



# **The Relationship Between the Economic Development of the Country and Food Security**

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## **1. Introduction**

The food industry is a source of significant dangers to the natural environment – soil, water, air, plants, animals and humans. The problem of environmental protection in the light of dangers from chemical substances used by the food industry include water and sewage management, waste management, air protection against pollution as well as soil and noise protection. Globalisation, which also affects changes in the food chain, presents new challenges and brings unknown risk factors determining, among others, drug resistance in the treatment process, chemical contamination of food, which can influence the quality of life of the consumers. Accession of Poland to the EU has initiated a series of dynamic changes in food-processing sectors, involving not only quality standards and food safety, but also the protection of the natural environment. The consequence of accession are changes in the adjustment of Polish regulation to the standards binding in the EU. Consistent with the *acquis communautaire*, environmental legal pacts impose on the mentioned parties the obligation to prevent and to reduce the risks throughout the food production cycle.

The use of chemical substances in food processing is necessary in order to obtain products with higher nutritional value, stability that ensures microbiological safety, better sensory properties and reduced content of substances with potentially harmful effects on human health. The

chemical compounds that are added to foods during the processing practice must be safe to human health and the amount of additives and processing aids added is strictly limited by the provisions of feed and food law. It must also be borne in mind that despite these undisputable benefits, it may also result in the formation of compounds with adverse effects on the quality of human life.

The aim of the article is to analyse the impact of the natural environment on food safety using critical literature analysis and analysis of the Global Security Index (food quality and safety sub-indicator) and its relations with the country's PKB on the example of the European Union.

## **2. Environmental contaminants and food safety**

The natural environment, a habitat for living organisms, has a significant impact on the safety of food – quality of life. The development of the industry (Bober et al. 2017, Wolniak & Skotnicka-Zasadzień 2014), in the nineteenth and twentieth centuries seriously contaminated the water and soil environment and the degradation of the air continues. Air contamination is detrimental to nature, and after reaching plants and animals, primary sources of food, poses a major hazard to the human organism. Surface waters are contaminated by a variety of substances deteriorating its quality, which impact negatively on its expiration date and on the use in production (Kołożyn-Krajewska 2007). Soil, which together with air and water constitute the main element of the natural environment, affect primarily the quality of raw materials used for food production. It contains high level of minerals, which, according to the origin of the soil, are used by plants which, in turn, are the main source of micro- and macro-elements for humans and animals. Environmental pollution has an effect on changes in the soil chemical, physical and biological properties. These factors are the crucial elements of the environment through which micro- and macro-elements are transferred to the living matter, where they are accumulated in tissues and organs. Concentration of specific pollutants causes food contamination, which is a risk to the safety of food being consumed. The quality of food has a significant impact on human live and health. The changing environment also generates new threats in the food chain causing exposure of the consumers to new unknown risk factors. Because they are not always aware of what

the food might contain, they might be exposed to chemical compounds, in particular those that can be found in food. In addition to microbiological purity, the percentage of chemical contaminants is the health safety criterion of food products. Among the chemical hazards we can distinguish those that can be commonly found in the environment (heavy metals, pesticide residues, dioxins, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons) and those which presence in food can be avoided or reduced to an acceptable level as a result of the use of systems providing food health safety (medical products, plant protection products, technological auxiliary agents and preservatives, substances which result from the improper food storage or processing technologies used). Currently the dynamics of food products development continuous to grow. New technologies, security management tools, the changing expectations of customers, lifestyle, changes in the state of the environment and the development of international food markets, are essential determinants for creating the new quality of food, which provides both nutritional value and health security. The fundamental responsibility to ensure food safety (Olkiewicz 2015) and environmental protection (Olkiewicz et al. 2015) falls not only on producers and distributors, but also on state authorities that supervise the food production chain – “from farm to fork”. Management through traceability of food and its labelling should be a significant tool used for monitoring the security of an integrated food chain, while taking into account the present-day threats, i.e. bioterrorism or chemical terrorism using food products. The concept of hygiene that deals with studying the effects of environmental pollution on food safety is also an important element in the analysis of the impact that environmental factors have on the human body. Therefore, maintaining high hygiene during food production determines the conditions for the production of both healthy and safe products for human health in terms of health quality (Dzwolak 2011).

### **3. Food safety measurement**

According to Codex Alimentarius, hazards are understood as undesirable contaminations, inter alia the chemical ones. By the analysis of the risk and threats in accordance to the ISO 9001 standard, a process-oriented approach can be taken into account to (Gadula 2008, Wolniak 2013):

- raise customer satisfaction,
- ensure ongoing surveillance (over the links between the processes, combination of processes, mutual interaction between the processes),
- stress the importance (to understand and meet the requirements),
- the need to consider processes in terms of an added value, the effectiveness of the processes,
- continuous improvement of the processes on the basis of an objective measure.

Therefore, fixing limit values of the daily intake and Acceptable Daily Intake (ADI) tolerance are the basis for the prevention against potential poisoning of the consumers. This serves as an indicator of the maximum amount of the substances that, in accordance to the current state of knowledge, people can intake daily without any adverse effects (Czerwiecki 2005).

For instance, pesticides can cause acute poisoning and chronic poisoning as a result of their accumulation in small doses in the body. Therefore, the biggest threat of poisoning and an adverse effect are insecticides, and in particular organophosphorous and carbamides. They are the cause of, inter alia, the defects in development, i.e. limb defects or infertility, hydronephrosis, cleft palate and DNA damage. It is very important because they are introduced into the body with food and skin pores (Juszczak 2008).

Food additives that have been approved, demonstrate applications that, inter alia, aim to increase health safety and substance protection against changes during storage or warehousing and transport. The attractiveness of the quality of products is additionally boosted along with the consumer attractiveness and availability if new features to products are added.

One of the most commonly used indicator to measure food safety in the world is the so-called *Global Food Security Index*, which measures issues related to food safety in three categories: affordability, availability and quality & safety. The Global Food Security Index consist of a set of indicators from 113 countries and measures food security across most of the countries of the world. The indicator was first published in 2012 and is managed and updated annually by The Economist's intelligence unit (Economist 2018). The index is a dynamic quantitative and qualitative

benchmarking model, constructed from 28 unique indicators that measures these food safety factors across both developing and developed countries. It is the first index to comprehensively study food safety. The use of a composite indicator has the advantage to summarise a significant amount of information in one unique score (Thomas et al. 2017). The advantages of composite indicators are as follows (OECD-JRC2008):

- can summarise complex, multi-dimensional realities to support decision makers,
- are easier to interpret than a number of separate indicators,
- can assess progress of countries over time,
- can reduce the size of a set of indicators without dropping the basic information base,
- makes it possible to include more information within the existing size limit,
- places issues of the country's performance and progress at the hearth of the policy arena,
- facilitates communication with general public (i.e. citizens, media) and promotes accountability,
- helps to construct/underpin narratives for lay and literate audiences,
- enables users to compare complex dimension.

The indicator on the food quality and safety index is the objective of this paper. In Table 1 data concerning the value of this indicator for 2017 for the EU together with the GDP was collected. In the research only those EU countries which can be found in the Global Security Index Database (Food security index 2018) were used. Twenty countries were included in the table: Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden and United Kingdom.

Taking into consideration the food quality and safety, Poland is ranked 29th in the world. Figure 1 shows the value of this indicator among European Union countries. Compared to the rest of EU, Poland is on the 16th place and the food quality and safety index has the value of 74.9. This is not a good result when we take into account that only twenty countries were used in the analysis. However, if we compare Po-

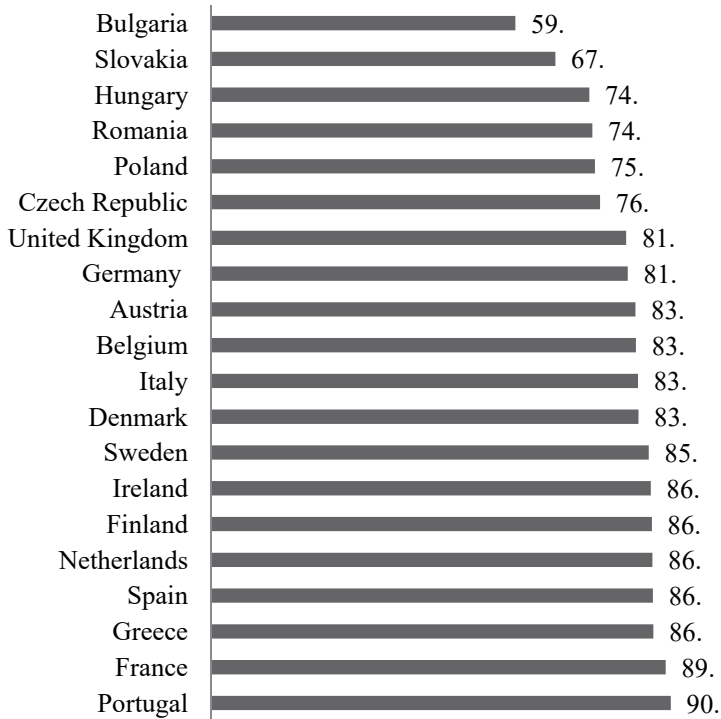
land to similar countries, i.e. the countries belonging to the Visegrad Group, its position is not so bad. From four countries of the Visegrad Group, Poland is ranked 2nd. Only the Czech Republic obtained better results when the researched problem is considered (index value at 75.9). The index value of other countries of the Visegrad Group, i.e. Hungary (73.8) and Bulgaria (67.2), is significantly worse compared to Poland.

**Tabela 1.** Wskaźnik jakości i bezpieczeństwa żywności i PKB

**Table 1.** Food quality and safety index and GDP

No	Country	Food quality and safety index 2017	GDP per capita [\$]
1	Austria	82.8	43435
2	Belgium	82.9	43243
3	Bulgaria	59.4	7924
4	Czech Republic	75.9	19818
5	Denmark	83.4	56335
6	Finland	86.0	45693
7	France	88.7	39673
8	Germany	81.3	44184
9	Greece	86.3	18945
10	Hungary	73.8	13459
11	Ireland	85.8	68604
12	Italy	83.3	31618
13	Netherlands	86.1	48271
14	Poland	74.9	13429
15	Portugal	89.7	20575
16	Romania	74.4	10372
17	Slovakia	67.2	17491
18	Spain	86.2	28212
19	Sweden	85.4	53248
20	United Kingdom	81.0	38847

Source: Own research (based on the data from: [www.foodsecurityindex.eiu.com/Resources](http://www.foodsecurityindex.eiu.com/Resources), [date of access 08/03/2018]; World Economic Outlook Database. International Monetary Fund, [www.imf.org/external/index.htm](http://www.imf.org/external/index.htm), 24 October 2017, [date of access 08/03/2018]).



**Rys. 1.** Indeks jakości i bezpieczeństwa żywności 2017 – Kraje Unii Europejskiej

**Fig 1.** Food quality and safety index 2017 – European Union Countries

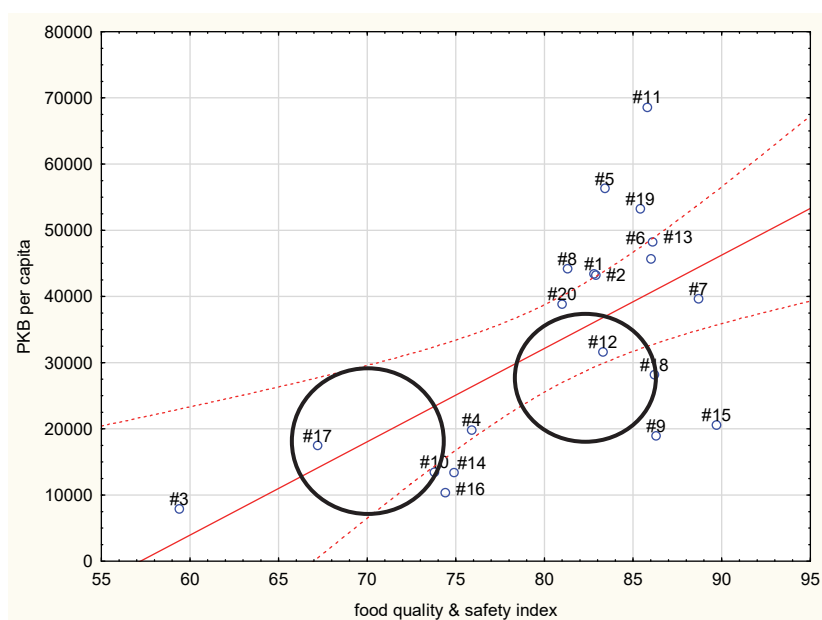
Source: own study based on the data: [foodsecurityindex.eiu.com/Resources](http://foodsecurityindex.eiu.com/Resources), [date of access 08/03/2018].

Figure 2 shows the analysis of the differences between the studied countries. The statistical analysis of the data at the level of significance at  $\alpha = 0.05$  proves the existence of a positive correlation between the variables of a 0.62 value. National prosperity affects the food quality and safety level in its area. In the figure, most of the surveyed relevant nations are in the 95% confidence interval. By analysing the data, two coherent groups of countries can be distinguished:

- Countries with similar average level of the food quality and safety index and low wealth measured by the GDP per capita index. This group includes four nations: Czech Republic, Hungary, Poland, and Romania.

These countries are on medium level of economic growth and cannot achieve a high level of food security due to the low level of their wealth. In the case of this group of nations can be difficult to afford a high level of security related to food safety, including chemical safety. Improvement of food safety can be difficult to achieve for those countries without further economy growth. Improvement of food safety in those countries requires financial outlays, which should be raised along with further economic growth of the analysed countries.

- An interesting group of countries are Greece, Portugal and Spain. In these nations, the level of food quality and safety index is much higher than their level of wealth might suggest. It should be noted that they are Mediterranean countries with a specific climate, which are focused on the production of healthy, natural food. For nations such as Poland, with completely different geographical conditions, following their path seems to be slightly more difficult.



**Rys. 2.** Wykres rozproszenia PKB na mieszkańca oraz wskaźnik jakości i bezpieczeństwa żywności

**Fig 2.** A scatter plot of GDP per capita and food quality & safety index

Source: own research.



Globally, based on the analysis, it can be concluded that a high level of food quality and safety can be achieved in the situation of high national wealth and it is very difficult to adopt technically highly advanced methods that would address the threats to food safety without considerable financial commitments.

The report on drug resistance (EFSA & ECDC 2016) is the basis of the addressed issue of the presence of chemical substances within the food processing industry. It was based on the analysis of data obtained from twenty-eight EU countries under the aegis of the European Food Safety Authority (EFSA) together with the European Centre for Disease Prevention and Control (ECDC). The report includes the results of studies that draw attention to the gravity of the current situation concerning infections with pathogenic microorganisms and the rapidly growing problem of resistance to bactericides (chemical contaminants present in food).

According to the authors of this report (European Union Summary Report 2014), pathogenic bacteria, which causes infections for humans and animals and are present in food, show an increased resistance to commonly used bactericides. Resistance to ciprofloxacin, which is essential in the treatment of human infections, is very high among *Campylobacter* species. The consequence of this situation is the reduction of the effectiveness of the treatment process of serious food borne infections. Furthermore, the phenomenon of a continuous expansion of the *Salmonella* bacteria resistant to a number of drugs is evident across Europe. The report also shows the issue of the resistance of *E. coli* and *Salmonella* strains (poultry microorganisms within the EU) to colistin.

Mike Catchpole, a scientific director of the ECDC, expressed his concern about the present situation because colistin is the last effective bactericide that may soon lose its efficiency in the treatment of severe *Salmonella* infections. The report further indicates the increasing differences in antibiotic resistance depending on the region. The highest Anti-Microbial Resistance (AMR) level can be observed in Eastern and Southern Europe, while bacteria living in poultry with lower resistance in the Northern Europe region, especially in countries where the application of germicides in animals is at a low level. According to Vytenis Andriukaitis, the European Union Commissioner for Health and Food Safety, around 25 000 deaths occur every year in the EU as a result of complications after infections caused by micro-organisms resistant to treatment.

It is not a problem that only concerns Europe but has become a global threat that requires a global solution. The European Union has long been a leader in the fight against resistance to bactericides.

Measures in this area are also being taken in Poland. Tests for the presence of harmful chemicals in food has shown that unauthorised substances have been detected only in individual cases. The hygienic and sanitary status in the production and food trade entities controlled by the National Sanitary Inspection, has improved significantly (2% of facilities supervised by the National Sanitary Inspection did not meet the sanitary requirements) (National Sanitary Condition 2007-2008 & 2015-2016). Therefore, food safety as result of the use of chemical agents in food-processing as well as the increasing resistance to bactericides should be one of the priority areas for national policy. The existing legal conditions impose restrictions on the food-processing industry, thanks to which a consumer can feel secure on the food market.

#### **4. Discussion**

The obtained results determine the conclusions that are not very optimistic. Apart from the undisputed advantages of using chemical compounds in the food-processing chain, there are also negative factors:

- Campylobacteriosis is the most commonly reported food borne infectious disease. Resistance to antimicrobials, i.e. ciprofloxacin among bacteria isolated from people may amount to as much as 60.2%, and in the case of animals (broilers) up to 69.8%.
- Salmonellosis is the second most commonly reported food borne illness. It has been noted that the resistance of bacterial strains isolated from people to commonly used bactericides is at the level of: 30% relative to tetracycline, 28.2% to sulfonamides and 28.2% to ampicillin. The overall multidrug resistance of bacteria is assessed at 26% for people, and in the case of broilers and turkeys – 30.5% and 24.8% respectively. Certain strains of salmonella (*Salmonella* Kentucky and *Salmonella* Infantis) have relatively high levels of resistance to ciprofloxacin and overall high multidrug resistance.
- The strains of *Salmonella* and *E. coli*, isolated from poultry originating from the EU, are characterised by significant resistance to colistin.

- At low levels of *Salmonella* originating from poultry, a wide spectrum of beta-lactamases (ESBL) was observed. The clones of *Salmonella* *Infantis* showing multidrug resistance and ESBL-producing were found in both people and poultry. However, no carbapenemase-producing *Salmonella* was found in poultry and meat.

Therefore, agencies such as EFSA or ECDC (through the combination of experience, theoretical and practical knowledge) for the protection and prevention of human and animal health should serve as databases, which provide a lot of valuable scientific information to policy-makers responsible for food policy in a given country or a region.

Food chemical pollution should become a significant element in the process hazard analysis, which is a tool in health safety management, taking into account different stages of the food supply chain, which includes primary production, processing and distribution as well as packaging and storage.

The presence of undesirable substances (chemical contaminants in food) poses a risk to the safety of the consumers. Therefore, according to the Codex Alimentarius and Food Hygiene Basic Texts, food safety is understood as an assurance that food will not cause prejudice to consumer health if prepared and / or consumed in accordance with the intended use. In the preventive part, it serves as an important element of the human health protection system (Łozowicka 2009).

The present paper described food chemical contaminants as critical quality of food and food safety factors. They were classified as:

- industrial – heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls,
- technological – PAHs, mycotoxins, heterocyclic amines (HCAs),
- environmental – heavy metals, pesticides, fertilizers and radioactive elements.

The majority of them, which are detected in food, fall within a group of pollutants that are difficult or even impossible to avoid due to their prevalence in the natural environment, durability and the ability to accumulate in individual links of the food chain.

The second group consists of chemical compounds which presence in the food processing process can be avoided by, inter alia, good manufacturing practice (GMP), good hygiene practice (GHP), and hazard analysis and critical control points (HAACP) – a method that ensures health security of food.

The last group are chemical agents that are added in the processing processes, i.e.: certain colourants, artificially sweeteners that are formed from improper storage of agricultural raw materials or in technological processes.

## **5. Conclusions**

Taking care of environmental protection by reducing the risks and water and energy consumption during food processing may prove to be, on the one hand, a complex process that requires substantial financial resources and, on the other hand, can lead to increased economic outcomes and improved image of companies that use environmentally friendly technologies. This can be often achieved through the monitoring of each stage of the technological process and an analysis of the capacity to implement measures which may lead to the reduction of the negative effects of the production process and thus the whole entity on the natural environment. Food safety can be mainly ensured through a preventive approach based on the implementation of good hygiene practice and procedures related to Hazard Analysis and Critical Control Point principles. The nature of food safety is based on a risk analysis of which one of its elements is risk assessment. The use of additives in the food industry brings benefits to both food producers, facilitation of production and storage processes, and consumers who receive a product with better quality of health and hygiene, often with a higher nutritional value.

On the one hand, their application is favourable for expanding the range of foodstuffs that can contribute to the diversification of food and the reduction of the risk of drug-resistant or diet-related diseases. On the other hand, given the low content of additives in food and thus the low intake, the risk to human health resulting from the use of additives appears to be minimal when compared to harmful effects, i.e. toxins produced by micro-organisms that can develop in foods that do not contain any additives with preserving effect.

It can be stated that the current state of knowledge indicates, among others, that the use of food additives in amounts consistent with the recommendations of the Codex Alimentarius and good production practice offers more significant benefits than possible threats to the quality of human life.

The main aim of the paper was to analyse the impact of the natural environment on food safety. On the basis of conducted research on the European Union countries we found that exist a positive correlation between food quality and safety and GDP per capita. Normally the high level of food quality and safety can be achieved in the situation of high national wealth. The identification of this relation is main contribution of presented research to the theory.

We think that if we want to improve the quality and safety of food in countries such as Poland, Czech Republic and Hungary it needs more investment to achieve this goal and is difficult without continuous development of the whole economy of the countries. Also we found that Mediterranean countries (Greece, Portugal and Spain) are specific because their quality and safety of food index is higher than their level of wealth can suggest. The cause of the phenomenon is specific climate of those countries, which are focused on the production of healthy, natural food.

The main limitation of the paper is that we analysed only European Union countries. In the future researches it would be good to analyse all world countries to check if the founded relations exist also on the global level. Other limitation is connected with the GDP per capita indicator. In the research we could use other indicators connected with development of the country – for example innovativeness indicators.

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## **Związek między rozwojem gospodarczym kraju a bezpieczeństwem żywności**

### **Streszczenie**

W publikacji przedstawiono kwestie dotyczące wpływu środowiska naturalnego na bezpieczeństwo żywności. Zaprezentowano w nim zagadnienia dotyczące występujących zanieczyszczeń środowiska w kontekście ich wpływu na

bezpieczeństwo żywności. W publikacji skoncentrowaniu się na analizie związków pomiędzy rozwojem gospodarczym kraju a bezpieczeństwem żywności. Celem artykułu jest analiza wpływu środowiska naturalnego na bezpieczeństwo żywności przy wykorzystaniu krytycznej analizy literatury oraz analizy wskaźnika Global Security Index (subwskaźnik jakości i bezpieczeństwa żywności) oraz jego związków z zamożnością kraju na przykładzie Unii Europejskiej.

### **Abstract**

The publication presents issues concerning the impact of the natural environment on food safety. It presents problems regarding existing environmental pollutants in the context of their impact on food safety. The publication focuses on the analysis of the relationship between the economic development of the country and food security. The aim of the article is to analyse the impact of the natural environment on food safety using critical literature analysis and analysis of the Global Security Index (food quality and safety sub-indicator) and its relations with the country's PKB on the example of the European Union.

### **Słowa kluczowe:**

jakość, bezpieczeństwo żywności, zanieczyszczenie środowiska, rozwój gospodarczy

### **Keywords:**

quality, food safety, environment pollution, economic development