

FOOD SAFETY AND GLOBALIZATION. PERSPECTIVES FROM NANOTECHNOLOGY

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ABSTRACT

We are living in the era of interconnection, an era where people are closer to each other more than they have ever been. Communication is simple and fast, liberalization of the markets resulted in products and services that are spread all over the world. This is the world of globalization where the complexity of today food supply chains became real challenge . In order to ensure better quality of the food and to eliminate food risks that can appear, nanotechnology nowadays has an important role. The use of nanoparticles with antimicrobial properties has, to some extent the role to protect and ensure durability of the food products. This paper discusses few of the main challenges related to food safety in the context of globalization and presents SWOT analysis for using nanotechnology in the food industry. We found that for global food safety finding innovative solutions can reduce the negative impacts. Nanotechnology has made first steps for better food safety and promises a better future for all of us. Still, in this stage there is much to do in order to eliminate any potential risks that can harm human health. Investments in Research and Development in Nanotechnology can help to eliminate these potential risks and can increase the trust of the consumers for using this technology in the food industry.

KEYWORDS: *food safety, foodborne diseases, globalization, nanotechnology*

1. INTRODUCTION

As it is very well known, food products are among the most sensitive products since its impact can harm the human health. In this sense, special conditions and food safety legislation should be applied in all stages of supply food chain. The term "globalization" has been defined along the years in many different ways by different authors and different world wide organizations. According to International Monetary Fund "Globalization is a historical process, the result of human innovation and technological progress. It refers to the increasing integration of economies around the world, particularly through the movement of goods, services, and capital across borders. The term sometimes also refers to the movement of people (labor) and knowledge (technology) across international borders. There are also broader cultural, political, and environmental dimensions of globalization". As per Cerny (1995), globalization can be defined as a system of economic and political structures based on a dynamics of the goods and assets within the whole international political economy especially when it comes to those increasing structural differentiation between those goods and services. When we refer to Economic globalization we mean interconnection of all economic activities within the global trade area, flow of capital, global economic activities, FDI, change of information, technologies and migration of people (Pekarskiene & Susniene, 2015). Within the social dimension of the globalization internet, telephone, social media plays the main role (Rudolph & Figge 2017). This cross border movement of people, exchange of cultures is supposed to increase people's perception about the benefits of it (becoming

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more aware, adopt better lifestyle) (Goryakin et al., 2015). To become powerful in the global complex system it is not the sole preserve of states, it is power distributed not only upwards towards supra state bodies but also downwards to sub-state bodies (Mc Grew, 2010).

Behind each active and demanding lifestyle full of challenges and of mix of cultures, it must lay always healthy alimentation. According to the 1996 World Food Summit, "*food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets dietary needs and food preferences for an active and healthy life*" (FAO, 1996)

2. FOOD SAFETY VS FOOD SECURITY

World Health Organization defined food safety as a "limiting the presence of potential hazards whether chronic or acute, that may make food injurious to the health of the consumer. Food safety is about producing, handling, storing and preparing food in such a way as to prevent infection and contamination in the food production chain, and to help ensure that food quality and wholesomeness are maintained to promote good health". For better understanding the slightly difference between these two concepts we present Fig. 1.

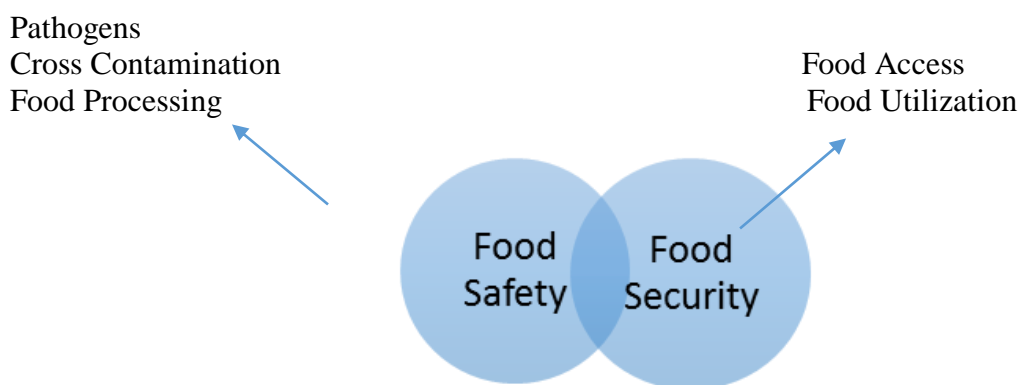


Figure .1 Food Safety vs. Food Security

Source: based on WFS (1996, retrieved from <http://www.fao.org/WFS> on 10/02/2018) and FAO (1996)

In the globalized era we live in, when technology brings lot of information and global interconnection all around the world, industry faces the big challenge. Standardization/ unification on the products and processes becomes very important, especially in the food industry due to high diversity (different taste, culture etc). As the food variation of the products is very different based on ethnic groups, history, geographical features, global citizens feel curios about trying a new food and in the same time trying to learn about that specific culture. The truth is that due to many different circumstances this unification cannot be covered in any place in the world in the same way. This situation sometimes can result with negative impact on the human health. (Kwon, 2017)

The most important part of the food safety framework is the development of microbial intervention technologies that can reduce, control or eliminate the foodborne pathogens from food products and contact surfaces. Recent high-profile foodborne illness brought a renewed collaborative approach in order to improve the food safety strategies – nanotechnology. At least two thirds of the foodborne illness are bacteria, viruses and parasites transmitted due to inadequate handling the food, either from producer side or from consumers side. Nanotechnology is trying to find solutions for higher food safety from the moment of production up until the moment of final consumption.

3. FOOD SAFETY PERSPECTIVE - CHALLENGES

- Long and complex food chains

The value chain it is a complex system of putting together different parties such as: suppliers, warehouse, logistics and so on. In Fig. 2. bellow we can see a model of how long this processes can be, from environment up until the final consumer (ex. Inappropriate holding temperature, using contaminated tools, Inadequate cooking or undercooked food). According to European Food Safety Authority risk factors can be found in each of the separate parts within the global food supply chain. Due to the different nature of all of them, complexity and dynamics, there are many challenges that need to be overcome, which can create problems when it comes to take a decision (WTO, 2013)

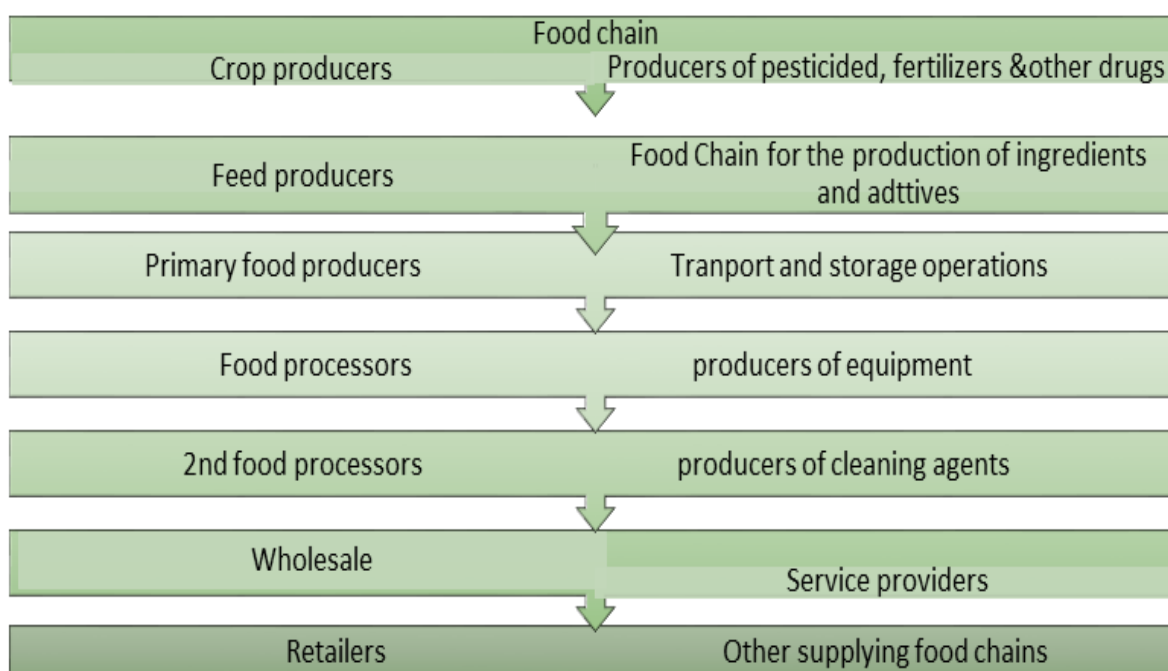


Figure 2. Food supply chain

Source: European Food Safety Authority (EFSA)

Due the growing complexity of the global food supply chain there is a tendency to appear many safety regulations across countries, but still, depending from one country to another it can defer. In this sense, existing standards is the key point. Some of the safety challenges can come into sight from the difference of income (King et al., 2017).

According to the same group of authors some of the main food safety issues can be: antibiotic resistance, viruses, unintentional chemical contamination, economically motivated adulteration of food, allergens and intolerances and nanotechnology.

-Antibiotic Resistance

Antibiotics are medicines that can prevent bacterial infections. Antibiotic resistance takes place when bacteria change in response to the use of these medicines. This can lead to higher medical costs, prolonged medical stays and sometimes mortality (WHO, 2017). Many countries, especially

European Union, over time, has made many efforts of implementing strategies and uniform standards that must be respected. In order to prevent antibiotic resistance, World Health Organization (2017) advised: use the antibiotics for animals only under veterinary supervision, not use antibiotics for growth promotion or to prevent diseases in healthy animals, use alternative for antibiotics if available and use vaccination in order to reduce the need for antibiotics.

-Viruses

The increasing demand of seasonal products globalized the food market within the last few years. This market globalization meets the challenge to work with the same hygienic standards across the world making the global food supply process even more vulnerable: higher flaws in the process can make the possibility of a faster contamination with different pathogens across the globe (Newell et al., 2010) cited in Koopmans (2012).

-Food Contact Materials (FCM)

Along the supply chain, food is exposed to many risk factors. Until the moment of final consumption, food comes in contact with many materials. All of these materials can come in direct or indirect contact with the food and can impact the safety of the food. Such materials can be: containers for transportation the food, equipment for food processing, packaging materials. Materials which come in contact with the food in one or another way should be in agreement with the European Union regulations. In 2002, European Food Safety Authority was set up due to the food safety crisis in the 90s as a source of scientific opinion based on present European policies and legislation. The safety of FCM lays on the competent authorities of the Member states, still technical competence regarding the methods used and scientific opinion can be maintained by European reference Laboratory for Food Contact Materials. According to the latest data, in 2016 in Romania, the greatest part of the whole number of notifications was due to Salmonella hazard. (Fig. 3.)

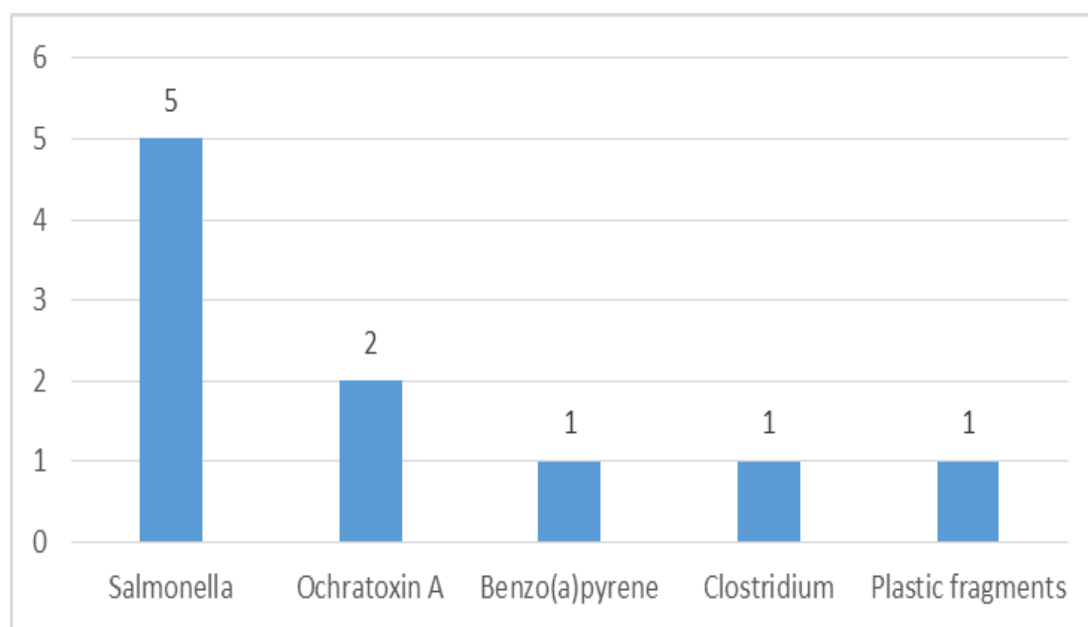


Figure 3. Top 5 hazards notified by Romania in 2016

Source: World Health Organization ([http://www.who.int/mediacentre/factsheets/antibiotic-resistance/en/updated in 2017](http://www.who.int/mediacentre/factsheets/antibiotic-resistance/en/updated%20in%202017) retrieved on on May 05, 2018)

4. NANOTECHNOLOGY – SWOT ANALYSIS

Historically, the term "nanotechnology" was created by Norio Taniguchi (Tokyo University) in 1974 in order to describe the precision manufacture of materials with nanometer tolerances¹, but its origins date back to Richard Feynman's 1959 talk "There's Plenty of Room at the Bottom"² in which he proposed the direct manipulation of individual atoms as a more powerful form of synthetic chemistry (source oecd)

European Commission adopted the following definition of nanomaterial in 2011 (EC, 2011): "Nanomaterial" means a natural, incidental or manufactured material containing particles, in an unbound state or as an aggregate or as an agglomerate and where, for 50 % or more of the particles in the number size distribution, one or more external dimensions is in the size range 1 nm–100 nm." According to the *Technical Committee 229 Nanotechnologies (ISO, 2005)* with the scope of standardization in the field of nanotechnologies includes either or both of the following:

"Understanding and control of matter and processes at the nanoscale, typically, but not exclusively, below 100 nanometres in one or more dimensions where the onset of size-dependent phenomena usually enables novel applications, Utilizing the properties of nanoscale materials that differ from the properties of individual atoms, molecules, and bulk matter, to create improved materials, devices, and systems that exploit these new properties."

Nanotechnology provides wide range of advantages and opportunities for development of innovative solutions in virtually every segment in the food industry from agriculture to food processing and food packaging. Undeniably the packaging is the most active in the food nanoscience research and development (Source: duncan). Nanotechnology has integrated many disciplines such as: chemistry, physics, biotechnology and implies use of nanomaterials whose nanoscale structures range from 1-100nm (source risk from nanotech). The size of the nanomaterials permit materials to adopt the unique desired properties. When it comes to food sector usually nanotechnology comes to help to increase the solubility and bioavailability of the products. According to The European Food Information Council in the Fig. 4 we can see the potential applications of the nanotechnology in the food sector. According to the EUFIC, nanotechnology can intervene in ensuring better traceability, reformulation of food lower in fat, salt, etc. while maintaining in the same time the food taste, appearance and all the healthy minerals.

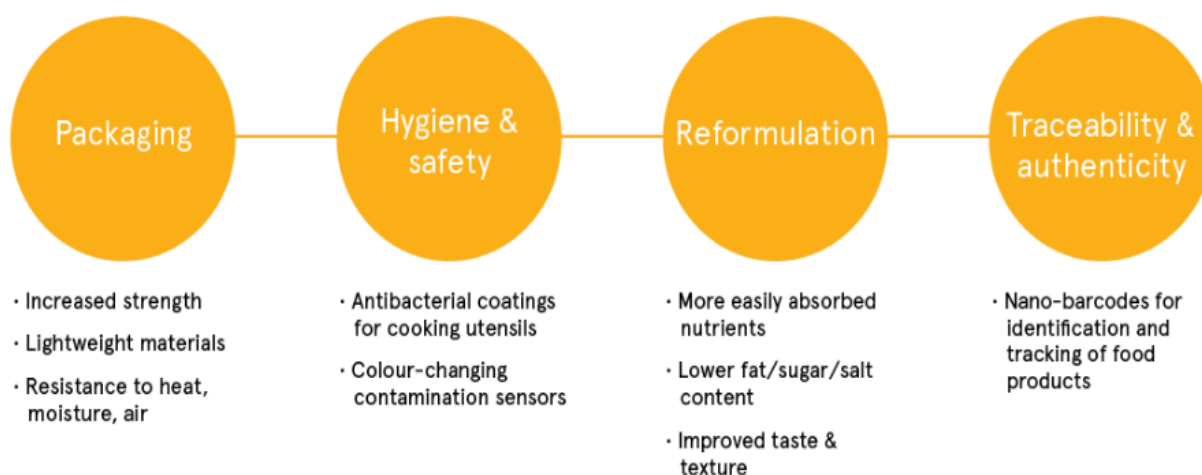


Figure 4. Some potential applications of the nanotechnology in food and feed
 Source: EUFIC - The European Food Information Council

Nanotools provide precise management, development and control of inputs which encourage to provide environmental pollutant detection and improving the quantity and the quality of agricultural products (Iavicoli et al., 2017). As we know, some of the traditional solutions for food packaging are: plastic, paper and glass. The need for using nanotechnology for better food safety came as a

result to counteract the existence of high risks that started to appear using the traditional methods. It has been understood that the role of packaging is not only to protect the food from external factors such as dust, oxygen, light, etc. but also to keep it healthy and fresh at the same time.

In the ancient societies, the use of silver was a method used very often for wine and water preservation. Today, silver nanoparticles are found to be beneficial in releasing antimicrobials that can be easily incorporated into different materials such as plastic, textile. Until this moment, the Food and Drug Administration containing zeolites for the use of food contact materials in order to provide disinfection. The use of silver nanoparticles still needs to be researched since it offers high potential (Duncan, 2011). In the chart bellow (Fig. 5) is presented the ratio of nanotechnology patents granted or published in USPTO and EPO per 100 ISO nano-articles published in the same year. As we can see in the Fig. 2 in the period 2015-2016 the ratio of nanotechnology patents was at its highest level.

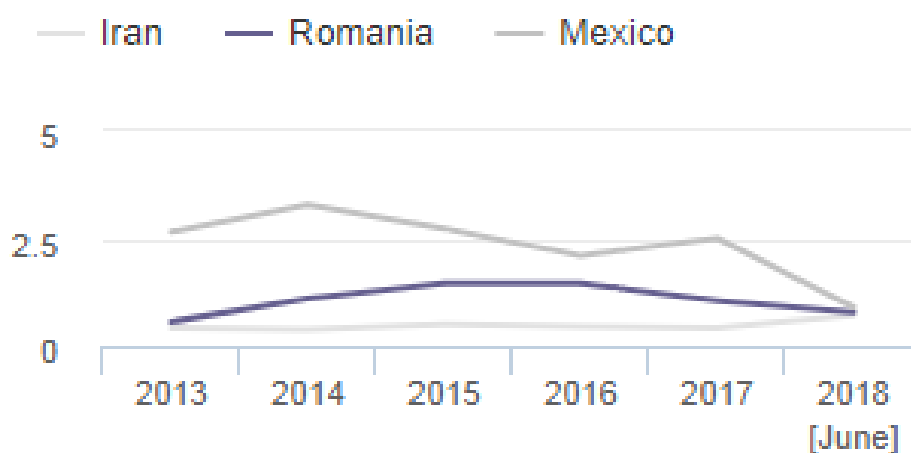


Figure 5. Ratio of nanotechnology patents to nano-articles

Source: <http://statnano.com/country/romania>

According to Eleftheriadou et al., (2017) Nano-enabled methods for food safety & Quality Enhancement are:

- Antimicrobial food Contact surfaces-smart antimicrobial surfaces for food preparation and storage
- Nano-Biosensors – intelligent sensors for food quality control
- Food packaging- suitable, biodegradable, stronger and smart food packaging
- Engineered water nanostructures- minimizing food pathogens and reducing spoilage

Atmospheric gases, water vapors and other natural substances can be a possible threat for the food industry. According to Deloitte, (2015) packaging is an important element of the food and beverage value chain as it estimates about 50 percent of the consumer decision. Now, this can offer added value to the functionality to the product, for example active packaging and smart tagging. Smart tags can be very useful when it comes to keeping low/high temperature, (simple quality sensors that can control the freshness of a product through entire supply chain). Only with better collaboration between retailers and manufacturers and use of nanotechnology can be found a sustainable solution for more effective packaging which in the same time can be flexible and secure to adapt to any retail shelves. Using nanotools in order to create better solutions for food packaging has become a major priority. However, special awareness is needed especially when it comes to fresh food and vegetables. Blocking the permeability of the external factors it is not recommended due to the

nature of the products. In contrast, the packaging of the carbonated beverages can prevent oxidation and re-carbonation (Abdollahi et al., 2012). The important role of the nanotechnology is coming especially in the case of fruits and vegetables where it is very important the durability of the freshness in the same time. Nanoparticle has special antimicrobial properties for food packaging with a diameter of less than 100 nm and is a thousand-times thinner than 100,000 nm thick book page can help to release the antioxidant and antimicrobial compounds and also is helping in the process of removing some negative factors such as oxygen and water vapor which leads to food safety (Ramanathan et al., 2008). In the present, the use of biodegradable polymers reinforced with nanofilters is being encouraged due to its eco-friendly effects. (Abdollahi et al., 2012). Still, in this stage some of the nanoparticles are toxic for the human body and R&D investments can help investigate how these nanoparticles migrate within the body how to eliminate them (Sia, 2017). According to EUFIC, in Europe there is no dedicated regulation/laws that guarantee the aspect of safety using nanotechnology in food and feed. For instance, the General food law in Europe states that safe food can be placed on the market and since 2014 the general legal requirement is to label foods that contain nanoparticles in order to inform the customers.

In the process of creating farm-to-fork food safety framework important part is the development of microbial intervention/control of the food and the final objective is to eliminate foodborn pathogens within the food or in any contact surface. The use of biosensors in nanotechnology offers much strengths due to the properties of the nanomaterials. These materials can help to miniaturize many biosensors to small and compact devices that are crucial for biochemical analysis (Sertova, 2015; Fraceto et al., 2016 in Patra et al., 2018). According to Sertova, N. M., (2015) nanometerials detect mycotoxins in the food. Nanotechnology slowly is becoming part of the pesticide sector with the development of many plant production products named "nanopesticide". The benefits of such products are: durability due to the reduce of the amount of active ingredients used, safer mobility and protection against premature degradation.

Beside all these strengths of nanotechnology we should not neglect that this science is still in the beginning of its journey. In present there are many challenges that appear and major concerns remain heavy metal release and allergies. The study conducted by Yoshida et al., (2011) found that nanoparticles can induce allergen-specificTh2-type allergic immune in vivo, evidence based on female BALB/c mice exposed to nanoparticles. Another concern can be found in the use of metal based nanoparticles integrated with the food contact polymers. According to the study by Fukui et al., (2012) where rat lung was exposed to ZnO particles, resulted that these nanoparticles generate oxidative stress in the lung in the acute stage. This means that the release of metal ions is highly correlated to the increase of intra cellular ROS level which can lead to DNA change. In this stage we should also mention the negative impact that nanomaterials can have on the environment especially when they are used as nanofilters and nanopesticides. (Iavicoli et al., 2017).

While there are benefits from the use of nanotechnology lack of awareness among the customers it is identified according to the European Food Information Council (EUFIC). This finding is also supported by the group of authors (Seigrist et al., 2007; Berg 2004 in Roosen et al., 2015) who found that in the sector of "trust" the use of nanotechnology is considered as "bad news". From my point of view raising the awareness can be done only by active informing the customers what this nanotechnology means and consequently investing in R&D which will make improvements in order to transform all the potential threats in strengths.

In the part of opportunities nanotechnology starts to enlarge its area and begins to integrate in the green innovation technology segment, offering high potential of green growth and lot if perspectives for social and economic development. Nanotechnology intends to provide more easily reachable supports and less dangerous from chemical point of view, which will lead to higher durability (ex. bio products) (Sia, 2017).

SWOT Analysis	
<p>Strenghts</p> <ul style="list-style-type: none"> - nanotools provide precise management, development and control of inputs which encourage to provide environmental pollutant detection and improving the quantity and the quality of agricultural products (Iavicoli et al., 2017) - using nanoparticles with antimicrobial properties for food packaging helps the food to release the antioxidant and antimicrobial compounds which leads food safety (Ramanathan et al., 2008) - nanotechnology promices development of high tech agricultural fields equipped with a big virietes of nanotools that help more precise management and control of the quality of the inputs (Iavicoli et al., 2017) - metal based nanomaterials in contact with food can enhance barrier properties for food safety, serve as antimicrobials and prevent photodegradation 117 (Xiaojia & Hwang, 2016) - silver nanoparticles in the food contact can help in the process of disinfection (Duncan, 2011) 	<p>Weaknesses</p> <ul style="list-style-type: none"> - present regulation does not guarantee traceability of the use of nanomaterials and also the imact that this particles can have when they are being releases in the air, enviroment anf health problems (Sia, 2017), - luck of research and development investments in nanotechnology can limit the possibilities that this technology can bring - the transition towards green economy using nanotechnology can be a challenge which requires thinking on a long run which can be cultural challenge and fallowing a new lifestyle (Sia, 2017)
<p>Threats</p> <ul style="list-style-type: none"> - certain nanoparticles can provoke allergies (ex.Th2-type) (Xiaojia & Hwang, 2016) - the increased level of competition in order to achieve fast results sometimes can have negative impact on human health and upon the environment (toxicity and biodegradability of nanoparticles) (Sia, 2017) - using nanoparticles in the agri-food sector can bring potential toxicological risks when these particles are being released for pollutant detection, cleanup and water treatment (Iavicoli et al., 2017) - using nanoparticles in the agri food sector can have negative impact on the health of the workers on a long run - the nanoparticles can be and eco-toxicological risk, biodegrade or bioaccumulate in the food chain (Szakal et al., 2014 in Sia, 2017) 	<p>Opportunities</p> <ul style="list-style-type: none"> -nanotechnology it is the first step towards sustainable production and consumption. Creating new ways for managing the suuply chain (ex sustainable procurment practicies, reduction of energy consumed (Sia, 2017) - opportunities for cross-sector and interdisciplinary approaches within food industry - development of innovative products and applications for agriculture, water treatment and food production, processing, preservation and packaging, and its use may benefit farmers, the food industry and consumers alike

Figure. 6. SWOT Analysis

Source: own elaboration according to different authors research studies

5. CONCLUSIONS

Interconnection is the key of the new era. Challenges that are being brought with this globalized world became a new priority of today's societies. A huge importance and the biggest challenges of the food industry are standardization and lack of R&D investment in the sphere of nanotechnology. For different cultures, traditions, religion, ethnic groups can be difficult to understand the concept of globalization in the same way. It is a big challenge to understand the food risks that can be found in each stage of the value chain due to their complexity. From our point of view only investments in Research and Development can help to emphasize all the beneficial points that nanotechnology can offer and transform all the threats and disadvantages into strengths. In this stage, there is much to do in the section of "trust", since nanotechnology is considered still as "bad news". In these conditions, it is difficult to assess customer's reaction in the future, but no doubt that for some time customer's acceptance will be critical if measures will not be taken in the near future. Therefore, there is the need to constantly inform the customers of the potential benefits and safety considerations in order to increase their understanding and willingness to try an innovative approach.

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