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COLLANA DEL DIPARTIMENTO DI ECONOMIA AZIENDALE

A cura di

MARIA CLAUDIA LUCCHETTI, MARIA FRANCESCA RENZI

QUALITÀ, INNOVAZIONE E SOSTENIBILITÀ NELLA FILIERA AGRO-ALIMENTARE

Il contributo delle Scienze Merceologiche

RomaTrE-Press
2025

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Indice

Synergies between the agri-food sector and the cosmetic industry through circular economy: evidences from a literature review

Alice Mondello
University of Messina
Roberta Salomone
University of Messina
Giovanni Mondello
University of Messina

Abstract
Sustainability goals are increasingly taken into consideration in all the economic sectors. The cosmetic industry is involved in the search of sustainable solutions aimed to reduce any negative environmental, economic and social impacts regarding the entire life cycle of its products. In this context, the scientific community has started to investigate the concept of Circular Economy (CE) as a way to achieve sustainability goals.
However, there is still a lack of information regarding the practical implementation of CE in the cosmetic industry. Thus, an analysis of the state of the art in this field is needed for providing an overview of CE practices and strategies which are or could be implemented in the cosmetic industry. Pursuing this aim, a systematic literature review is performed in order to identify and analyse studies in which potential CE strategies are applied in the cosmetic sector, and also to understand the role of the agri-food sector in this regard. In addition, the 4Rs principles are considered in order to analyse the characteristics of the proposed CE options. Scopus and Web of Science databases have been used for searching the scientific articles to be included in the analysis. A final sample of 58 articles was identified according to specific selection criteria. Results highlight that the majority of studies is focused on the valorisation of waste and by-products from the agri-food sector to be used in the formulation of cosmetics. Furthermore, a predominant importance of the principles reduce and recovery has been highlighted in the application of CE in cosmetic industry through agri-food sector.

Keywords: circular economy; sustainability; cosmetic industry; agri-food; systematic literature review.

1 Introduction

The cosmetic industry is involved in the search of sustainable and natural alternatives for its products (McIntosh et al., 2018), due to the increasing pressure in terms of environmental, economic and social aspects (Cosmetics Europe, 2012).

The interest in sustainability and sustainable products is also due, on the one hand, to the increasing attention and demand of customers (Beerling, 2014) and, on the other, due to the increasing commitment of the European Commission (EC) in establishing directives aimed to push the transition towards sustainability in all the economic sectors and the entire society (EC, 2019).

One of the most important regulations published by the EC is the European Green Deal (EC, 2019), which introduces an industrial strategy that includes, among the others, the Circular Economy (CE) Action Plan (EC, 2019). The action plan is aimed to define a «sustainable products» policy (EC, 2019:7), promoting the need of reusable, durable and repairable products.

After these directives from EC, both companies and academics are increasingly taking into consideration how to develop sustainable solutions and products, investigating the concept of CE as a potential way for achieving this objective (e.g. Suárez-Eiroa et al, 2019; Geissoerfer et al., 2017).

In literature, many definitions of CE are proposed, among which the ones of EC states that: «circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimizing the generation of waste» (EC, 2015:2). In addition, the EC established a framework aimed to prevent and reduce the generation of waste (EC, 2008), in which EC sets 4Rs principles in compliance with the concept of CE, that are: reduce, reuse, recycle and recovery.

Thus, CE could support the cosmetic companies involved in the search of sustainable solutions for example for the formulation of products (e.g. Novara et al., 2022) or for the design of their packaging (e.g. Gatt and Refalo, 2022), but also for the overall transition to sustainability (e.g. Morea et al., 2021). However, CE could support also other economic sectors involved in the transition to sustainability, for example the agri-food ones, as pointed out by Scandurra et al. (2023).

The agri-food industry is searching solutions aimed to the reduction of its losses and waste, which represent a huge amount that annually consists of about 931 million tons (Morganti et al., 2022). Generally, the agri-food waste and by-products are discarded or used as animal feed (de Souza Silva et al., 2021), disposed in landfills or burnt (Del Rio Osorio et al.,

2021). In this context, CE could support the agri-food sector in the preservation of resources and the reduction of its losses and waste, also mitigating the related negative impacts (Scandurra et al., 2023).

In literature, many authors propose circular solutions for the transformation of agri-food waste and by-products into new resources which could also mitigate the related environmental impacts. For example, Del Rio Osorio et al. (2021) discuss the potential of agri-food by-products considering their high content of valuable compounds to be used as an input in other industries, such as the cosmetic ones.

In this context, CE practices could find a practical application through the cross-industries synergies. For example, it is interesting to note that many potential synergies between agri-food sector and cosmetic industry are already reported in the scientific literature (e.g. Del Rio Osorio et al., 2021; Faria-Silva et al., 2020).

Starting from the results emerging from a wider study carried out by the authors (still under development), it is interesting to delve deeper into the potential synergies between the agri-food and the cosmetic sectors. Thus, in this paper the results of a literature review aimed to provide an overview of circular practices and strategies emerging from synergies between the agri-food sector and the cosmetic industry is presented. Particularly, the aim of the study is to identify what and how synergies with the agri-food sector could support the implementation of circular practices in the cosmetic industry.

2 Methodology

The literature review performed in this study is carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (PRISMA) (Moher et al., 2009) for the definition of the sample of studies (Figure 1).

A systematic analysis of the sample is carried out pursuing the aim of the study of providing an overview of CE in the cosmetic industry. The systematic analysis (Khan et al., 2003) is aimed to provide a full vision of the analyzed topic defining the state of the art with reliable results and minimal bias.

The analysis aims to answer to the following research questions:

– What is the state of the art of circular economy in the cosmetic industry according to the scientific community?
– What synergies emerges with the agri-food sector that could support the practical implementation of circular economy in the cosmetic industry?

The search query is defined using two keywords, «cosmetic*» and «circular economy», pursuing the aim of collecting all the studies that explicitly take into consideration CE in the cosmetic sector. Then, the aim of this paper is to identify, within the selected sample, circular practices and strategies emerging from synergies between agri-food and cosmetic sectors sample.

The investigation of the query is carried out using the Scopus (SP) and Web of Sciences (WoS) Core Collection databases, focusing the search on the title, abstract and keywords. A time frame is not defined and the search is updated at the 31st January 2023.

This search strategy allows to obtain a total of 332 results, of which 188 are collected from SP and 144 from WoS. Then, some types of publication are excluded limiting the results to only the articles and reviews. More in details, the excluded results are: book chapters (n=20), conference papers (n=8), early access (n=5), meeting abstract (n=1), editorial (n=1).

After that, the sample is again limited to the results published in English (282) and also duplicates (n=125) and not-available studies (n=8) are excluded. The obtained sample is composed by 149 studies, for which abstract and text-full screening is performed according to specific exclusion criteria, that are: i) cosmetic application of CE is mentioned only in abstract, introduction or conclusion without any complete description in the study; ii) cosmetic application of CE is mentioned as potential, but without any complete description in the study; iii) cosmetic application and CE are mentioned in the study but discussed separately, without any connection; iv) the context of the study isn't in line with the research strategy, thus does not refer to CE in the cosmetic sector. According to these criteria, further studies are excluded (n=63) allowing to obtain 86 studies on CE in the cosmetic industry, that in details are 49 articles and 37 reviews. Then, the sample is further restricted to the 58 studies which report exchanges with the agri-food, that are 33 articles and 25 reviews, in order to identify the potential synergies between the agri-food sector and the cosmetic industry

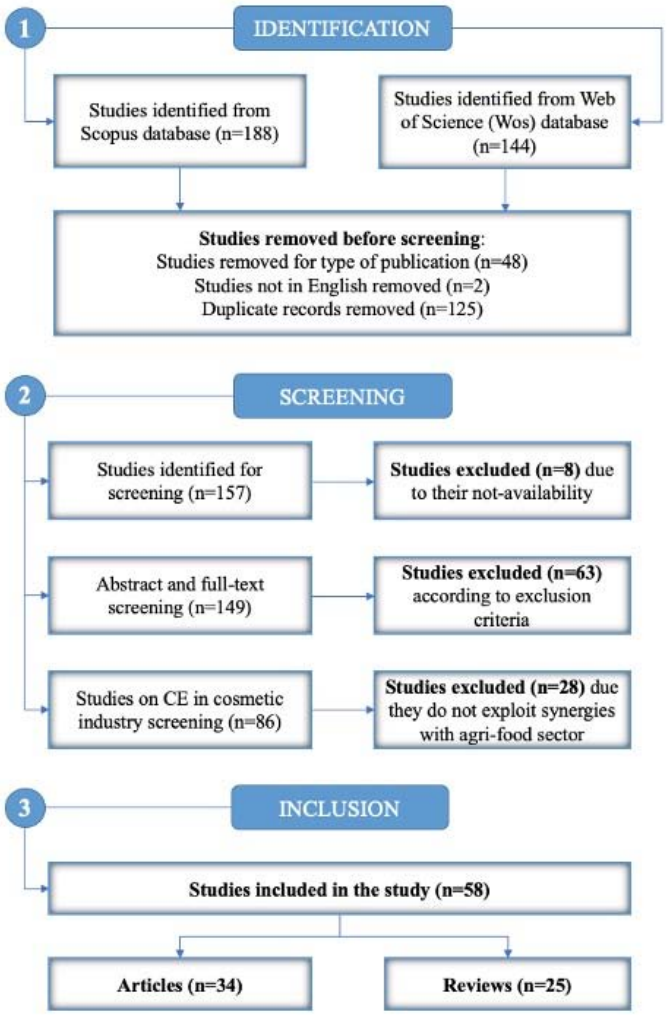

Figure 1 – Search strategy diagram (based on PRISMA guidelines)

The final sample is investigated with the analysis of the characterization of the circular practices as well as the synergies existing between the two sectors. More in details, the following elements are considered: a) the object of analysis, that refers to materials, substances or practices analyzed in the study; b) the research method, that refers to the techniques employed for the description of the circular practices; c) the typology of practice, that refers to the 4Rs principles which are classified according to

the EC framework established by the Directive 2008/98/CE (EC, 2008); d) the link with sustainability, considering the presence of an explicit reference to sustainability and its dimension and also analysing the level of contextualization of the concept based on three levels, that are: not mentioned, mentioned, argued.

Finally, in the present study, the attention is focused only on the studies which highlight synergies between the agri-food and the cosmetic sectors, that are a total of 58 studies among which 33 articles and 25 reviews.

3 Results and Discussion

The results are presented and discussed according to the characterization of circular practices, which exploit synergies between the agri-food sector and the cosmetic industry.

The systematic analysis allows to analyse the results in terms of circular practices specifically aimed at the input valorization of materials and substances to be used as ingredients in the formulation of cosmetic products, also considering the methods for their extraction and valorization in compliance with the CE principles.

The importance of input valorization is probably due to the high interest of cosmetic companies in finding sustainable alternatives for their ingredients in order to replace synthetic materials and to mitigate the environmental impacts and the effects to human health (e.g. Antunes et al., 2022; Gaspar et al., 2022).

The selected sample is composed by a total of 58 studies that propose the extraction and valorization of materials and substances of waste and by-products from the agri-food industry. In details, the studies mainly propose the valorisation of the agri-food waste and by-products to obtain valuable compounds and secondary raw materials (e.g. Chamorro et al., 2022; Morganti et al., 2022; Del Rio Osorio et al., 2021). For example, the study of Del Rio Osorio et al. (2021) analyses the use of many agri-food by-products (e.g., passion fruit seeds, grapeseed, industrial coffee waste, etc.) and of the relative extracted compounds, as ingredients in the formulation of cosmetic products, such as sunscreens and other protective products due to their antioxidant properties. Another example is given by the study of Chamorro et al. (2022), who discuss the valorization of different types of kiwi by-products for obtaining ecological pigments or other ingredients of cosmetic products. Furthermore, the study of Morganti et al. (2022) explicitly argues the important role of agri-food waste and by-products for obtaining new and sustainable ingredients and products. In

details, the authors discuss the valorization and extraction of natural ingredients and biopolymers to be used in green cosmetics (Morganti et al., 2022).

In addition, it is interesting to highlight the study of Faria-Silva et al. (2020) which explicitly discuss the convergence between food and cosmetics. The authors argue the potential of food-derived ingredients for adding value and certain benefits to the cosmetic products (Faria-Silva et al., 2020). The synergies between agri-food and cosmetic sectors bring two types of advantages: on one side, the beneficial effects, for example for health and skin (e.g. Silva et al., 2021; Faria-Silva et al., 2020), deriving from the integration of compounds extracted from agri-food products, by-products and waste in the cosmetic products; on the other, the large amount of food loss and waste produced annually by the agri-food industry could be reduced or eliminated through its valorization and transformation aimed to the consequent use in the cosmetic industry (e.g. Morganti et al., 2022; Del Rio Osorio et al., 2021).

In the analysed circular practices between the agri-food and the cosmetic sectors, the importance of chemical and biochemical analysis emerges. The systematic analysis of the sample shows that 29 out of the 58 studies that take into consideration the valorization of agri-food waste and by-products employ chemical and biochemical analyses. Generally, chemical and biochemical analysis are needed for the examination of the composition of materials and substances and of the methodologies employed for the extraction of high-added value compounds (e.g. Mellinas et al., 2022; Truzzi et al., 2022). In addition, the analysis of chemical composition of raw materials used as ingredients in the cosmetic products is fundamental for assessing the potential impact on health of the products (Morganti et al., 2022).

Overall, the studies mainly demonstrate the importance of a cross-sectoral intersection, which is needed for the practical implementation of CE.

The identified circular practices include strategies oriented to: i) the valorization of agri-food waste and by-products, discussing the related processes and/or technologies (e.g. Del Rio Osorio et al., 2021); ii) the extraction of compounds and the methodologies employed for this purpose, discussing how to obtain new raw materials, their characteristics and the most appropriate methodologies (e.g. Mellinas et al., 2022); iii) the transformation of materials and substances and the related processes, discussing how to re-valorize agri-food waste and by-products (e.g. Russo et al., 2021); iv) the evaluation of different processes of valorization and their impacts, discussing the appropriate tools for the implementation of the circular practices and assessing their environmental impacts (e.g. Novara et al., 2022).

These strategies are aimed to exploit synergies between the agri-

food and the cosmetic sectors, which are implemented also in compliance with the 4Rs principles.

Figure 2 summarizes the practices proposed by authors of the sample. In details, the outputs of agri-food industry could be valorized, extracted, transformed and evaluated with the aim of obtaining secondary raw materials to be used as inputs in the cosmetic industry.

In addition, the proposed strategies are linked to one or more 4Rs principles.

Figure 2 shows how secondary raw materials could be obtained through the implementation of different circular practices that are oriented to the reuse (R2), recycle (R3) and recovery (R4) from the output of the agri-food industry. In addition, these practices imply the reduction (R1) of raw materials used as input in the processes of the cosmetic industry.

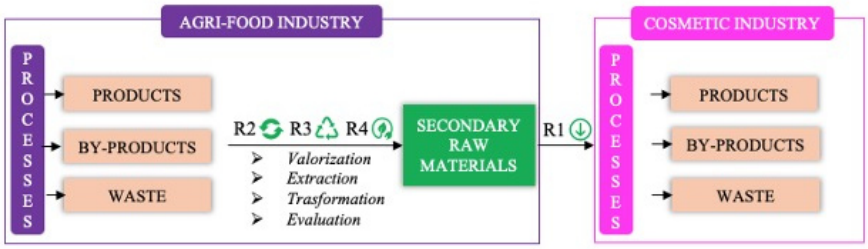

Figure 2 – Identified CE practices exploiting synergies between the agri-food and the cosmetic industries

Among the 4Rs principles, the Reduce (R1) and Recovery (R4) ones are the most argued in the studies. The Reduce (R1) principle refers to circular practices aimed to the improvement of resource efficiency by valorizing natural resources and by-products, but also to the reduction of waste and the cost of its disposal (e.g. Gaspar et al., 2022; Kumar et al., 2021). The Recovery (R4) principle refers to circular practices aimed to the recovery of raw materials and, in some cases, also energy, by extracting compounds from the agri-food waste and by-products (e.g. Bojorges et al., 2022; Dubois et al., 2022). In addition, some studies propose circular practices related to both the principles and aimed to both the objectives previously described (e.g. Naviglio et al., 2022; Cairone et al., 2022). Finally, also the principles of Reuse (R2) and Recycle (R3) are discussed by authors, which propose circular practices aimed to obtain secondary raw materials to be used as ingredients in the formulation of cosmetic products through the valorization of the agri-food waste and by-products (e.g. Chamorro et al., 2022; Panwar et al., 2021).

In addition to the discussion of 4Rs principles, about 86% of studies explicitly address the proposed practices to sustainability and its dimensions. Indeed, many studies argue the relationship between CE and sustainability (n=21), while others only mention it (n=21). However, the majority of studies is focused on the general concept of sustainability (n=34). Indeed, some are focused on the link with the environmental dimension of sustainability (n=7), with the environmental and the economic ones (n=6), or with the economic ones (n=1). The remaining two studies only refer to sustainability reporting the term among the article's keywords.

Overall, also the studies that mention sustainability without explicitly discussing its dimensions, implicitly include economic and/or environmental issues. For example, the study of Novara et al. (2022) argues the general concept of sustainability but discusses economic and environmental aspects, such as the reduction of the use of both resources and energy and also the reduction of Carbon Footprint (CF). It is interesting to note that no study refers to the social dimension of sustainability.

Figure 3 reports the relations among research methods, typology of the proposed strategies, 4Rs principles (R1: reduce; R2: reuse; R3: recycle; R4: recovery), level of contextualization of sustainability and the focus on its dimensions.

The employed research methods are represented by different colors: the green represents case-studies, the purple represents reviews.

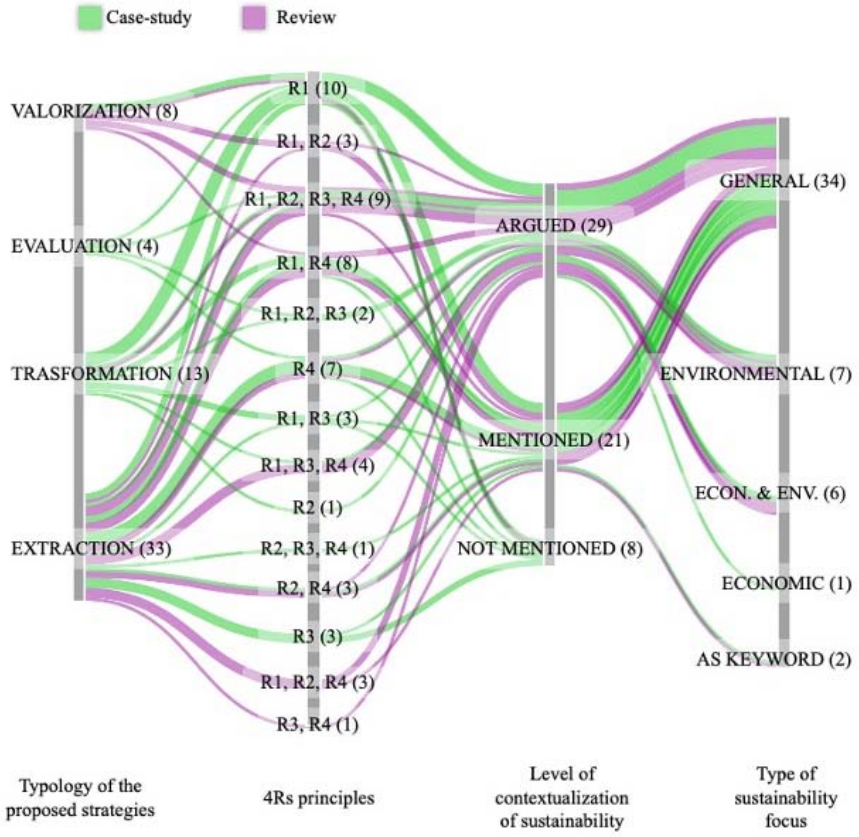

Figure 3 – Relations among research methods, typology of the proposed strategies, 4Rs principles, level of contextualization of sustainability and focus on its dimensions

It is interesting to note that the studies which refer to all the 4Rs principles include strategies of valorization, evaluation, transformation and extraction. In addition, in all these studies the concept of sustainability is at least mentioned or argued. This result demonstrates that the implementation of circular practices in compliance with the 4Rs principles could be also considered sustainable and find application with the different strategies that exploit the synergies between the two analyzed sectors.

However, the majority of studies propose strategies related to the extraction that are linked to almost all the combinations of the 4Rs principles discussed by the authors of the sample. After that, strategies of trans-

formation are proposed in some studies that represent a significant part of the sample, specifically almost all case-studies, while only one is a review. Among these, only two case-studies do not mention sustainability.

Overall, these results show that many synergies could be explored between the agri-food and the cosmetic sectors in compliance with one or more 4Rs principles. In addition, the related practices are almost all related to sustainability and its dimensions.

4 Conclusions

The present study aimed at providing an overview of the circular practices and experiences which are or could be applied in the cosmetic industry exploiting the synergies with the agri-food sector. Pursuing this aim, a systematic review is carried out. The analysis allowed to identify 58 studies, that discuss the synergies between the two considered sectors; they were considered in order to answer to the defined research question.

The academic research on CE in the cosmetic industry covers different areas of interest, implying an interdisciplinary and cross-sectoral interest in the topic. The systematic analysis showed the connection between the cosmetic industry and the agri-food sector in the implementation of circular practices. The results are focused on the input valorization of materials and substances obtained from the agri-food sector to be used as ingredients in the formulation of cosmetic products. More in details, many synergies can be found due to the huge amount of agri-food waste and by-products that could be valorized, also through the extraction of high-added value compounds, to obtain secondary raw materials to be used as ingredients in the formulation of cosmetic products. In addition, the chemical and biochemical analysis has an important role in the achievement of these synergies, mainly due to the need to identify the characteristics and properties of materials and substances, but also the methodologies of extraction of compounds from the agri-food waste and by-products.

The identified circular practices include strategies of valorization, extraction, transformation and evaluation, all of which are aimed to exploit synergies between the agri-food and the cosmetic sectors.

All the circular practices analysed refer to the 4Rs principles, especially the Reduce (R1) and Recovery (R4) ones, but overall, all of them are explicitly discussed, together or separately, in almost all the studies of the sample. In addition, almost all the studies link the circular practices with the concept of sustainability and its dimensions.

The study presents some limitations mainly due to the fact that this analysis is part of a wider study and the search query applied aimed to col-

lect all the studies that explicitly refer, without any distinction, to CE in the cosmetic industry. Thus, the potential synergies between the two sectors need a further exploration with future research that should be oriented specifically on the relation between them.

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