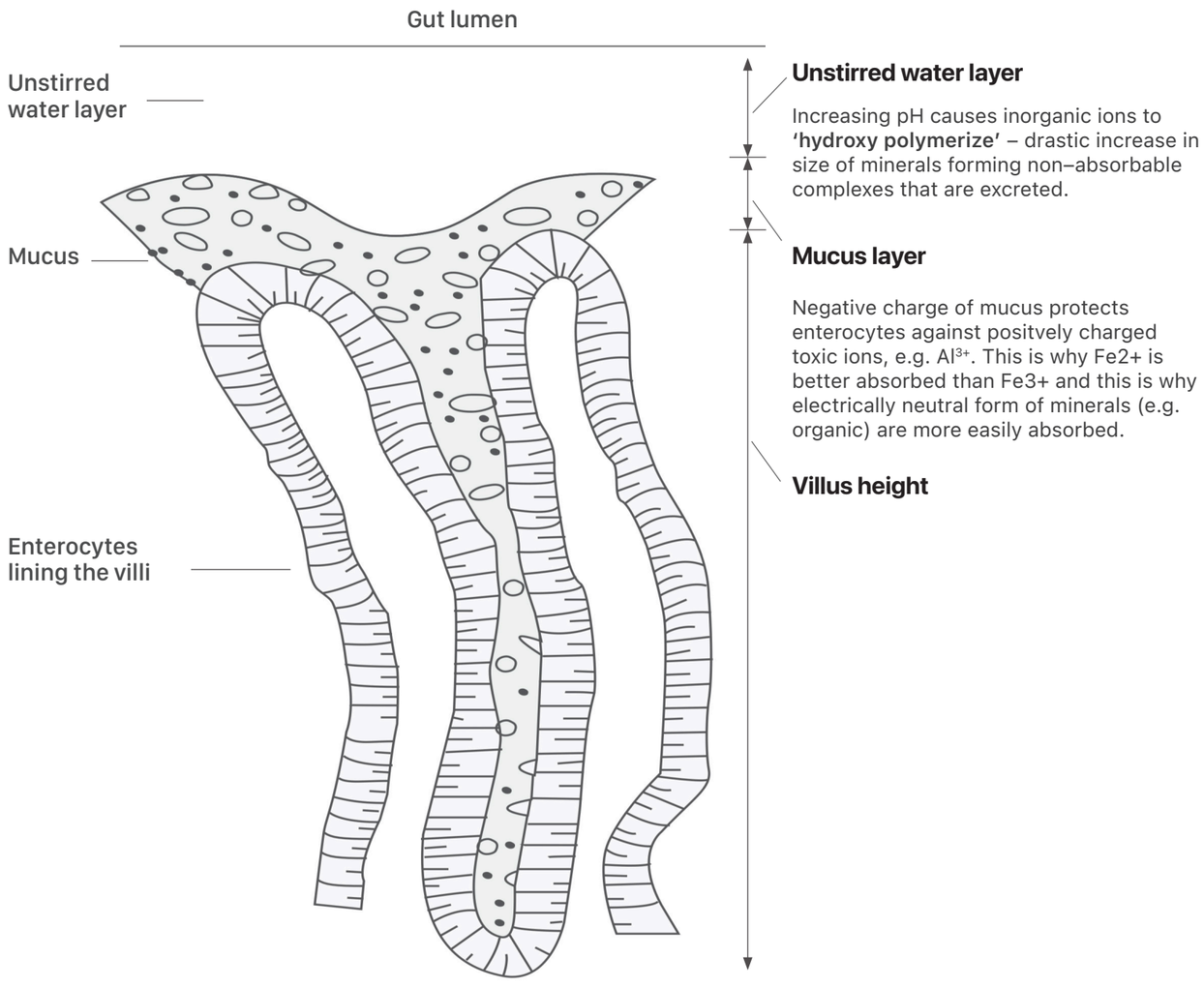
[1]Dicalcium phosphate
[2]Monocalcium phosphate

Conventional trace and macro minerals

In fish gut, inorganic minerals have the risk of undergoing 'hydroxy polymerization' and trap in mucus layer leading to poor bioavailability. Besides, there are several unwanted interactions resulting in nutritional disadvantages.

Major nutritional disadvantages of inorganic minerals:

- Interact with other minerals and excrete into the environment
- Poor bioavailability of minerals
- Complexes with phytate, and poor efficacy of phytase against phytate – mineral complexes
- Reduces efficacy of phytase and retention in fish diet
- Absorption in gut requires energy expense

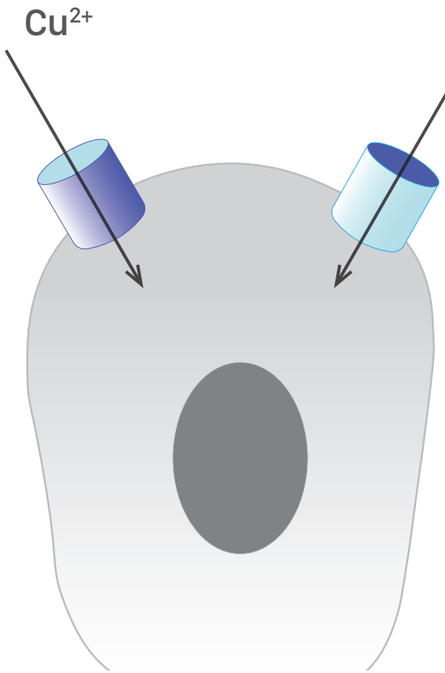


Conventional trace and macro minerals

In fish gut, organic minerals have relatively better bioavailability as compared to inorganic sources. However, there are concerns that deter consistent results.

Concerns on consistency:

- Structural stability varies widely with the manufacturing process
- Higher molecular size and mass depending on the ligand (e.g. proteinate)



Voltage gated ion channel

- Requires energy (ATP) for transportation
- Requires electrochemical gradient
- Interaction with other charged mineral ions and feed ingredients

Amino acid transporter channel

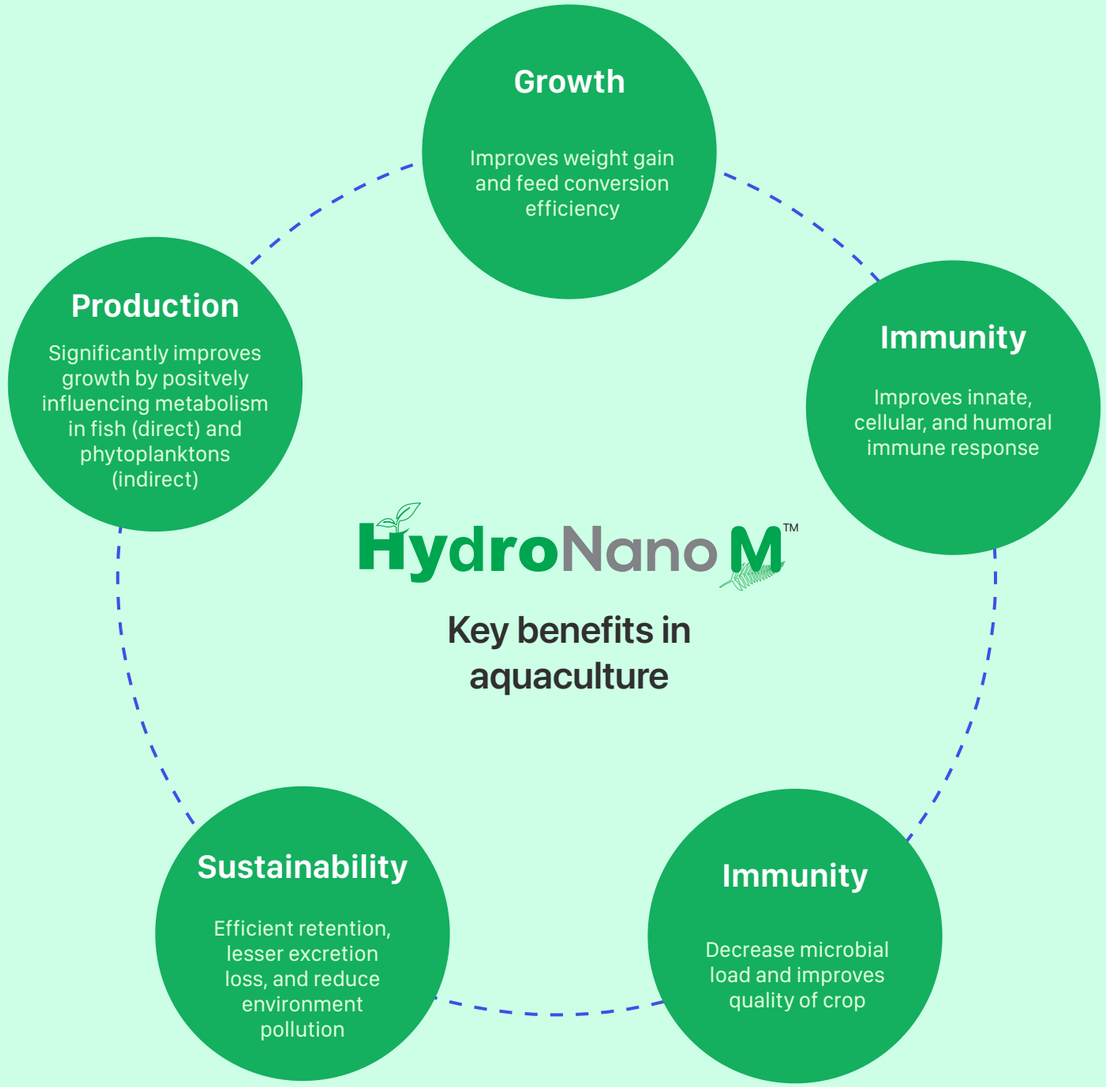
- No energy required
- Enters through amino acid transporter channel

Nano–scaled minerals: Light years ahead

Nano-particles (NPs) possess different physico-chemical properties than other forms of minerals. It results in significantly higher biological activity.

World of advantages:

- Enhanced surface area of NPs results in significantly higher bioavailability
- Significantly lesser unwanted interactions
- Minerals are important component of metabolism and exoskeleton. Higher biological activity of NPs result in significantly better performance indices of fish
- NPs have been proven to modlate gut health of chickens towards beneficial microflora
- NPs have excellent antimicrobial activities against pathogens



HydroNano M™: Usage guidelines

Conditions	Dosage	Frequency
General	4 litres per acre or 10 litres per hectare	Once in every 15 days
Problems (loose shell, soft shell, poor moulting, poor growth, less plankton etc)	8 – 10 litres per acre or 20 – 25 litres per hectare	Once in every week

HydroNano M™ can be used in aqua feed at 10 ml per kg feed during conditions as indicated above

05 > HydroNano M™ : Microanalysis Report

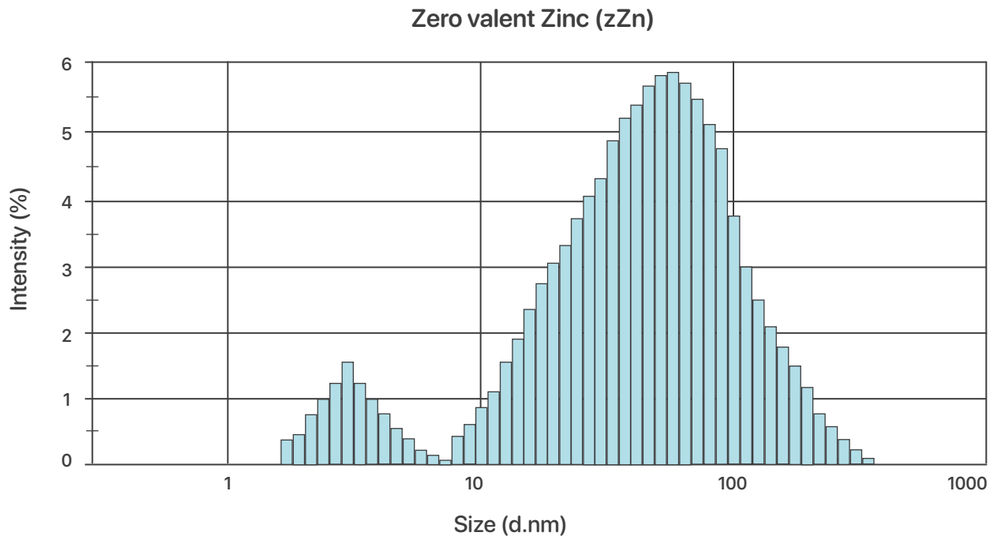
Mineral size distribution | Electron Microscopy

Individual minerals in HydroNano™ M is synthesised separately, transforming them to zerovalent nanoparticles, coated with essential nutrients, and formulated in water soluble carbon base. The particle size, distribution, and stability of the minerals are periodically tested by dynamic light scattering and Electron microscopy.

Mineral size distribution

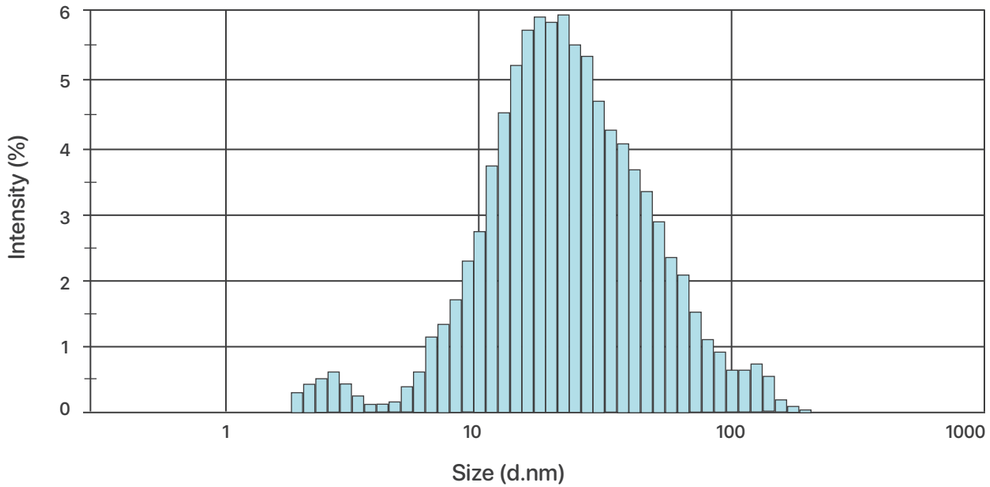
HydroNano M™ is a result of proprietary (patented) synthesis transforming minerals to nanoparticles (NPs) and zerovalency state. The NPs in the formulation are periodically evaluated for stability by dynamic light scattering (DLS).

Zero-valent Iron, Magnesium, Zinc, Calcium, and Boron are present in particle size < 100 nm as detected by dynamic light scattering (DLS). This results in unmatched efficacy of HydroNano M™ in comparison to the commercially available products.

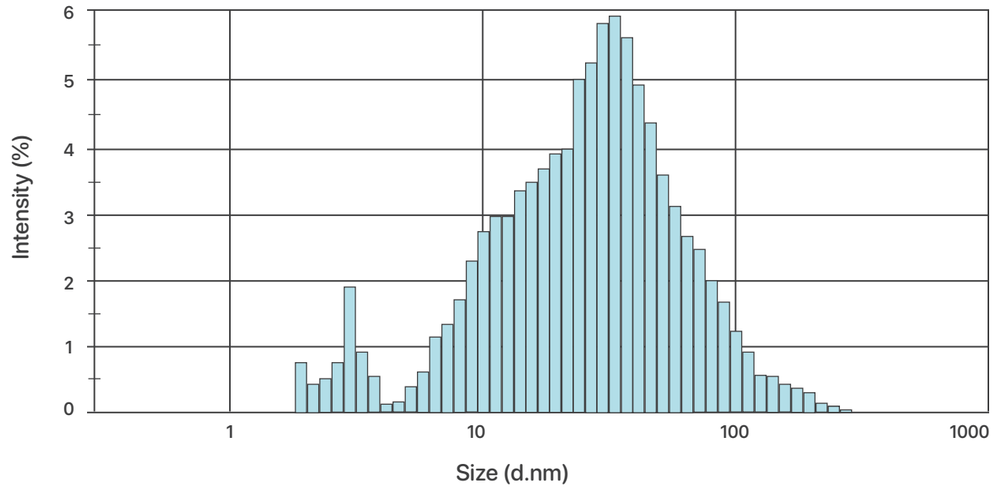


Mineral size distribution

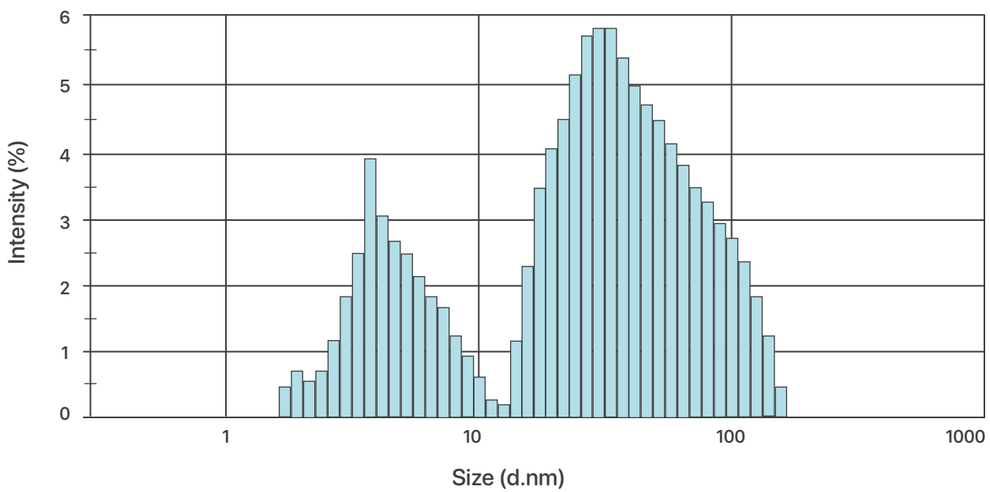
Zero valent Iron (zFe)



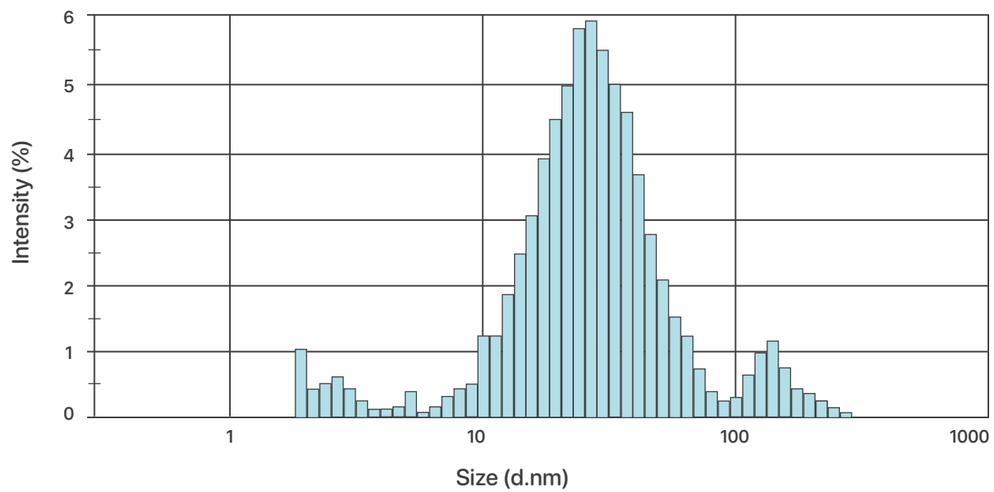
Zero valent Calcium (zCa)



Zero valent Boron (zB)

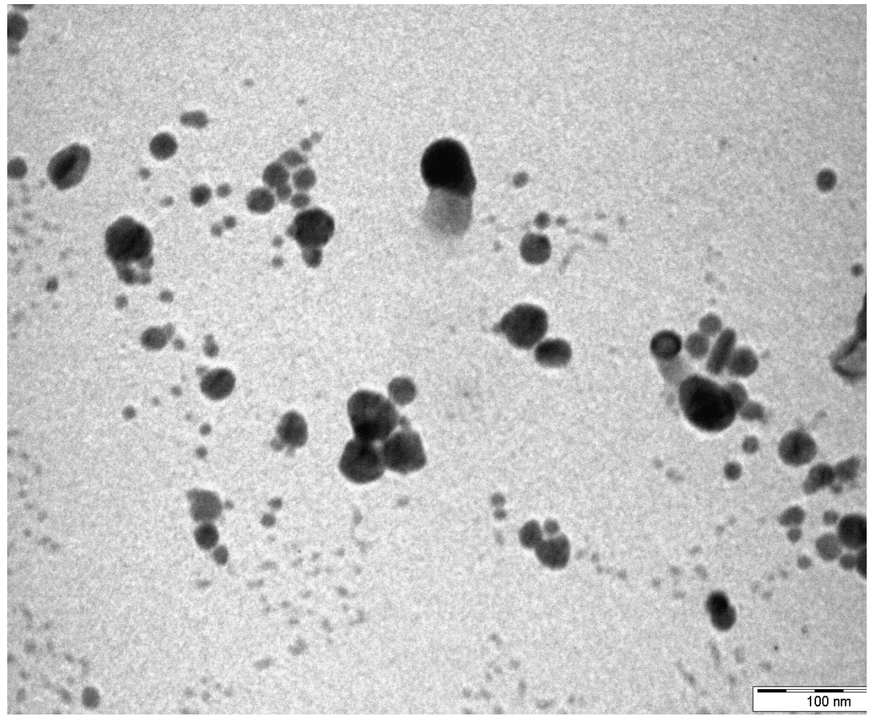


Zero valent Magnesium (zMg)



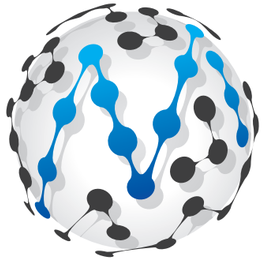
Electron Microscopy

For shelf life evaluation of HydroNano M™, production batches are periodically tested by Transmission Electron Microscopy (TEM).



Notes:

- The mineral nanoparticle size varies 10 –100 nm.
- There are few nanostructures with more than one mineral combination.
- The shape of mineral nanoparticles are nearly spherical.
- The nano scaling of the minerals are visible in the electron micrograph



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