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Nanotechnologies in the food industry

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Abstract
Nanotechnology is an emerging field with significant applications in the food industry, offering innovative solutions to increase product safety, quality and sustainability. The use of nanoparticles and functional nanomaterials allows the development of smart and active packaging, capable of detecting contaminants, extending shelf life and protecting food against microbial agents. Nanotechnology is also applied in improving the bioavailability of nutrients through controlled delivery systems (nanoemulsions, nanocapsules), as well as in the rapid detection of pathogens through nanosensors. However, large-scale application raises concerns about the impact on health and the environment, which is why regulations and safety studies remain essential. Thus, nanotechnologies have the potential to fundamentally transform the food sector, balancing innovation with the need for rigorous risk assessment.

Keywords: Nanotechnologies, industry, food

Introduction
Nanotechnologies will have an impact on the food industry, from how food is grown, produced, and processed to how it is packaged, transported, and consumed. Companies are producing nanomaterials that will make a difference not only in the taste of food, but also in the safety and health benefits of food.

Dietary supplements
In the food industry, nanotechnology is most commonly found in dietary supplements. The promise of nanotechnologies is that they will allow ingredients to be redesigned using nanoparticles that can be absorbed more quickly by the body. This can create a supply of beneficial nutrients for the body, while allowing less desirable components to be filtered out [1-5].

Food freshness
In general, producers, retailers, and society will benefit from methods that eliminate prematurely throwing away good products due to expiration dates. One idea is to incorporate nanotechnology-based sensors into sealed food or pharmaceutical packaging, providing visible information on the condition of the contents, their freshness or even the condition of the packaging, indicating whether it has been kept at the right temperature in the supply chain or whether it has been spilled, etc.

Food packaging
Nanotechnologies are also used in some food packaging and containers. Silver nanoparticles are particularly used due to their antibacterial properties.

Possible Risks
Recent research has shown that some nanoparticles, such as carbon nanoparticles, can be found in a variety of products containing “food caramels”, such as bread, corn flakes and biscuits. This demonstrates that we have already been exposed to nanomaterials, probably for a long time, without any harmful effects. However, scientists are now looking at other types of nanomaterials that could have different effects than the “unintentionally used” nanoparticles produced during food processing, to which we are already exposed. As far as regulation is concerned, in the EC, foods containing artificially created nanomaterials must indicate this in the list of ingredients, according to the EC regulation published in 2011 and which will enter into force in 2014 [6-12].

The effects can be devastating
The aforementioned regulation warns: “Nanomaterials offer technical and commercial opportunities, but they can pose risks to the environment and raise safety and health concerns for humans and animals, therefore consumers must be properly informed.” In other words, the materials in question preserve food well, but can kill the consumer…
University Professor Dr. Eng. Eden Mamut, from the Institute of Nanotechnologies and Alternative Energy Sources at Ovidius University in Constanta, told us that nanoelements are very small particles that carry active substances, that is, Es, which increase the resistance of food over time.
Nanoelements increase the efficiency of Es. Thus, food has a longer shelf life, which is indispensable in today's food industry.
"It should be noted that nano technologies make the action of the active substances they carry more efficient, by modifying the structure of matter, which makes them unpredictable and extremely dangerous. It is not yet known what they can produce in the food sector and beyond, because they have been tested too little! It is possible that this technology has opened a Pandora's box!" Professor Eden Mamut emphasized.
The nanotechnology industry is expected to grow, in general, to 1 trillion dollars by 2015. The European Institute for Health and Consumer Protection reported that the market for nanomaterials used for food packaging alone will grow to 20 billion dollars by 2020. These include nanoglues used to seal plastic bottles, nanoaluminum to improve the classic foils already used in kitchens, nanosilver, used as an

antibacterial in some food storage boxes, but also in cutlery, nanotitanium, used in refrigerator filters, etc. “Nanosilver releases ions, which can end up in food,” says Jennifer Sass, a senior researcher at Natural Resources Defense. “The ions are toxic, they are what kill bacteria! The properties of nanoparticles are not the same as those that govern the physics of large particles. We are talking about quantum mechanics.” It is difficult to say how they affect the body without thorough research. McDonald’s is the only chain that “does not approve” of nanoparticles in food products, bags, or toys [13-19].

Conclusions

1. Nanotechnologies offer innovative solutions to improve the quality, safety, and sustainability of food products through smart packaging, nanosensors, and nutrient delivery systems.
2. The main benefits include increasing the shelf life of products, rapid detection of contaminants, reducing food waste, and developing functional foods with increased bioavailability.
3. The major challenges are related to assessing the impact of nanoparticles on human health and the environment, the lack of comprehensive regulations, and consumer acceptability.
4. The responsible development of nanotechnologies requires investment in research, standardization, and transparency regarding their use in the food chain.
5. Future prospects indicate a high potential for transforming the food industry, but success depends on the balance between innovation, safety, and sustainability.

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