Bibliometric analysis of the use of black soldier fly larvae (BSFL) for organic waste treatment

O. Zboon[1], J. Martín-Pascual[1], M. Zamorano-Toro[1], L.M. Ruiz-Hernández[1*]

[1]Civil Engineering Department. E.T.S.I. Caminos, Canales y Puertos. University of Granada.
Dr. Severo Ochoa s/n, 18071, Granada (Spain)
Keywords: Bibliometric analysis; Black soldier fly larvae; Organic fraction; Waste treatment

Presenting author email: luzmruiz@ugr.es

Based on the current population growth, world production of municipal solid wastes is expected to reach 3400 million metric tons per year in 2050, being food waste the most significant component of these wastes (Sauve and Van Acker, 2020). However, despite being the largest fraction of municipal waste, recycling or valorization of the organic fraction (OFMSW) remains limited, especially in low- and middle-income regions. According to the Food and Agricultural Organization of the United Nations (FAO), approximately one-third of the food produced globally is wasted out without being consumed (FAO, 2017). In this context, the improper handling of organic waste has led to a multitude of environmental hazards and economic challenges (Ferronato and Torretta, 2019) and it is imperative to establish effective waste treatment and valorization strategies in order to properly manage this fraction of urban wastes while minimizing the environmental impacts and waste experts worldwide are developing more sustainable methods for municipal waste treatment and valorization, aligning with the paradigm of circular economy (Bakan et al., 2022).

Black soldier fly larvae (BSFL) constitutes a new treatment system for addressing challenges related to organic waste management, which this insect uses for feeding. At the same time, flies growth produce flies larvae which become a sustainable source of nutrients mainly used for purposes such as animal feed or as fertilizer (Siddiqui et al., 2022). Other advantages of this technology are that it can be applied to many different types of organic wastes (Singh et al., 2021) or that the Global warming potential (GWP) is negligible in comparison with other processes currently used for treating OFMSW (Mertenat et al., 2019). Consequently, there is a concerted effort to promote the use of BSFL for organic waste removal, although this technology has not been deeply evaluated yet and data about the process viability is still scarce (Bosch et al., 2019).

A bibliometric analysis was carried out in order to evaluate the evolution of this technology among the scientific community in the last 25 years. As shown in Figure 1, the evolution in the number of publications including the term “black soldier” sharptly increased. This trend is especially relevant since 2016 until 2023. When other terms such as “animal feed” or “waste treatment” are also included in the search carried out using the Scopus database, the number of contributions is significant reduced. However, the most significant results showed in Figure 1 are those related to the terms “full scale” and “life cycle analysis (LCA)”, which appeared for the first time in 2016 but have not been widely evaluated yet, with no more than 14 and 25 publications respectively, from 2016 to 2023. According to this information, it can be concluded that eventhough it is a technology which is gaining relevance among researchers and management companies, information about this new technology is still scarce and most of the studies are limited to lab-scale experiments.

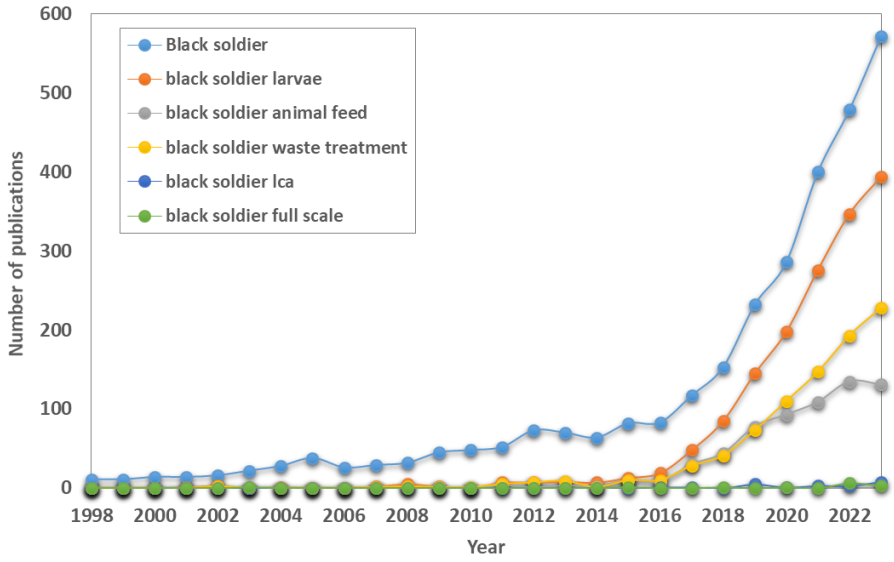

Figure 1. Evolution of black soldier related publications in the last 25 years.

Besides data shown in Figure 1, a full bibliometric analysis was carried out, taking into account factors such as country, research group and other relevant information in order to increase the knowledge about the evolution of this technology in the last decades and other information related to aspects such as environmental impact or global warming potential (GWP), life cycle analysis (LCA), technical issues related to the process, economic feasibility, plant size of existing plants or residue post-treatment required prior to valorization have also been taken into consideration for this study.

References

- Bakan, B., Bernet, N., Bouchez, T., Boutrou, R., Choubert, J.M., Dabert, P., Duquennoi, C., Ferraro, V., García-Bernet, D., Gillot, S., Mery, J., Rémond, C., Steyer, J.P., Trably, E., Tremier, A. (2022). Circular Economy Applied to Organic Residues and Wastewater: Research Challenges. *Waste and Biomass Valorization* **13,** 1267-1276. https://doi.org/10.1007/s12649-021-01549-0
- Bosch, G., van Zanten, H.H.E., Zamprogna, A., Veenenbos, M., Meijer, N.P., van der Fels-Klerx, H.J., van Loon, J.J.A. (2019). Conversion of organic resources by black soldier fly larvae: Legislation, efficiency and environmental impact. *Journal of Cleaner Production* **222,** 355-363. https://doi.org/10.1016/j.jclepro.2019.02.270
- Food and Agricultural Organization of the United Nations (FAO). The future of food and agriculture: Trends and challenges. (2017). FAO publications.
- Ferronato, N., Torretta, V. (2019). Waste Mismanagement in Developing Countries: A Review of Global Issues. *International Journal of Environmental Research and Public Health* **16(6),** 1060. https://doi.org/10.3390/ijerph16061060
- Mertenat, A., Diener, S., Zurbrügg, C. (2019). Black Soldier Fly biowaste treatment - Assessment of global warming potential. *Waste management* **84,** 173-181. https://doi.org/10.1016/j.wasman.2018.11.040
- Sauve, G., Van Acker, K. (2020). The environmental impacts of municipal solid waste landfills in Europe: A life cycle assessment of proper reference cases to support decision making. *Journal of Environmental Management*, **261,** 110216. https://doi.org/10.1016/j.jenvman.2020.110216
- Siddiqui, S. A., Ristow, B., Rahayu, T., Putra, N. S., Widya Yuwono, N., Nisa, K., Mategeko, B., Smetana, S., Saki, M., Nawaz, A., Nagdalian, A. (2022). Black soldier fly larvae (BSFL) and their affinity for organic waste processing. *Waste Management*, **140**, 1–13. https://doi.org/10.1016/j.wasman.2021.12.044
- Singh, A., Srikanth, B.H., Kumari, K. (2021). Determining the Black Soldier fly larvae performance for plant-based food waste reduction and the effect on Biomass yield. *Waste Management*, **130**, 147-154. https://doi.org/10.1016/j.wasman.2021.05.028