Metal Contamination in Food & Beverages

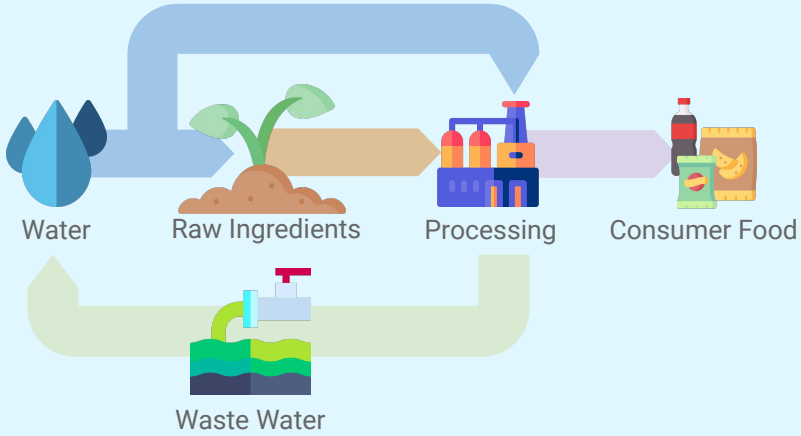
Strategies for managing metal contaminants in food production

PRESCOUTER

Food companies are coming under increasing scrutiny for the levels of toxic and other harmful metals found in end food products reaching consumers. Metals can enter the food production process at several stages. Emerging technologies are helping food companies detect and reduce metal contamination at each of these stages.

Artificial Intelligence, Microbiota, and Nanoparticles are just some of the emerging technologies that can be used to detect and reduce metal. In this report, we profile these technologies and some of the companies pioneering their use.

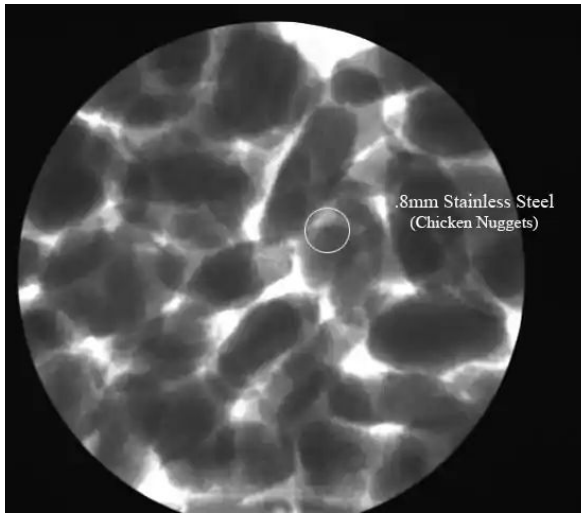
The stages of food production



US government scrutiny into baby food, as well as recent food recalls, have increased concern for metals in food products.

A recent congressional subcommittee report shed light on the problem of baby food products being contaminated with toxic heavy metals such as arsenic, lead, cadmium, and mercury.

In the meanwhile, metal contamination is increasingly being identified in processed baked items and meat products reaching consumers. Tyson Foods, Jimmy Dean and Spam are just some of the companies that have issued recalls in recent years for metal in their products.



A tiny piece (0.8 mm) of stainless steel shown in an X-ray of a batch of chicken nuggets. This is at or below the sensitivity of many metal detectors or X-ray detectors and below FDA risk for choking hazard (7 -25 mm). This size is the grey zone for what to do because it shouldn't be there but it may be difficult to avoid. (Image from FoodXInspections, Washington Post).

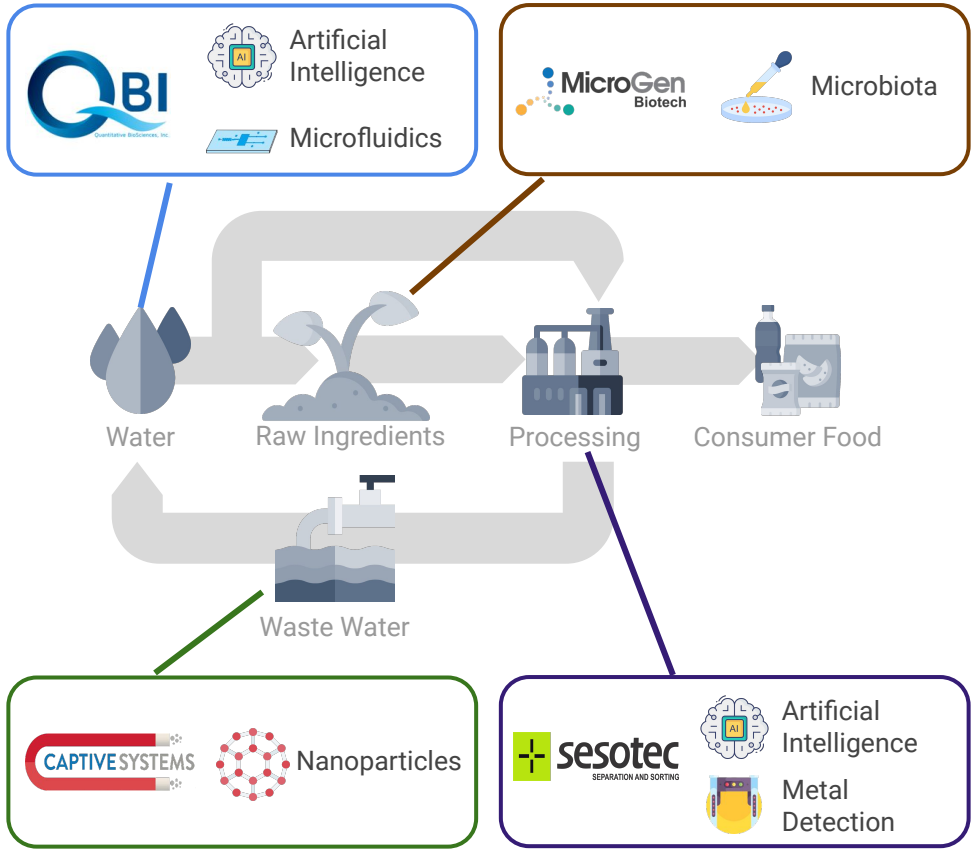
An FDA testing result investigation by Hain[2], the maker of Earth's Best Organic baby food, revealed that finished baby food products contain even higher levels of toxic heavy metals than estimates based on individual ingredient test results.

[1] Washington Post, "Processed meat recalls rise dramatically" (Dec 2019)
[2] Hain Celestial, FDA Testing Result Investigation (Aug 2019)
[3] Bad Food Recalls

A number of companies are leading the way to reducing contamination from metal through advances in artificial intelligence, bioremediation, and decontamination.

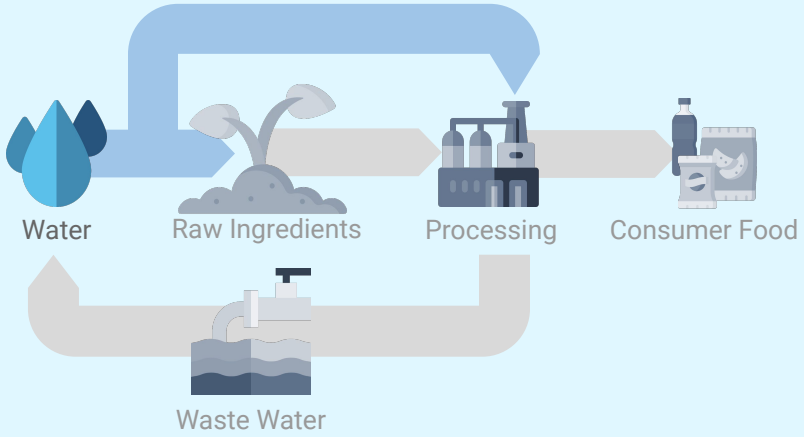
Heavy metal contamination can occur from the raw ingredients used in food processing, such as water, as well as raw agricultural products that come from the farming land that contains high concentrations of heavy metals. Industrial processes may shed metals, some of which may find their way into input streams used during food processing.

The Companies and Technologies Profiled In This Report

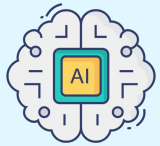


Quantitative BioSciences, Inc. (QBI) uses AI and microfluidics for rapid detection of heavy metals to meet FDA standards.

Water can be a major source of heavy metal contamination. Crops such as rice that can accumulate high amounts of arsenic can be grown in soil and water contaminated with heavy metals. Quantitative BioSciences, Inc. has a heavy metal detection system that comprises custom-bioengineered bacteria in a microfluidic device. The system can allow for continuous and quantitative testing of water for heavy metal contaminants.



How It Works



Artificial Intelligence

Microfluidics

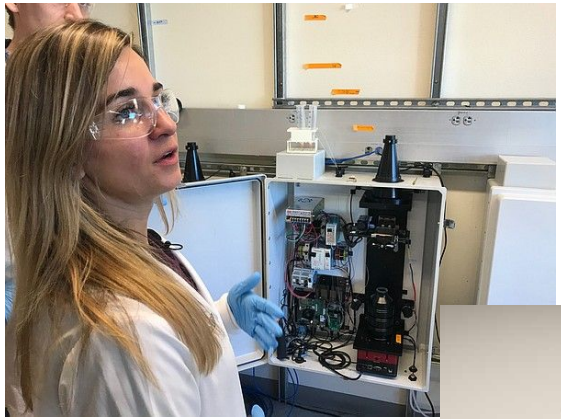
Quantitative BioSciences, Inc. (QBI)

At a glance

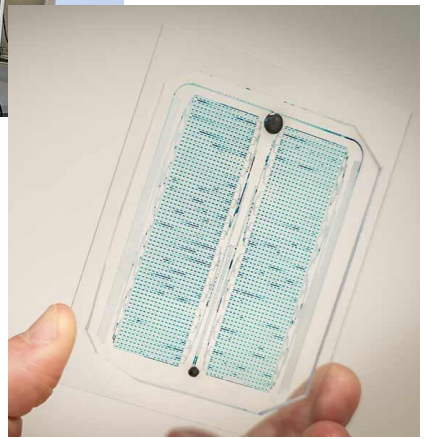
Type	Rapid heavy metal detection
Year Founded	2010
Key Technology	Microfluidic chip using an AI system
Current Application	Lead, Arsenic, Mercury, Cadmium
Applicability	Testing water containing heavy metal contaminants
Main Limitation	Bulky setup

Technology

Researchers at QBI have designed and manufactured a microfluidic chip that houses about 2000 strains of bacteria held in individual chambers. The bacteria contain plasmids with fluorescent genes that are activated when the bacteria encounter heavy metal contaminants. Tiny channels allow water to be delivered to each chamber in a controlled manner. The fluorescent signal produced by the bacteria on the chip is then imaged and fed into an AI system. This AI system identifies when the bacteria are in contact with a specific heavy metal based on the fluorescence pattern.



Complete setup of the device with the imager and AI system. Source: QBI.



2000-strain microfluidic chip. Source: QBI.

Quantitative BioSciences, Inc. (QBI)

Benefits

- Since the device can detect lead, arsenic, cadmium, mercury, phosphorus, and uranium, testing can be carried out for multiple heavy metals simultaneously.
- Water can be tested continuously and contamination can be observed in real time.
- Requires minimal intervention except for changing the cartridge once a month.

Drawbacks

- Device is bulky and not portable.

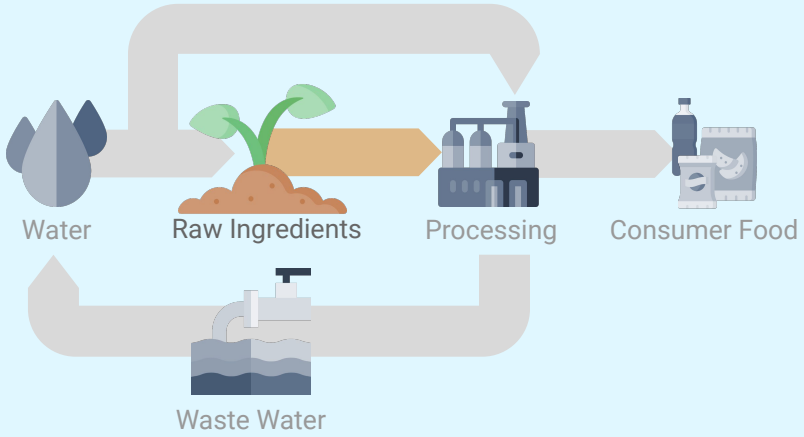
The company is planning to deploy their device at US government sites this year. Their aim is to make the device smaller and cheaper so it can be installed and used as widely as possible.

References

1. https://ucsdnews.ucsd.edu/feature/scientists-design-way-to-use-harmless-bacteria-to-detect-heavy-metals-in-drinking-water
2. https://www.kpbs.org/news/2020/feb/18/bacteria-water-fountain-how-san-diego-scientists-u/
3. https://www.qbisci.com/

MicroGen Biotech uses microbiota to remove heavy metal is soil through bioremediation, reducing contamination in raw ingredients.

Heavy metal contamination in raw agricultural products comes from farming on land that contains high concentrations of heavy metals. Removing these metals from the soil is an expensive task and requires replacing the soil. MicroGen Biotech uses microbiome consortia that prevent uptake of heavy metals by plants while boosting the crop yields.



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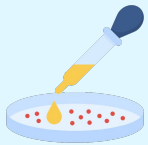


Microbiota

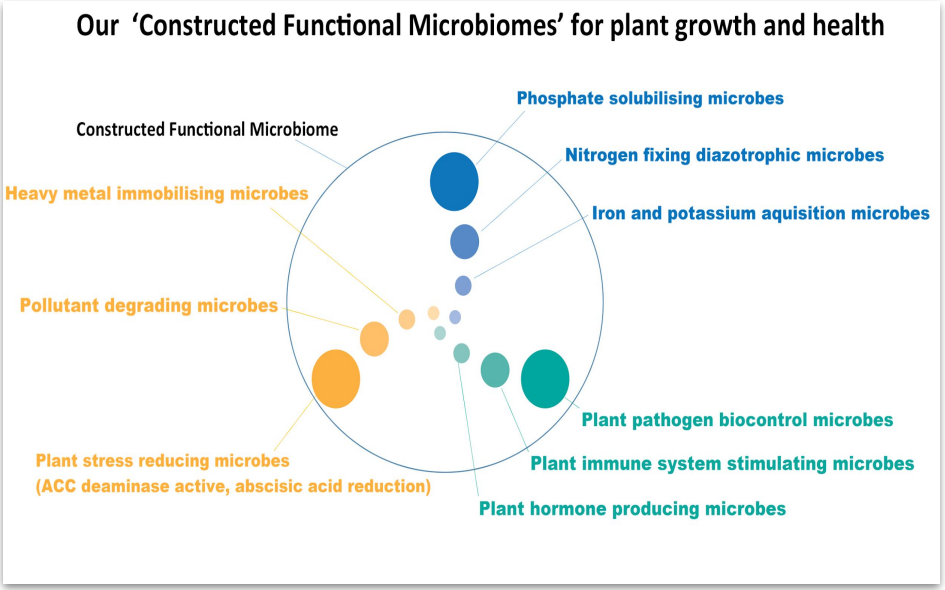
MicroGen Biotech

At a glance

Type	Bioremediation
Year Founded	2012
Key Technology	Use of microbe consortium
Current Application	Arsenic and cadmium
Applicability	Preventing crops from accumulating heavy metals
Main Limitation	Scale up relies on agro retailers for distribution and licensing

Technology

MicroGen Biotech has developed a platform technology called Constructed Functional Microbiome that uses a microbe consortium. The technology provides the ability to block the uptake of heavy metals by crops growing on contaminated land. It also has a plant growth-promoting function and can be applied as a seed coating or spray. The microbial consortia immobilize heavy metals and promote plant growth.



Source: MicroGen

MicroGen Biotech

Benefits

- Low cost and environmentally friendly technology.
- Protects plants grown in soil contaminated with heavy metals.
- Prevents heavy metal absorption by plants while boosting their yields and decreasing fertilizer use.
- The technology can be used to treat very large volumes of soil.

Recent News and Developments

- The company raised $3.8m from its latest funding round in 2020. To date, the company has raised close to $10M.
- MicroGen is the winner of the Agtech Food Category at the Extreme Tech Challenge (XTC) competition, selected from over 2400 companies across 80 countries.

One fifth of China's agricultural land is contaminated by heavy metals. MicroGen Biotech is currently performing more than 800 field trials in China. So far, the company reports that its microbial products are resulting in a 30% to 40% reduction in cadmium.

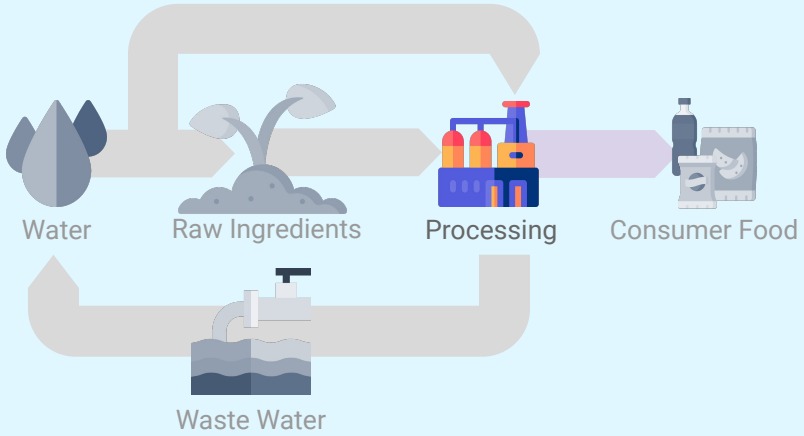
References

1. https://www.siliconrepublic.com/start-ups/microgen-biotech-funding-soil-heavy-metal-china
2. https://irishadvantage.com/microgen-biotech-new-frontiers-in-the-biotechnology-revolution/
3. http://www.microgenbiotech.com/

sesotec
SEPARATION AND SORTING

Sesotec's separation and sorting machines use artificial intelligence to detect foreign metal objects that may work their way into the food production process.

Metal detectors can be used throughout the food production process in order to protect consumers by detecting metallic contaminants. Like conventional metal detectors, Sesotec's THiNK uses a multi-simultaneous technology to apply several frequencies to the product being inspected. Using AI technology, THiNK isolates the signals from "product effect", creating additional detection thresholds. All signals that lie outside of these thresholds are identified as metallic contaminants.



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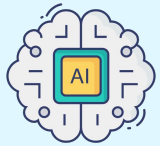
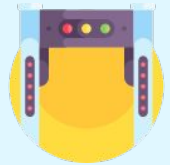


Artificial Intelligence



Metal Detection

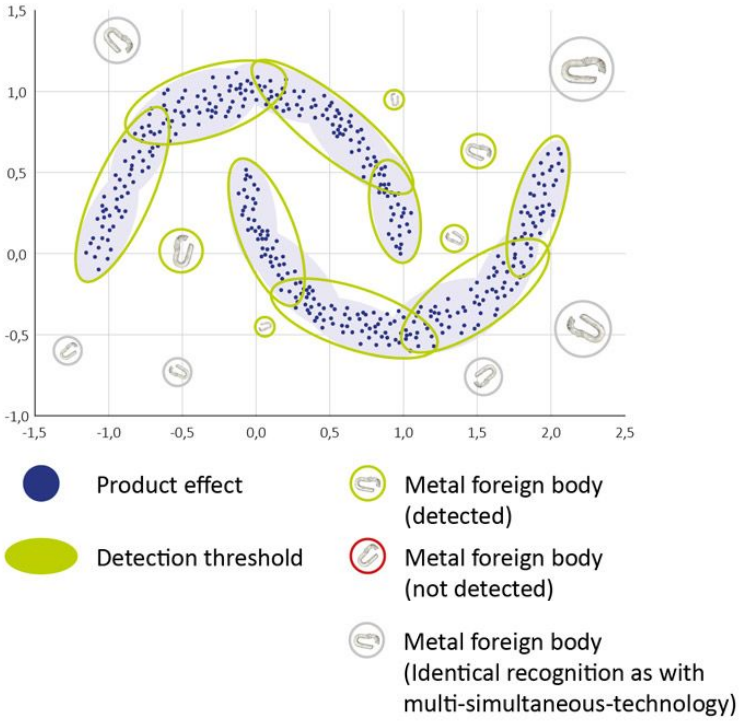
Sesotec - THiNK

At a glance

Type	Rapid metal detection
Year Founded	THiNK launched 2020, company founded: 1976
Key Technology	AI interpretation of conventional metal detection methods
Current Application	General metal detection
Applicability	Detecting metal contaminants in foods with a “product effect”, including products with metallized packaging
Main Limitation	The sensitivity, specificity, and particle size threshold are not specified

Technology

“THiNK” is a metal detection system equipped with artificial intelligence. Sesotec claims this technology makes it possible to virtually eliminate the interference caused by product effect. The technology is for the macro-scale detection of metal contaminants, not for quantification of toxic metals in the product.



How metal detection with THiNK works. Source: Sesotec.

Sesotec - THiNK

Benefits

- Reduces interference caused by “product effect”
- Products including for example metallized packaging or storage in brine or water can be more reliably inspected
- With artificial intelligence - these "interfering signals" can be faded out better than with conventional metal detectors

Drawbacks

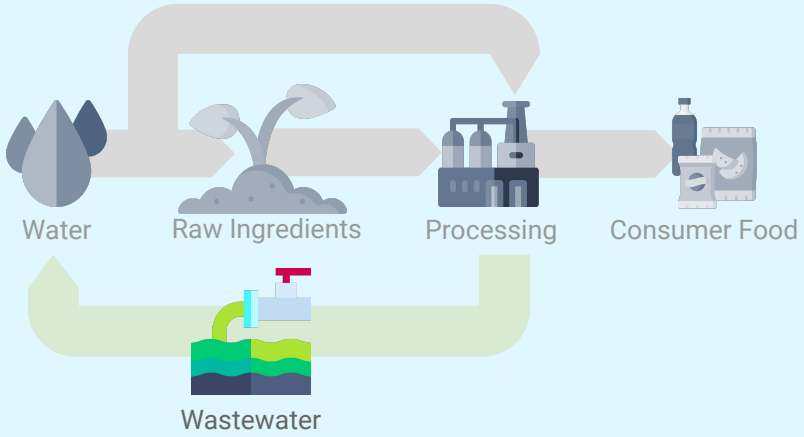
- Suitable for macro-scale detection of metal contaminants in food products, and not for quantification of toxic metal levels in products
- The sensitivity, specificity, and particle size threshold are not specified

AI algorithms increase the reliability and precision with which contaminants are detected in the food manufacturing process. AI-enabled metal detectors can efficiently inspect products packaged in metallized films. Food waste can be reduced, food safety standards are upheld, and resources are saved.

References
1. https://www.sesotec.com/na/en-US/resources/blog/using-artificial-intelligence-for-sustainably-profitable-food-processing

Captive Systems uses nanoparticles to remove heavy metals in wastewater, decontaminating water that may be reclaimed in agriculture and elsewhere.

One of the ways toxic heavy metals are released into the ecosystem is through wastewater. Treating the waste to remove harmful contaminants before they enter the food chain or seep in the groundwater is important. Captive Systems is a company in Italy that aims to solve this problem with the help of magnetic nanoparticles. These have been deployed in existing industrial systems. Additionally, these magnetic nanoparticles can be recovered and easily reused.



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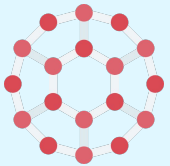


Nanoparticles

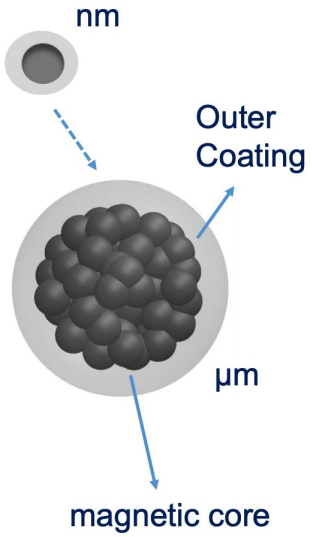
Captive Systems

At a glance

Type	Decontamination
Year Founded	2016
Key Technology	Use of magnetic nanoparticles
Current Application	Lead, Arsenic
Applicability	Removal of heavy metals from liquids
Main Limitation	Feasibility on purification of soil not yet proven

Technology

Captive Systems has developed a technology referred to as MagnetoSponges. These make use of micro-aggregates of functionalized magnetic nanoparticles with a ferromagnetic core and external coating. By easily choosing the type of coating to specifically bind to a required contaminant, Captive Systems believe this will offer the possibility of removing different types of pollutants like hydrocarbons and heavy metals from water, soil, and air.



Oil refinery wastewater before and after treatment with MagnetoSponges. Source: Captive Systems

Captive Systems

Benefits

- Could be integrated into existing manufacturing setups.
- No pretreatment required for the nanoparticles.
- Tunable outer coating can be customized according to the needs of the customer.
- Reusable.

Drawbacks

- Feasibility on purification of soil not yet proven.

Recent News and Developments

In 2018, the company received a Seal of Excellence from the European Commission managing HORIZON 2020, which is the biggest EU research and innovation program.

Given the versatility of the MagnetoSponges, they can be used in wide-ranging applications such as groundwater purification, wastewater treatment, and purifying toxic gases.

References

1. https://www.eitfood.eu/news/post/the-startup-captive-systems-wins-the-innowise-challenge-lab-in-Italy
2. https://www.captivesystems.it/en/the-product.html
3. https://www.captivesystems.it/en/public/Captive%20Systems%20srl_ENG_NO%20VIDEO.pdf

Next Steps

- PreScouter can help conduct a thorough and comprehensive review of your entire supply chain testing and methodologies.
- PreScouter can review minor ingredients' potential impact to Food Safety Plan Hazard Analysis and Quality Assurance
- PreScouter can find alternative sources of brown rice and other key ingredients

SOME POSSIBILITIES THAT PRESCOUTER CAN OFFER FOR CONTINUATION OF OUR RELATIONSHIP

☑ COMPETITIVE INTELLIGENCE	☑ TECHNOLOGY ROADMAPPING	☑ TECHNOLOGY & PATENT LANDSCAPING	☑ MARKET RESEARCH & ANALYSIS
☑ TRENDS MAPPING	☑ REVIEW BEST PRACTICES	☑ PATENT COMMERCIALIZATION STRATEGY	☑ DATA ANALYSIS & RECOMMENDATIONS
☑ ACQUIRE NON-PUBLIC INFORMATION	☑ SUPPLIER OUTREACH & ANALYSIS	☑ CONSULT WITH INDUSTRY SUBJECT MATTER EXPERTS	☑ INTERVIEWING COMPANIES & EXPERTS

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Gareth Armanious is one of PreScouter's Project Architects. He specializes in the Food & Beverage and Life Sciences industries. As an academic, he specialized in membrane protein biochemistry, working with an international research group assembled to study structural and functional aspects of these challenging targets in health and disease. Gareth graduated with a BSc in biochemistry, medical specialization, from the University of British Columbia, and is completing his PhD in Biochemistry at the University of Alberta.

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Tanmay received his PhD in Medicinal Chemistry from the University of Illinois and completed his postdoctoral training at Stanford University. He is currently a scientist working in the domain of drug discovery. He also works as a freelance science writer and consultant. He is deeply interested in learning about upcoming technologies that can impact our daily lives.

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