

REVIEW

Obtaining Microalgae Biomass Tolerant to Herbicides for Production of Bio-fertilizers: A Review Based on *Methodi Ordinatio* Methodology

Ana Cláudia Zanata^{*a}, Fernanda Aparecida Brocco Bertan^a, Caliandra Bernardi^a, Casi Santos dos Santos^a, Gerusa Albertina Ferreira^a, José Antonio de Oliveira Junior^c, Maria da Conceição Constantino Fernandes^b, and Andréia Anschau^a

^aFederal University of Technology (UTFPR) – Post-Graduation Program in Biotechnology (PPGBIOTEC). Letter Box 157- CEP 85660-000, Dois Vizinhos, Paraná – Brazil.

^bPolytechnic Institute of Bragança (IPB) – Investigation Center of Montanha (CIMO), Agrarian Superior School. Campus of Santa Apolónia, Apartado 1172, 5301-855, Bragança, Portugal.

^cFederal University of Maranhão (UFMA) – Coordination of Chemical Engineering (COEQ). Av. dos Portugueses, 1966 - Vila Bacanga, CEP 65080-805, São Luís – MA, Brazil.

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Abstract:

The objective of this work was to use a systematic review of the literature on the cultivation of microalgae resistant to herbicide using the Method *Methodi Ordinatio*, which assists the search, selection, collection and classification of scientific articles. Initially, research was done on the databases Scopus, Science Direct and Web of Science, using the keywords “microalgae” and “herbicide”. The results were imported to the Mendeley bibliographic reference manager. Subsequently, the index *In Ordinatio* index was applied, which works with the three most important factors in a scientific article: The impact factor, the year of publication and the number of citations of the research. This index turns it is possible to classify the most important articles in the area of herbicide-tolerant microalgae and note the importance of this method, which made it possible to find current studies and demonstrate the relevance of this research theme. In order to show the dynamics of the methodology, a research with the theme is presented, comprising works from years 2008 to 2018. The results indicate that the methodology is effective in relation to the objectives proposed, and the most relevant work on the cultivation of herbicide resistant microalgae are used to construct the scenario in this theme.

Keywords: herbicides; *In Ordinatio*; microalgae; systematic literature review

1. Introduction

Producing sustainable food without using chemical fertilizers is one of the major concerns in the current days. Researchers with bio-fertilizers have been developed, compounds of natural origin, also denominated as organic fertilizers, and used as bio-controllers to nourish arable land. Bio-fertilizers are sources of essential micro and macronutrients which function as defenses and are rapidly converted by plants [2].

An organic fertilizer can be produced from natural products such as biomass, food, manure,

among others, based on composting and refining processes [1]. In this sense, the benefits in which the soil, plants and environment will have by utilizing organic fertilizers are many, such as: An enhancement of beneficial micro-organisms cultures, greater soil stability and nutrients being assimilated by plants, among others.

The use of microalgae biomass as one of the possible constituents of bio-fertilizers has many positive aspects. Microalgae are photosynthetic organisms which can produce large amount of biomass and can be found in several biotypes due to the ease of adaptation and ecological diversity

*Corresponding author. E-mail: [✉ anaczanata@hotmail.com](mailto:anaczanata@hotmail.com)

[3], with little cultivation area and low cost of production. Additionally, biomass can provide plants a better rooting and emergency, apart from favorable flowering, granulation and enlargement of fruit conceiving [4].

One of the herbicides which stands out as being one of the most used in the agricultural sector is the 2,4-D [5]. Aminopyralide and Fluroxypyr are active herbicide ingredients recently commercialized on the market, highly indicated for the post-emergence control of herbaceous and semi-shrubby dicotyledonous weeds.

Methodi Ordinatio is a systematic literature review, which builds bibliographical portfolios and maps the state of the art of a specific research [10]. It is composed of nine steps and 7th step is named *InOrdinatio*, *InOrdinatio* that measures the scientific relevance of the selected papers. For the evaluation of the documents, three factors are crossed: Impact factor, year of publication and number of citations and applied in an equation, identifying the most relevant works of bibliographic selection [9].

In this sense, the objective of this work was to systematically review three databases, studies related to herbicide tolerant microalgae, using the *Methodi Ordinatio* methodology, which aims to rank the most relevant studies in this topic

2. Results and Discussion

Based on the bibliographic review performed in the databases, a total of 332 results were obtained.

Posteriorly, the duplicates and titles which did not match the subject under study were withheld,

144 results were gathered. Among the databases used in the research, the 'Web of Science' presented the highest number of results (136), followed by 'Scopus' (105) and 'Science Direct' (91). Figure 1 shows the number of articles published as of 2008 for the topics selected.

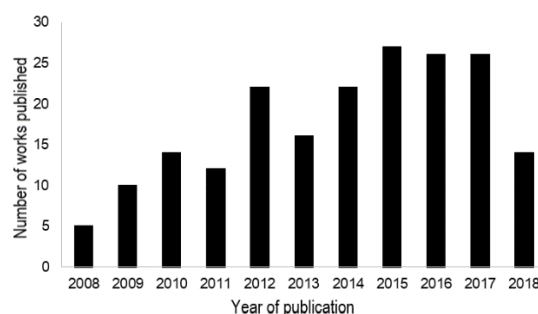


Figure 1. Number of published articles in the filed studied in the last decade.

There has been a tendency for an increase in the number of publications over the years, due to the importance of research in this area. With *Methodi Ordinatio* it is possible to guide the search, selection, collection and classification of scientific articles, based on its relevance. The purpose of the publication year is to serve as an indicator of data currentness. New and innovative advances are more likely to have been achieved in recent publications, so that great contributions to knowledge can be found [9].

From the *InOrdinatio* index, the highest ranked article (138) was published in 2017 by Ahmed et al at the Journal of Hazardous Materials, which has an impact factor of 4,836. This study deals with a literature review on wastewater treatment and presents the use of microalgae in the removal of emerging contaminants. Table 1 presents the 10 highest ranking results by the *InOrdinatio* index for the topic studied.

Table 1. Ranking of articles according to the *InOrdinatio* index.

Ranking	Author	Periodic impact factor	Number of citations of the paper	<i>InOrdinatio</i> index
1	Ahmed et al. (2017)	4.836	48	138
2	Noguera-Oviedo & Aga (2016)	4.836	42	122
3	Waclawek et al. (2017)	2.463	25	115
4	Olajire (2013)	4.764	62	112
5	Raval et al. (2016)	3.131	29	109
6	Monari et al. (2016)	4.959	22	102
7	Meléndez-Martínez et al. (2018)	2.780	2	102
8	da Silva Filho et al. (2018)	4.959	1	101
9	Ramezanalizadeh & Manteghi (2018)	4.959	1	101
10	Ding et al. (2018)	4,836	1	101

Studies on microalgae have been growing in several fields of research. As fertilizers there are still few developed studies. According to some patents, the use of microalgae as biomass and proteins is equivalent to 6.90% and as fertilizer to 3.45% [7], which shows little applicability of this microorganism in this area of research and the interest in deepening the knowledge in this field, given the importance to society in general.

3. Material and Methods

All procedures were realized using the 'Methodi Ordinatio' methodology. The application of 'Methodi Ordinatio' is based on 9 general steps, from the topic of interest, search and definition of keywords in databases, filtering, word localization, task localization and reading and analysis of the selected articles [9].

Initially, a search in the literature in the databases Science Direct, Web of Science and Scopus was done. This method follows an adaptation of 'ProKnow-C' to the selection of publication and the 'InOrdinatio' index to present criteria to define the articles, in order to rank them by relevance. A classification crossing three important factors is needed: year of publication, impact factor and the number of citations [8].

Thus, the articles found in the data basis already mentioned on the cultivation of microalgae tolerant to herbicides can be classified, knowing that these data basis are indeed consistent and show a significant number of publications. Afterwards, a search for descriptors 'microalgae' and 'herbicide' as topics was done, as of 2008, only selecting single articles.

After the research of the articles, the 'Mendeley' software (a reference manager) was used in order to filter off double searches which did not fit the theme in question.

4. Conclusions

By using the *Methodi Ordinatio*, the classification of published articles in microalgae related to herbicide tolerance was done by analyzing the relevance of these works based on the year of publication, impact factor of the journal and number of citations of the author. In this way, future works, research projects and studies in general, can be produced with more foundation and literary consistency, since the works cited will have relevant scientific importance. It is also noticed that there are few published articles with microalgae focused on the production of a bio-fertilizer, indicating how important the development of research in this area.

References and Notes

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