Radiation Physics and Chemistry ∎ (∎∎∎∎) ∎∎∎–∎∎∎

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

journal homepage: www.elsevier.com/locate/radphyschem

European research and the Hungarian school of food irradiation

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HIGHLIGHTS

- Food irradiation had developed in cold war era in two systems in a parallel way.
- Scientometrics can reveal the central role of a person within network of scientist.
- Farkas had been able to exploit the window of opportunities to establish a school.
- Farkas has been an important hub of international research in food irradiation.

ARTICLE INFO

Article history:
Received 1 April 2016
Received in revised form
8 August 2016
Accepted 12 August 2016

Keywords:
Citation analysis
Co-author analysis
Multidimensional scaling
Science mapping
Scientometrics

ABSTRACT

In second half of the 20th century the research of application of irradiation to food preservation become a new and prospective field of food science and technology. This activity has been supported and developed in a parallel way in both halves of the that-time world, divided by the iron-curtain. Under these conditions, fulfilling a specific "bridge-role", some highly innovative scientists, first of all Professor József Farkas has been able to achieve considerable results in this new field of science. Based on citation analysis and science mapping it can be proven, that his path-breaking research has been exercise a fertilising effect on development of a wide range of fields of science, and considerably contributed to proliferation of this science and technology in numerous countries of the world.

1. Introduction

According to Diehl (2001) the development of food irradiation in the last century can be divided into three periods: the first half of the century there had been emerging pioneering studies on effects of ionising radiation to microorganisms and insects; between 1950 and 1970 the research had been focussing on application of irradiation in food preservation, insect disinfestation and sprout inhibition by optimization of technological parameters, in last decades of the century the research had been concentrating on problems in integration of food irradiation technology into the societies, analysing its nutritional, ethical, legal, and marketing aspect.

Early history of emergence of food irradiation, as well as the technology development in second phase are well documented (Josephson, 1983), but our level of knowledge on development of food irradiation technology is relatively low.

However, the application of irradiation of food has been relatively high in eastern states. This has been promoted by four factors: (1) Based on a wide range of specialised scientific research institutions, backed by such leadings scholars as Landau and Tamm (Фандо, 2014), the analysis of effects of irradiation of biological organisms has achieved considerable results in Soviet Union (Rogachev, 1966); (2) In opinion of Josephson (1996) "in each period of its history, the Soviet Union embraced large-scale technologies with an energy that belied its economic backwardness…they believed large-scale technologies would marshal scare resource efficiently…" (3) the application of food irradiation seemed an useful solution to food crisis (1957) and decreasing the very high waste level (Prybyla, 1962). (4) the emphasis of peaceful utilisation of atomic energy served well the inward and outward (Krige, 2008) Soviet propaganda.

Under these conditions the regulatory framework of the food irradiation was relatively favourable in Soviet bloc, offering an advancement of application of irradiation technologies, even if these had been in a relatively backward position in relation to western states. A striking example of this is the fact, that however the first commercial irradiation apparatus in the world had begun

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http://dx.doi.org/10.1016/j.radphyschem.2016.08.010
0969-806X/

to work in Germany, in 1957 the new food law banned the treatment of food with ionising radiation (Diehl, 2002). At the same time, the USSR was the first country, where the irradiation of potato begun to apply, one year before Canada and two before USA (Kuprianoff, 1964).

Another important field of research of food irradiation in former Soviet Union has been the study of irradiation on fish preservation (Биденко, 1958). Irradiation experiments have proven, that 14,700–19,600 Gy is enough to achieve the sterility of the fresh fish, but this irradiation is not enough to inactivate the hormones, that is why there are considerable autolytic processes. There are some changes in taste and odour of meat, but this can be eliminated by culinary technology. As a summary, the shelf-live of fishes can be increased by 0.5–2 month, depending of fish-variety and the temperature of storage (Кардашев and Коржова, 1962).

A striking example of dynamics of acceptance of results of irradiation methods supplied the disinfection of grain by ionisation. In the USA and Turkey there had been constructed some sophisticated apparats soon in sixties, but the had not been working as commercial. The first such apparat had been constructed in USSR in 1980 and had begun to work in 1983. It is based on Co^{60}, the two electron-accelerators had been built in the USSR, with a capacity of 20 kW, for 1.4 MeV. The dosage had been 200–400 Gy, with a capacity of 400 t/h grain (Boisseau, 1990).

In Hungary, the first researcher of food irradiation has been Károly Vas (1919–1981). Before "closing of the iron curtain", in 1947 had been able to travel to a study tour to visit the leading centres of food research US (Michigan State University, University of California) as well as in the United Kingdom (University of Cambridge). In these centres he has acknowledged with complex approach of that-time leading food scientists in technology development of food preservation, applying a combination of different (chemical, physical and biological methods) and interest of Károly Vas had been focussing on possibilities of increasing of shelf-life by combined methods of food preservation. On this topics he had widely publicised in eminent academic letters (Vas and Ingram, 1949,). This problem has led him to the field of analysis of effects of irradiation of agricultural and food industrial products (Vas et al., 1968). This new, highly innovative field of research has been a prospective discipline for a generation of young scientists, who-under conditions of iron curtain and isolation have tried to join to the mainstream of global food research. Among them József Farkas (1933–2014) has been dedicating all his life and energy to systematic research of irradiation of agricultural products and food. As it can be judged on base of his works, written in foreign languages (Annexure A), he had been a key personality in a wide range of food science and technology (Fig. 1), research of food irradiation had been a leitmotiv of all his academic activity.

The aim of article is to present the influence of key food researchers in development of scientific foundations of food irradiation in Europe, and the diffusion of knowledge in food irradiation research as well as the interconnection between food irradiation research and food research in general by latest methods of scientometrics, applying the citation analysis, network analysis as well as science mapping.

2. Materials and methods

As a preliminary investigation, we have tried to determine the general, long-range trend of development of food irradiation science, based on number of papers, published in this field. A long-range longitudinal analysis of literature of a given field of science is a rather hard task, because (1) just a few electronic database try to cower a relatively long period, (2) there is a rapid proliferation

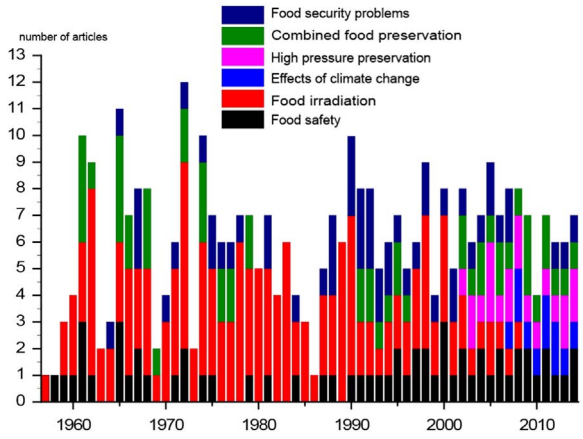

Fig. 1. Scientific articles of József Farkas according to main topics of his publications.

of academic journals and another publication possibilities; (3) the appearance of earlier academic papers in electronic databases is relatively less complete. We have applied two electronic databases for this purpose: the "google scholar" and the "Scopus" databases, and collected the results in different years to search keywords: irradiation and food. Of course, we knew it very well that the results are very far to be exhaustive, but in our opinion can be applied as a proxy of dynamics of level of interest towards the food irradiation problem.

In first step, we have collected scientific works of professor Farkas on base of Web of Science (hereinafter: WoS) system of Institute for Scientific Information (ISI, now part of Thomson Reuters). However there are some arguments for application of its most important concurrent, Scopus of Reed Elsevier (Meho and Yang, 2007). Archambault et al. (2009) had been proven an extremely high correlation between the "performance" of these two databases based on number of papers and number of citations, largely independently of the field of sciences. The rigorous, systematic analysis of academic publications had begun just some decades ago (Leydesdorff, 1998), that's why the time-horizon in our research begun from 1975, because the WoS system (like another citation-retrieval system) is not able to offer reliable results from an earlier period. In this way we had been able to analyse a more than four-decade long period. Based on WoS we have been able to identify 92 academic works of professor Farkas. In next step we have selected such works, which had been focussing on food irradiation problem. This subset of publications consists of 62 elements. Hereinafter we call this set as Corpus No. 1.

In second step we identified those publications in WoS which cite the works of professor Farkas, focusing on food irradiation. Some years ago this task had been a relatively easy one, and some software had been developed to analysis of these pieces of information (e.g. HistCite (Garfield, 2009) and Sci2 (Börner, 2009)) but recently WoS has changed its searching and downloading possibilities, and there exist not a direct way to assign the citing publications to source publications. Using the citation analysis option provided by WoS, we retrieved the set of citing documents, that is, documents referencing any publication of Farkas belonging to Corpus No. 1. This collection, representing the impact of Corpus 1. has been called Corpus No. 2., from which we extracted the author names to obtain the collection of scholars influenced by the works of Farkas. This search yielded more than 1900 authors, but we had to experience, that there had been a considerable number of duplications of citing authors. This is a general problem of scientometric research (Sweetland, 1989; Folly et al., 1981) The names of authors have been duplicated due to different

Please cite this article as: Lakner, Z., et al., European research and the Hungarian school of food irradiation. Radiat. Phys. Chem. (2016), http://dx.doi.org/10.1016/j.radphyschem.2016.08.010