

State of the Art on Food Packaging: A Bibliometrics Study

Sorin Corneliu Iorga^{1,2}, Oana Mihaela Niculae², Livia Apostol², Claudia Elena Mosoiu²,
Mona Elena Popa¹

¹University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, District 1, Bucharest, Romania

²National Research and Development Institute for Food Bioresources-IBA Bucharest, 5 Baneasa Ancuta, District 2, Bucharest, Romania

Abstract

The interest for food packaging (FP) has been constantly increasing in the last years. The number of the publications (articles and proceedings papers) as well as sectorial reviews available on relevant databases as Science Direct (SD), Springer Link (SL), Taylor & Francis (TF) or Wiley (WL) reflects such interest. However the evolution of the entire field on its bibliometric parameters is needed.

The present study is focusing on over 245 FP articles published between 2010 and 2017, with a relevant extension of other 58 articles published earlier, available on SD, SL and WL databases.

Impact relevance, citations, publications and countries are emphasized, as well as main topics are summarized.

Keywords: review, food packaging, bibliometrics

1. Introduction

The food packaging (FP) is covering all the food production fields, from meat products to sweets or bakery products. Various technologies were developed in recent years, generated the need to organise the published materials according various criteria. Abdul Khalil and al., 2016 [1] systemised the studies on environmental friendly materials and advanced technology to develop sustainable packaging. They emphasized the place of cellulose nanofibers as most abundant renewable polymeric materials. Many studies covered the carbonated soft drinks microbial stability. Azaredo and al., 2016 [3] reviewed the studies, based on relevance, as well as with the factors influencing their survival and role in soft drink spoilage. They pointed on the role of different critical aspects, including packaging when formulating and produce a shelf-stable a soft drink.

A comprehensive overview on smart packaging covered oxygen scavengers, carbon dioxide absorbers, ethylene scavengers or sensors and

indicators [4]. Hollands and al., 2015 [5] pointed on the role of package in changing the food consumption. Their principal finding was that people consistently consume more food when offered larger-sized packages than when offered small-sized versions.

Meat and muscle-based products packaging review carried out by Kerry and al., 2006 [6] included forms of active packaging relevant to muscle foods include; oxygen scavengers, carbon dioxide scavengers and emitters, drip absorbent sheets and antimicrobial packaging. The authors also concluded on the need of further studies and technological advances for increasing cost efficiency.

Convenient low cost packages and their safety requests, generated increased research interest on migration phenomenon. S. Arvanitoyannis & V. Kotsanopoulos, 2014 [2], reviewed studies on migration relations with nature of food, number of migrants, type and time of contact between package material and food.

Bio based plastics materials as packaging products, advances and emerging technologies researches were covered by P. Scarfato and al., 2015 [11]. Conventional chemical synthesis polymers, biomass extracted polymers, biotechnological produced blended products were considered, concerning their migration limits.

K. Kuorwel and al., 2015 [8] focused their review on studies on nanomaterials role in active packaging. Nanoclays and nanosilver were considered on mechanical properties and antimicrobial contexts.

S. Khoshgozaran and al., 2012 [7] reviewed studies on modified atmosphere packaging (MAP) influence on cheese characteristic, revealing the potentiality of MAP in increasing cheese sensorial and microbial shelf life. Similar MAP reviews, of A. Rojas-Graü and al., 2009 [10] and M. Oliveira and al., 2015 [9] on fresh-cut fruits and vegetables considered gas composition, temperature and product type variables. overviewed several packaging techniques to maintain freshness in fresh-cut fruits and vegetables.

P. Singh and al., 2012 [12] synthesized the studies on MAP for milk and dairy products that analyse the use of carbon dioxide in packaging.

2. Material and Methods

The data sources for research in this paper were Science Direct, Springer Link and Wiley. “Food packaging”, “Smart packaging”, “Bakery”, “Meat”, “Diary”, “Fresh products”, “Sweets”, “Drinks”, “Egg packaging” and “Drinks packaging” were filtered key words in searching titles, abstracts, authors. The period was concentrated on 2009 to 2017, but some earlier selection were considered. The citation scores were acquired from Research Gate or the previous mentioned sources, ISI relative scores were acquired from RIS 2016, offered by Romanian Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI), according to Journal Citations Report (JCR) 2016 release. Data processing was made on IBM SPSS 24 PS IMAGO 4.0 program and on Microsoft Excel (version 2010).

They were predefined 9 categories of “products”: Drinks, Meat Products, Spices, Sweet products, Fat Products, Dairy Products, Fruits and vegetables, Eggs and Bakery Products

3. Results and discussion

3.1. Articles statistics

The present study focused mainly on articles. Fig.1 demonstrate the continuous increase of interest over 2009 till present (253 articles), of which 81.72% (210 articles) were released from 2012. The lower value for 2017 is due to the fact that the article considered only 3 months of this year.

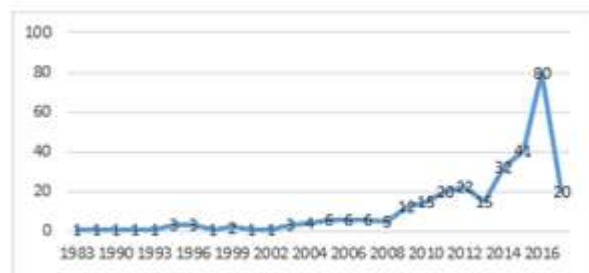


Figure 1. Distribution of articles in time

The articles summarized 4957 citations, with a maximum of 402 citations/article. There is a variance of citations in time ($\alpha < 0.05$). 2965 citations were registered for articles published between 2009-2015 (59.81%), with a maximum of 788 citations for articles released in 2009. Journals ISI rank is also influencing the citations number ($\alpha < 0.05$), as presented in Fig.2.

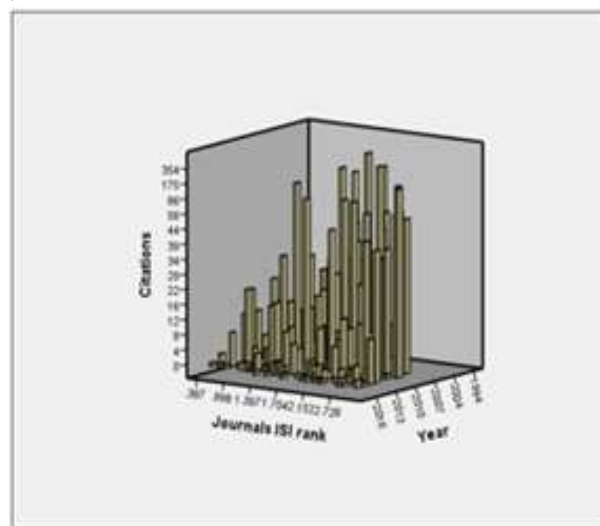


Figure 2. Distribution of citations in time, related to Journals ISI rank

The author’s key words (KW) analysis was concluded after a significance evaluation, in order to group similar or content similar KW, to determine real frequency.

The results (see Table 1) indicated a maximum wide of KW for Sweets products (only 20.95% of presences are generated by KW with multiple frequency).

A maximum KW frequency (29) was registered in articles related to Drinks and Meat products.

The Bakery products related articles registered the highest level of multiple frequency KW (58.14%).

There were identified 88 multifrequent key words that determined the total of 527 presences. 278 of these (52.75%) were been generated by 12 key words, with more than 9 presences.

Table 1. Matrix of key words frequency

Product	KW	Minimum frequency	Maximum frequency	Mean	Total presences	Total over 2 presences	Percent over 2 presences
Drinks	176	1	29	1.44	254	112	44.09
Meat Products	155	1	29	1.44	270	149	55.19
Spices	63	1	4	1.35	85	36	42.35
Sweet products	129	1	8	1.15	148	31	20.95
Fat Products	61	1	7	1.28	78	24	30.77
Dairy Products	104	1	20	1.41	147	58	39.46
Fruits and vegetables	81	1	12	1.42	115	46	40.00
Eggs	29	1	6	1.52	44	21	47.73
Bakery products	42	1	17	2.05	86	50	58.14

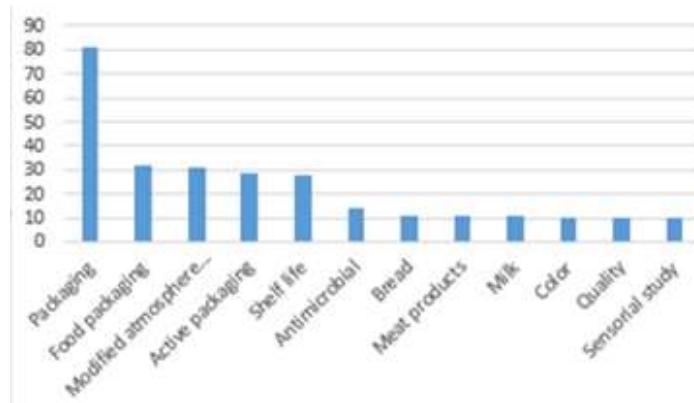


Figure 3. First 12 multifrequent authors key words

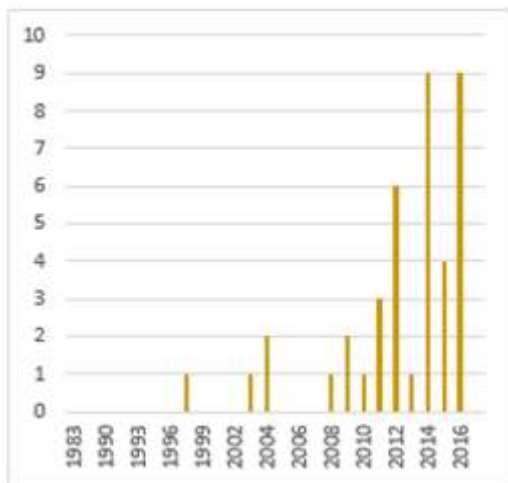


Figure 4. MAP key word evolution

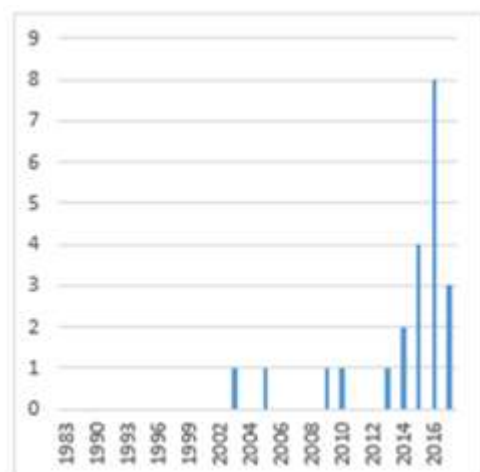


Figure 5. AP key word evolution

Apart from general category of Packaging or Food packaging, there is a significant interest on novel methods, as Modified atmosphere packaging (MAP) or Active packaging (AP), increasingly present in last years among authors' key words selections.

3.2 Journals statistics

The articles were released in 122 publications. 62 journals are listed on International Scientifically Index as impact factor journals. Minimum ISI factor is 0.387 and maximum 25.194. The mean ISI factor is 1.999.

There are 43 journals that have more than 1 article. Maximum total presence (TP) is 15. The 79 journals with TP=1 represent 26.07 % from the TP. First 11 journals have TP=122 (40.26% of TP), generated 119 citations. The maximum ISI impact factor is 2.855.

3.3 Countries distribution

The origin of the published originated from 50 countries. During the studied period, Spain generated 34, USA 31 articles and India 22. The

first 10 countries totalized 182 articles (60.07%). It is a significant increase of articles in 2016 for USA (10 articles), India (7 articles) Brazil and China (6 articles). As a general trend, al top 10 countries have an increasing tendency, as presented in Fig.5. Results indicate a high interest of FP research in countries with strong economies (USA, UK, China, Italy, Australia, and Republic of Korea), specific developed food sector (Greece, Spain) and in leading emerging economies (Brazil, India).

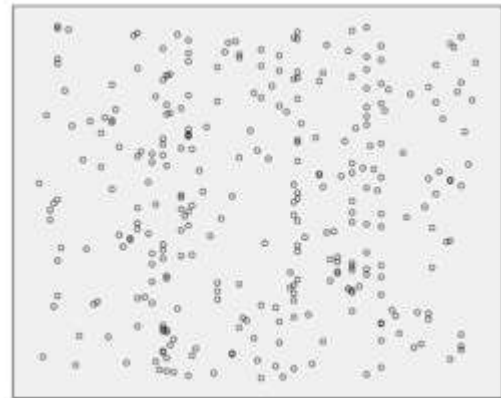


Figure 6. Articles distribution in journals

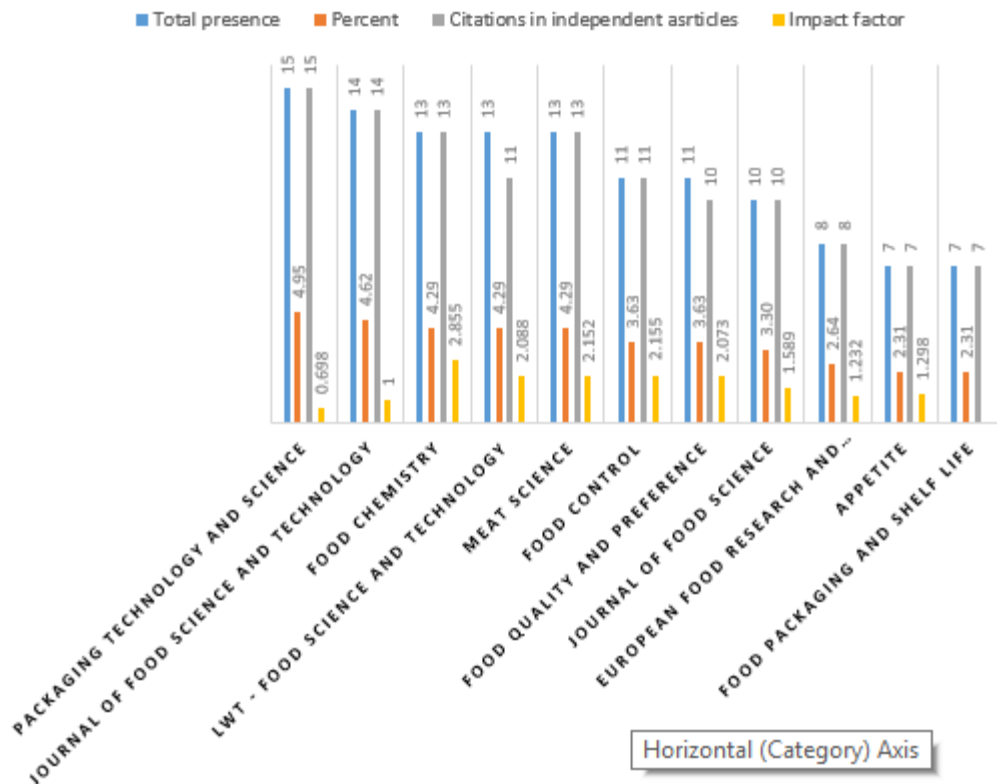


Figure 7. Top 11 most productive journals

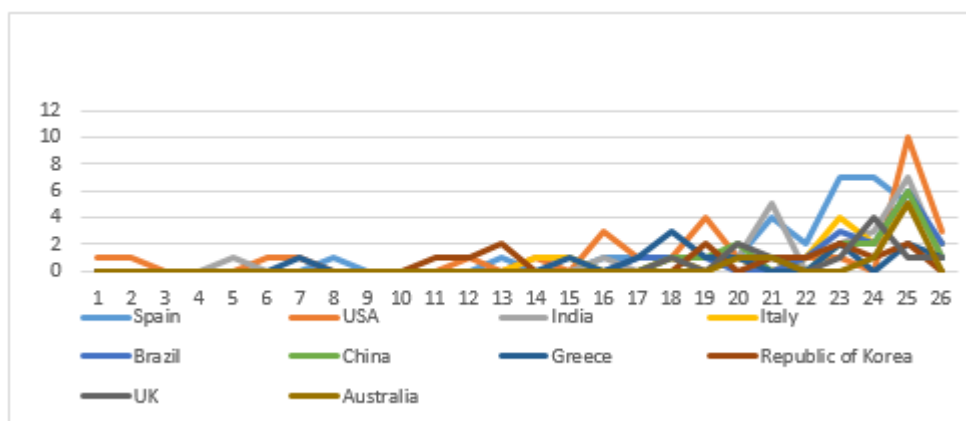


Figure 8. Top 10 countries from 1983 to 2017 (1 – 26 on X axis)

4. Conclusion

The interest for packaging studies was constantly increasing during the last 5 years.

The FP studies are unevenly distributed overall countries. The developed countries are dominating the list, where ever from G7 group (USA, UK, Italy), traditional economies (Australia, Spain even Greece) or newly economic powers (Republic of Korea, Brazil, India, China). Analysis of the articles quality of top 11 countries demonstrates a high level of studies, demonstrated by top citations scores.

In total, 303 articles were listed in 122 publication. The citations scores as well as the journals ISI rank suggests a large range of articles quality. Researches on FP field were focused on product type as well as packaging products or methods. The authors WK choices of last years reveal an increasing interest of authors on active or modified atmosphere packaging solutions, revealing the consumer preference for raw or low processed products, also demonstrate by frequent mentions on sensorial aspects or colour.

Acknowledgements. This research work was carried out with the support of Ministry of Agriculture and Rural Development, University of Agronomic Sciences and Veterinary Medicine of Bucharest and was financed from project ADER 15.1.1/ 2015-2018.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

References

1. Abdul Khalil, H.P.S.; Davoudpour, Y.; Saurabh, K.C.; Hossain, Md.S.; Adnan, A.S.; Dungani, R.; Paridah, M.T.; Islam Sarker, Md.Z.; Rnurul Fazita, M.; Syakir, M.I.; Haafiz, M.K.M., A review on nanocellulosic fibers as new material for sustainable packaging: Process and applications, *Renewable and Sustainable Energy Reviews* **2016**, *64*, 23–836
2. Arvanitoyannis, S.I.; Kotsanopoulos, V.K., Migration Phenomenon in Food Packaging. Food–Package Interactions, Mechanisms, Types of Migrants, Testing and Relative Legislation—A Review, *Food Bioprocess Technol* **2014**, *7*, 21–36 [DOI 10.1007/s11947-013-1106-8](https://doi.org/10.1007/s11947-013-1106-8)
3. Azeredo, D.; Alvarenga, V.; Sant'Ana, S.A.; Sabaa Srur, U.O.A., An overview of microorganisms and factors contributing for the microbial stability of carbonated soft drinks, *Food Research International* **2016**, *82*, 136–144
4. Biji, K. B.; Ravishankar, C. N; Mohan, C. O.; Srinivasa Gopal, T. K., Smart packaging systems for food applications: a review, *J Food Sci Technol* **2015**, *52*(10), 6125–6135, [DOI 10.1007/s13197-015-1766-7](https://doi.org/10.1007/s13197-015-1766-7)
5. Hollands, G.J.; Shemilt, I.; Marteau, T.M.; Jebb, S.A.; Lewis, H.B.; Wei, Y.; Higgins, J.P.T.; Ogilvie, D., Portion, package or tableware size for changing selection and consumption of food, alcohol and tobacco (Review), *Cochrane Database of Systematic Reviews 2015* **2015**, *9*, Art. No.: CD011045. [DOI: 10.1002/14651858.CD011045.pub2](https://doi.org/10.1002/14651858.CD011045.pub2).
6. Kerry, J.P.; O'Grady, M.N.; Hogan, S.A., Past, current and potential utilisation of active and intelligent packaging systems for meat and muscle-based products: A review, *Meat Science* **2006**, *74* 113–130
7. Khoshgozaran, S.; Azizi, Md. H.; Bagheripoor-Fallah, N., Evaluating the effect of modified atmosphere packaging on cheese characteristics: a review, *Dairy Sci. & Technol* **2012**, *92*, 1–24, [DOI 10.1007/s13594-011-0044-3](https://doi.org/10.1007/s13594-011-0044-3)

8. Kuorwel, K.K.; Cran, J.M.; Orbell, D.J; Buddhadasa, S.; Bigger, W.S., Review of Mechanical Properties, Migration, and Potential Applications in Active Food Packaging Systems Containing Nanoclays and Nanosilver, *Comprehensive Reviews in Food Science and Food Safety* **2015**, 14, doi: [10.1111/1541-4337.12139](https://doi.org/10.1111/1541-4337.12139)
9. Oliveira, M.; Abadias, M.; Usall, J.; Torres, R.; Teixid, N.; Vinas, I., Application of modified atmosphere packaging as a safety approach to fresh-cut fruits and vegetables A review, *Trends in Food Science & Technology* **2015**, 46, 13-26
10. Rojas-Grau, A.; Oms-Oliu; G.; Soliva-Fortuny, R.; Martín-Belloso, O., The use of packaging techniques to maintain freshness in fresh-cut fruits and vegetables: a review, *International Journal of Food Science and Technology* **2009**, 44, 875–889
11. Scarfato, P.; Di Maio, L.; Incarnato, L., Recent advances and migration issues in biodegradable polymers from renewable sources for food packaging, *Journal of Applied Polymer Science* **2015**, DOI: [10.1002/app.42597](https://doi.org/10.1002/app.42597)
12. Singh, P.; Wani, A.A.; Karim, A.A.; Langowski, H.C., The use of carbon dioxide in the processing and packaging of milk and dairy products: A review, *International Journal of Dairy Technology* **2012**, 65(2).