Bibliometric Research on the Impact of Pesticide Use on Food Safety

Constanta Laura Zugravu [1], Gheorghe Adrian Zugravu [2]

[2] Corresponding Author
[1, 2] University "Dunarea de Jos" of Galati,
Domneasca 47, 800008, Galati Romania.

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Abstract

The food safety represent the main objective of agricultural policy. Food security requires a quantitative, qualitative and social approach. The use of pesticides contributes to ensuring food security from a quantitative point of view, but negatively influences food security from a qualitative point of view. The main objective of this study is to carry out a bibliometric study of the impact of pesticides on food security. The data used in this analysis were obtained by querying the Web of Science database. In last years, there has been a growing interest regarding the impact of pesticides on food safety. This study offer opportunity to identify the evolution of research, major trends and issues in the field of the pesticides impact on the food safety.

Keywords: Bibliometric Study, Food Safety, Pesticides, VOSviewer

1. Introduction

Plant protection products, which are pesticides used to protect agricultural crops, can play an important role in food production and storage. All chemicals authorized for use in food must first go through a rigorous risk assessment to ensure its safety. The possible effect of these chemicals on our health and safety depends on our level of exposure to them, for example through the food we eat or other sources of environmental exposure [1]–[3]. That is why regulatory bodies carry out rigorous risk assessments of all chemicals proposed for use in food, to determine which substances can be used and to what extent. In this way it is ensured that the use of chemicals in food and on crops (e.g. pesticides) does not have adverse effects on animal or human health e.g. on the environment. The verification of the presence of pesticide residues in food of animal origin is carried out both through community control plans applicable in all member states or through national plans established by natural persons. Community plans, generally for three years, provide for a yearly rotation of the matrices to be controlled, to cover during the three-year period in which they are active all types of food: milk, butter, eggs, meat (muscle and liver), honey [4]–[6].

Plant protection products are pesticides used by farmers to protect their crops from pests and diseases. In the EU, sales of active substances used in plant protection products exceed 350,000 tonnes per year. Plant protection products can have an impact on water and soil quality, biodiversity and ecosystems and can be found as residues in food [7]–[9]. These food residue values should be reviewed regularly with a view to lowering the maximum residue limits, taking into account the decrease in levels observed in more recent control programs. The European agency with skills in the field of food safety, EFSA, noted that some countries did not report the results in accordance with the provisions of European legislation, namely that the results, mostly part of food of animal origin, must be expressed on a fat basis . Due to the difficulties in comparing the reported results, EFSA could not draw valid conclusions and recommendations regarding the revision of the MRLs. To improve the situation, however, EFSA recommends that Member States provide clear guidance on how to report pesticide residue findings for food of animal origin [10]–[13].

The list of pathologies caused by the use of pesticides in agriculture is long and includes: Parkinson's disease, Alzheimer's, ALS, cardiovascular diseases, autoimmune and kidney diseases, diabetes, reproductive disorders, malformations and developmental defects, occupational asthma, chronic bronchitis and thyroid diseases. We can add celiac disease to this list. To all these pathologies we can add allergies, food intolerances, skin rashes, all caused by the chemicals used in crops. Unfortunately, these are revealed by the presence of organic derivatives used in agriculture and pesticides in the water we drink. So let's not be surprised if people keep getting sick. Living near places where pesticides are used, produced or disposed of increases your risk of exposure either through inhalation or through contact with water. The government should take care of this issue by trying to adopt some coercive measures in law enforcement. Protecting the health of the population should be one of the first issues to be addressed. Institutions should also rely on health experts and ensure that they are not corruptible by the companies that produce and sell these pesticides.

2. Proposed Algorithm

A pesticide is a chemical compound used as a means of fighting against harmful animals (insects, mites, nematodes, rodents, etc.) and against fungal or weed infections. They are classified taking into account their use (insecticides, herbicides, fungicides, fungicides, acaricides, etc.) or their chemical structure. Some pesticides remain on the plant as a superficial deposit (and therefore removable by washing), most instead penetrate the tissues (so it becomes impossible to eliminate the toxicity by washing). These substances have a very different chemical composition between them, they are classified as: organophosphorus, organochlorine (derivatives of DDT), halogenated hydrocarbons (fumigants), vegetable (pyrethrum, nicotine), mineral oils (associated with the active ingredients).

Chemical substances have the ability to eradicate parasites by acting in several ways:

- Contact pesticides: they only work if they come into direct contact with parasites;
- Insecticides active by ingestion act on the digestive system of insects that introduce them when they feed on the vegetables on which they are scattered;
- Systemic pesticides are primarily absorbed by the plants and then act on the parasites that feed on them.

Bibliometric analysis includes concepts that researchers use to describe their research, index terms or classification codes. The bibliometric analysis technique is based on a grouping that determines the

connection between publications based on direct citation relationships. With the VOSviewer software we use direct citation relationships, bibliographic coupling or co-citation relationships. After the relationship between the publications is determined, the publications are assigned to the clusters. Thus, each publication is assigned to exactly one cluster. The grouping of publications into clusters is achieved by maximizing a quality function:

$$Q(x_1,\ldots,x_n)=\sum_{i=1}^{n}\sum_{j=1}^{n}\delta(x_i,x_j)\left(a_{ij}-\frac{\gamma}{2n}\right)$$

Where:

- n represent the number of publications,
- a_{ij} represents the relationship between publication and publication j,
- γ represents the resolution parameter, -xi the activity cluster company is assigned publication i,
- The function $\delta(x_i, x_j)$ is a traffic light function, equal to 1 if $x_i = x_j$ and 0 otherwise.

The relation a_{ij}, between publication i and publication j is given by the following expression:

$$a_{ij}=\frac{c_{ij}}{\sum_{k=1}^{n}c_{ik}}$$

Where, c_{ij} has the value 1 if a publication i cites another publication j, and if we have the reverse situation where publication j cites publication i, the value of the cij parameter is 0 [14]–[19].

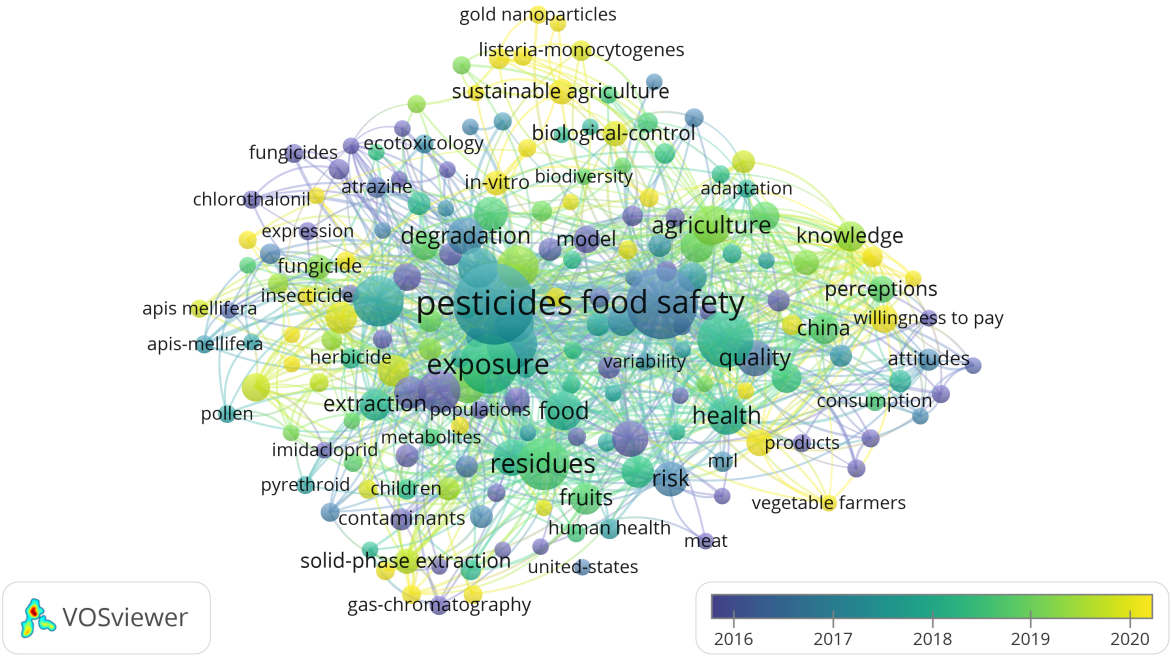
3. Experiment and Result

Using the presented methodology, with the help of the VOSviewer software, the specialized literature indexed in the Web of Science database was used to identify and visualize the evolution of the main trends. Thus, 580 WoS articles from the period 2014-2023 were selected based on three main criteria which are:

- Topics regarding “the impact of pesticide use on food safety”,
- Document type "article"
- Year of publication in the period 2014-2023.

There are eight major keyword clusters related to the impact of pesticide use on food safety database in the most recently accessed WoS articles from 2014 to 2023, which we determined based on thematic clusters.

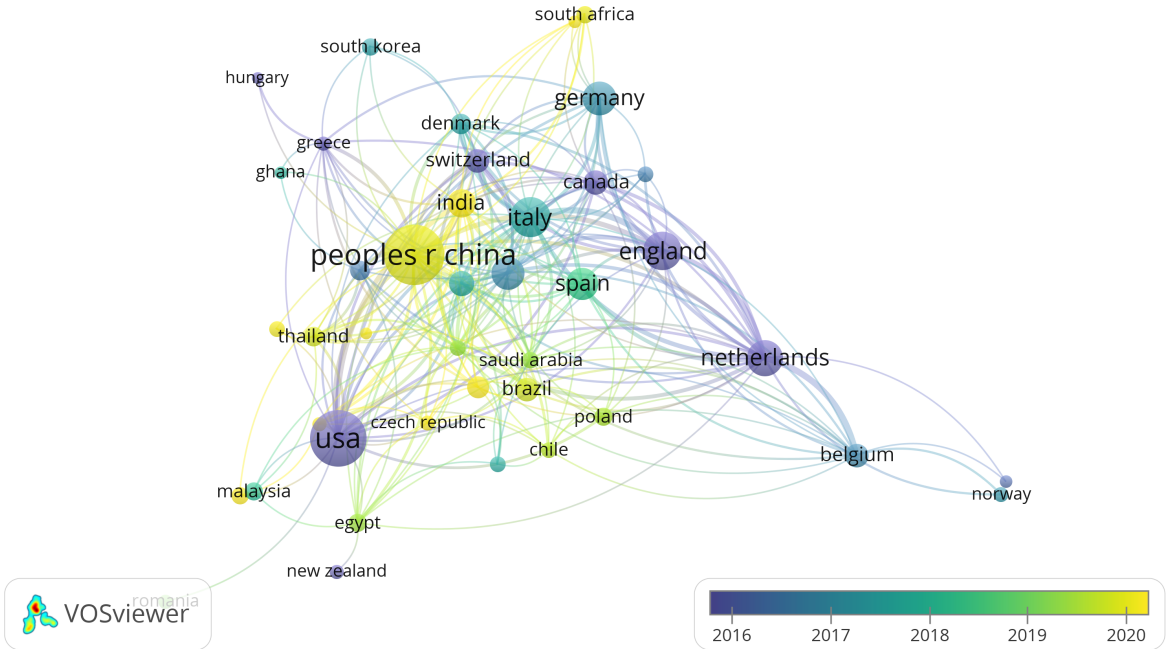
Figure 1: Keyword Co-occurrence Relationship Map and also Describes the Dominant Links between Keywords and Groups



No single database could cover all related articles and the best form of bibliometric analysis is to use multiple databases for the search process. The bibliometric analysis of traditional food market studies established the most popular concepts as well as their evolution over time (Figure 1).

The USA, China, Italy, India, Spain, Poland and Brazil had the biggest contributions to the research and development of scientific concepts according to the bibliometric analysis regarding the market of traditional food products (Figure 2).

Figure 2: The countries with the Greatest Contribution to the Development of Concepts Related to the Market of Traditional Food Products



VOSviewer is a tool that combines different types of interactive visualizations to support users in exploring the scientific literature. A publication clustering technique based on direct citation relationships, similar to the technique used in this paper, will be at the heart of the new tool. In this paper, using VOSviewer, we obtained a series of clusters with different levels of detail to understand the evolution of the scientific concepts encountered regarding the market of traditional Romanian food products. The dynamics of these clusters in the analysis carried out over the last 10 years reveals how interest in a subject has increased or decreased over time. Regarding traditional Romanian food products that reinvent food products and techniques from the past decades, an association with a series of very current scientific concepts can be observed in the current period.

The use of these products can create environmental pressures and pose risks to groundwater and surface water quality, soil quality, biodiversity, ecosystems and human health, including through food residues. Plant protection products sprayed on fields can enter the soil and water in the vicinity of those areas. At EU level as a whole, sales of active substances contained in plant protection products have remained relatively stable in recent years. However, the volume of sales is not directly correlated with the risks and effects associated with the use of these products. The risks and effects of plant protection products vary not only according to the active substances they contain, but also according to their composition and where, when and how users apply them in practice. In Europe it is considered that the maximum level of pesticide residues in food should not exceed 0.01 mg/kg. However, the amount of pesticide residues in food can also reach higher levels, depending on certain factors such as: the type and amount of chemicals used, failure to observe the interval between application and harvest, natural factors (rainfall, wind, exposure to the sun), the processes food goes through, storage conditions [4]–[6]. An important distinction must be made between mild (non-persistent) pesticides. they are rapidly biodegradable compounds and heavy (persistent) pesticides. instead, they are compounds that remain in the environment for relatively long periods of time. Their persistence depends on many factors: the type of soil, the humidity, the Ph and the extent of the crops, edédeterminante to establish the safety interval, that is, the time that must pass between the last treatment and collection. By their very nature, pesticides can be dangerous to humans or other animals because their purpose is to kill or harm living organisms. They can be absorbed by inhalation, by contact with the skin or through the digestive system. The acute effects of pesticide poisoning are liver disorders, cancer, lung diseases, skin, blood. These substances can not only have negative effects on the exposed individual, but, acting on the germ cells themselves, determine the changes that are transmitted to successive generations, through epigenetic changes. The main harm to human health for exposure to these substances have been identified in: - Decrease in male fertility; - Spontaneous abortion; - Autoimmune disorders; - Increased risk of cryptorchidism; - Diabetes/certain forms of obesity; - Increased risk of tumors; - Cognitive deficiencies and behavioral disorders; - Hormonal dysfunctions (especially thyroid). Based on toxicity, 4 groups can be classified: - the first in which pesticides can cause death; - the second group in which they cause severe poisoning, - in the third group it causes mild intoxication, - in the fourth it causes negligible poisoning. Integrated pest management is a concept that emerged in the 1970s that emphasizes the prevention of pest infestation and uses sustainable agricultural practices such as crop rotation and the selection of pest-resistant seeds. This concept also includes monitoring pests and establishing reliable threshold values to allow a decision to be made as to whether and when to apply pest control measures. Compared to the systematic application of plant protection products, integrated pest management is a greener approach, combining "common sense" practices. It allows reducing dependence on plant protection products: if they apply this approach, farmers resort to chemical plant protection products only if necessary, after

exhausting preventive, physical, biological or other non-chemical methods of pest control [7]-[9]. The maximum level of pesticide residues provides a standard by which it can be checked whether the food for which pesticides have been used in the technological process are safe for human consumption. The simple fact that there are pesticide residues in food does not automatically mean that they are harmful to health. The maximum residue level accepted to be ingested every day, for life, is calculated by applying a safety factor of at least 100 times lower than the dose at which possible harmful effects of the active substance on health could be found. Thus, in order not to affect the health of humans and animals, through their excessive infiltration in food, pesticides must be used in agriculture in the quantities and in the combinations provided by international bodies.

In Europe it is considered that the maximum level of pesticide residues in food should not exceed 0.01 mg/kg. However, the amount of pesticide residues in food can also reach higher levels, depending on certain factors such as: the type and amount of chemicals used, failure to observe the interval between application and harvest, natural factors (rainfall, wind, exposure to the sun), the processes food goes through, storage conditions [10]–[13]. The European Food Safety Authority (EFSA) presents an annual report examining the levels of pesticide residues in food on the European market. This report is based on data from official national control activities carried out by EU Member States, Iceland and Norway and includes a subset of data from the EU Coordinated Control Program (EUCP), which uses a random sampling strategy. Every year, the number of food samples analyzed for pesticide residues increases.

4. Conclusion

Using VOSviewer as a bibliometric analysis tool, selected publications in the field of the impact of pesticide use on food safety can be clustered without the need for deep knowledge of clustering techniques. In addition, no advanced knowledge of information technology is required. The data set downloaded from the Web of Science online database can be provided directly as input to software tools without the need for data preprocessing. Of course, despite the ease of use of our tools, a basic understanding of clustering techniques remains essential to perform meaningful analysis and avoid misinterpretation of the results obtained.

The use of pesticides as a means of pest control must be achieved through an integrated management of plant diseases and pests such as: biological control, habitat manipulation, modification of cultural practices and the use of resistant varieties.

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