CIRCULAR ECONOMY IN THE CONTEXT OF REDUCING FOOD WASTE – MINIREVIEW

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ABSTRACT
Circular economy was globally adopted by many countries as solution for a sustainable development, and an intensive research is performed in order to reduce the food waste. The study presents a bibliometric analysis of the literature published between 2000 and 2019 on topics related to this subject, such as food chain, industry, biotechnology, catering, consumers' behaviour, etc. Parameters considered for analysis were related to publications (name, year of appearance, number of articles hosted), data bases that allowed identification, citations, first authors affiliation (institution, country), content category (topic, sector of food chain addressed, geographical relevance). It was found that an intensive publishing activity was done between 2016 and 2019, and Science Direct was the most productive data base for their identification. Also, it was found that top three publications in the field were Journal of Cleaner Production, Waste Management and Resources, Conservation and Recycling, while top five countries of the first authors' affiliation were UK, Italy, China, USA and Sweden.

INTRODUCTION

Food waste is reported by FAO (Food and Agriculture Organization of the United Nations) as a large global phenomenon, likely to affect food security worldwide. In this context, both international and European institutions, as well as national governments are reviewing the regulations so that specific action plans related to food waste and corresponding objectives may become active in the shortest possible time.

Although accessibility to food resources has increased at global level, a rather high level of malnutrition is still recorded. Food products are lost either during the production phase, or in further phases, such as wastage generated by inadequate consumption, or inappropriate marketing strategies and legislation.

The causes of food loss and waste are not always the same, differences are related to the phase in the food supply chain, to the type of product and where the food is wasted. Once one considers the food chain divided into five sectors (agricultural production, management and storage, processing, distribution and consumption), it may be observed how different behaviors corresponding to each of these sectors lead to elimination of perfectly edible foods: starting with the loss recorded during harvest and storage, until shipping under unsafe conditions, labeling errors and, in the end, some bad habits of end consumers when buying and using food products.

Exhaustive studies showed that food waste is a phenomenon with deep implications for modern societies, and it has ethical, economic and environmental implications, in the context of limited natural resources (Thyberg et al., 2016).

The solutions to reduce food waste is a serious concern in all the links of the food chain, from primary production in the field to the style of households' consumption.

This documental study on the phenomenon of food waste and its reduction and controlling solutions is part of the doctoral thesis "Reducing food waste in bakery industry through technological integration by applying the principles of transversality and circular economy". The study includes a bibliometric analysis of the scientific interest on the topic in the last years, the current state of food waste statistics, as well as an inventory of different approaches to reduce food waste, with focus on food production and on final phases of the food chain - food households' consumption. Conclusions drawn from the documented studies and corresponding analysis carried out will be the basis to establish the PhD thesis research plan, on the investigations and experimental research to be performed, and subsequently to establishing the editing structure of the thesis.

MATERIALS AND METHODS
The context of food waste – bibliometrics
A total of 235 articles were included in the documental process, whose publication date ranges from 2000 to 2019. The following databases were consulted: Science Direct, Springer Link, Taylor & Francis, Willey, Mendeley, as well as other independent sources. The literature search focused on the following keywords: food waste / food loss, consumer behaviour, consumer chain, food chain, industry, catering, retail, reuse, system analysis, case study, circular economy, biotechnology.

Parameters considered for analysis took into account the year of publication, the field addressed (generic names were formulated by the documentarist), the database that allowed identification of articles, total number of issues published by the journal in the studied time frame, the number of independent citations of each article, as they were mentioned by the

searching engines or from Research Gate (RG). There were also considered the first authors, their institutions, and their countries of origin. Statistical processing was performed using the following software programs: IBM SPSS 24 PS IMAGO 4.0 and Microsoft Excel version 2010. The descriptive data took into account the occurrence frequency of the FRQ parameter, the percentage represented by the entire batch of samples (including missing data, if any) (%), the percentage compared to validated data (V %), and the cumulative percentage (CUM %).

RESULTS AND DISCUSSIONS

Time distribution of selected articles
Of the 235 articles selected, 85.5 % were published between 2013 and 2019, and 115 of them (48.7 %) were published between 2016 and 2019.

Distribution of articles on search engines
Science Direct was the most productive search engine (138 articles), followed by Springer Link (31 articles) and Wiley Online Library (25 articles). These 3 search engines provided 82.2 % of the selected documentation package. The rest of 17.8 % were provided by Taylor & Francis, Mendeley engine and other independent sources.

Distribution of articles on independent citations
Selected articles sum up for a total of 3716 independent citations for 174 articles in the selection. The number of citations per article covers a wide range, from 1 to 483 citations.

The diachronic analysis reveals that articles published in 2014 and 2010 sum up most of the citations (1622 citations).

Distribution of articles by publications
A total of 112 publications were listed. It was found that *Journal of Cleaner Production* is the most requested publication, with 44 articles, followed by *Waste Management*, with 21 issues and by *Resources, Conservation and Recycling*, with 10 issues. First nine publications hosted 45% of the selected articles (106 articles).
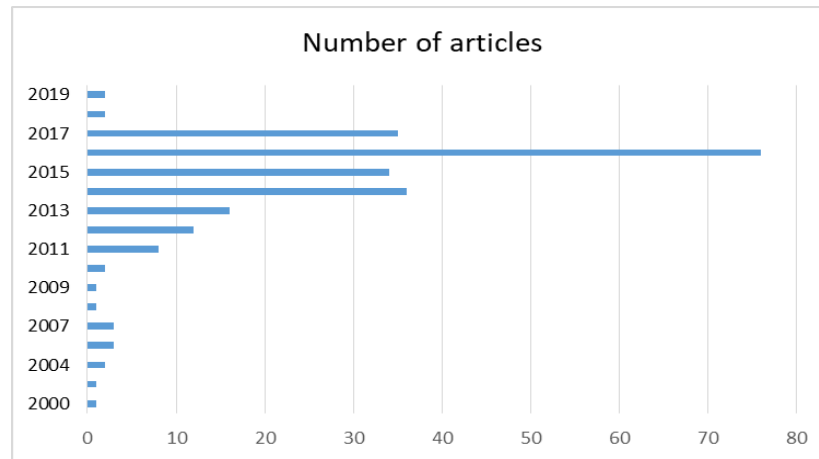
Figure 1. Time distribution of selected articles (number of published articles per year)
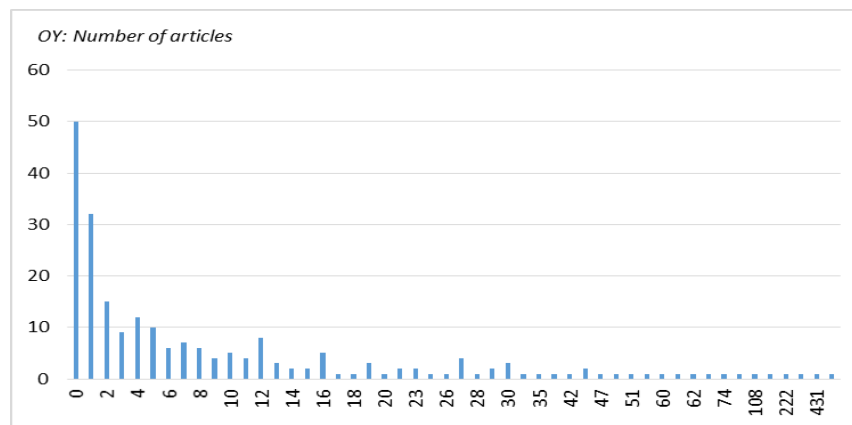

Figure 2. Independent citations diagram of selected published articles

Distribution of articles by the first authors and their institutional and country affiliation

The data analysis acknowledged the role of the first authors in promoting and coordinating researches and corresponding articles.

The selected articles have been coordinated by 217 first authors. Sixteen of them coordinated at least 2 articles. This rather high number of research activities performed indicates the wide interest of researchers' community towards the food waste phenomenon. Similar wide spread interest was identified with regards to the institutions where first authors are affiliated: 185 institutions - universities, colleges, research centers - from 43 countries. However, the top ten countries in the list covered 60.4% of the selected articles (142 articles), as shown in Table 1. The most active country is UK (32 articles), followed by Italy, China and USA.

Distribution of articles by content category

The selected articles were grouped into several relevant categories, from various point of views such as: topic (synthesis articles, analysis, case studies, recovery and valorization, etc.), sector of the food chain addressed (whole chain, HoReCa, retail, consumers, etc.), geographical relevance (global, EU or Romania). One of the findings was that researchers showed a significant interest for the synthesis articles, most probably because of the need of higher correlation and dissemination of the large volume of specific punctual data published in the field of food waste. A total of 14 categories were identified, as shown in Table 2. Valorization studies, system analyzes, consumer behaviour are among the top topics. The first 10 topics were addressed by 97.4 % of the selected articles. A distinct place is the circular economy topic, as the main action in controlling food waste.

The relevance of these criteria was considered for further detailed review.
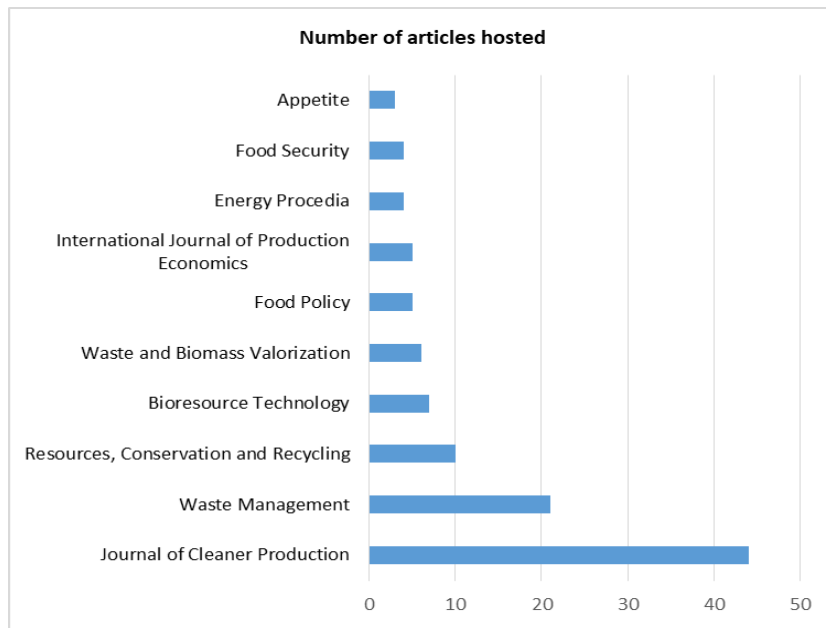
Figure 3. Top 10 journals by number of issues published in the studied time frame

Table 1. Top 10 countries of first author affiliation

Country	Number of articles	%
UK	32	13.6
Italy	26	11.1
China	18	7.7
USA	15	6.4
Sweden	11	4.7
Australia	8	3.4
Greece	8	3.4
India	8	3.4
Switzerland	8	3.4
The Netherlands	8	3.4

Table 2. Content structure of selected articles

Category	Frequency	%
1. Valorization	42	17.9
2. System analysis	38	16.2
3. Review	35	14.9
4. Circular economy	32	13.6
5. Consumer behaviour	32	13.6
6. Case study	28	11.9
7. Catering & hospitality	10	4.3
8. Retail	6	2.6
9. Consumer Romania	3	1.3
10. Global perspective	3	1.3
11. Statistics EU	2	0.9
12. Bioeconomy	1	0.4
13. EU 27 households analysis	1	0.4
14. Functional food	1	0.4

Circular economy contributions

Circular economy (CE) is increasingly considered as the solution for a sustainable future development (Lieder et al., 2016, Geissdoerfer et al., 2017, Murray et al., 2017). CE involves adoption of cleaner production models at enterprises level (Qi et al., 2016), increased responsibility and awareness of producers and consumers (Geisendorf et al., 2018, Stahel, 2016), the use of renewable technologies and materials (whenever possible), as well as adoption of appropriate policies and tools, clear and stable (Strazza et al., 2015, Lieder et Rashid, 2016, Rajput et al., 2019). Lessons learned from successful experiences is that transition to CE may be realized by involvement of all stakeholders in the society and using their ability to create connections and appropriate models of collaboration and exchange. Success stories also highlight the need for an economical return on investments to provide adequate motivation for companies and investors (Liu et al., 2009, Liu, 2012, Liu et al, 2012, Gille, 2012, Zsuzsa et al., 2012, Ghisellini et al., 2016) and not less reveal many barriers to be overcame in implementation (Ritzén et al., 2017, Rajput et al., 2019).

Launched as a technological solution to maximize the profit and maintain the growth on the basis of limited resources (Reh, 2013; Tukker, 2013; Bocken et al., 2015), the circular economy concept has been adopted by the European Commission and many other leaders worldwide. China appears to be one of the first and most fervent supporters of this concept (Yuan et al., 2006, Su et al., 2013, Stahel, 2016), developing some multiannual implementation strategies, that led to growth over time, with inherent fluctuations, depending on the effectiveness of the supporting measures (Wu et al., 2014). Circular economy is considered essential for the sustainable development of China agriculture (Jun et al., 2011; Xi, 2011), or for regional development (Qiping, 2011; Liu, 2012). CE is considered as a support in the re-use of by-products (Li et al., 2013), but also in food production given the low level of processing, but also the large number of by-products having a high recycling potential (Qi et al., 2016).

However, political adoption of CE also involves transformations at social and political level, and thus imposes nuanced approaches in some fields such as consumption (Hobson et al., 2016). A continuous monitoring of processes is needed, as well as real time adjustments. The benefits of CE are also recorded in the environmental sector. Thus, CE enhances ecological sustainability by accrediting the idea of transforming products in a way that generates viable relationships between ecological systems and economic growth (Genovese et al., 2017). A significant number of good practice examples exists, and these are analyzed and systematized by categories (De los Rios et Charnley, 2017), as well as by each step of the processes involved (Bocken et al., 2016).

One notable characteristic is that not all the initiatives are an expression of CE, as they are not using their own by-products in the process. An explanation is also the fact that waste collection systems are designed mainly as centralized systems, rather than as factory-centered systems (Singh et al., 2016, van Buren et al., 2016, Banasik et Kanellopoulos, 2017, De Angelis et al., 2018). A standard example of CE applied to food industry is transformation of the residues from grinding olives into bio-fuel, where 70 tones of solid residues from 10 hectars of olive plantation were transformed by pyrolysis into biofuel (Zabaniotou et al., 2015).

4. CONCLUSIONS

The bibliometric analysis performed in present study showed an intensive publishing activity between 2016 and 2019, on the topic of circular economy and related subjects. Science Direct was proved to be the most productive data base for publications identification, top three journal in the field were Journal of Cleaner Production, Waste Management and Resources, Conservation and Recycling, while top five countries by first authors' affiliation were UK, Italy, China, USA and Sweden.

Circular economy becomes more and more relevant as major solution in food waste reduction policy. The process involve all stakeholders of social economic environment, from central and local authorities, to companies' management, and from policy initiatives to sectorial technological assessment, materials life cycle assessments and technological innovation.

It is of a major importance the fact that social marketing among final consumers, technological innovation and a global cost efficiency evaluation are needed to support local initiatives towards circular economy.

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