Effect of Different Ulvan Extraction Conditions for Biotechnology Applications: A Meta-Analysis

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ABSTRACT

Algae play a great role in the field of biotechnology because they have important metabolites in their phytochemical composition useful for their inclusion in the concept of biorefinery and bioeconomy. These metabolites are usually extracted from dry biomass using a variety of methods to allow higher yields of bioactives of greatest interest in product development. In this research, metanalyses were used to evaluate the effect of the factors such as temperature, time, and the type of extraction method in obtaining the ulvana of *Ulva lactuca*. With this work, it was possible to observe that the acid extraction has led to a higher yield of ulvan in relation to the more eco-friendly methods, for example, aqueous and assisted ultrasound, although the latter is more favorable for obtaining the highest purity ulvan for purposes biological. Research on extraction methods needs to be further developed to better define the processes that fall into the ulvan biorefinery for biotechnological purposes, for example for the food, cosmetics, and biofuels industries.

Keywords: Algae. Ulvan. Extraction. Methods.

1 INTRODUCTION

The *Ulva* is a species of green algae, which presents in its cell wall the ulvan which is a sulfated polysaccharide. The ulvan is soluble in water and constitutes 9 to 36 % of the dry biomass of Ulva and is composed of sulfated rhamnose monosaccharides, uronic acids (glucuronic acid and iduronic acid), and xylose(1) . In addition, the species of Ulva have three other polysaccharides in their cell wall namely (insoluble cellulose, linear xyloglucan soluble in alkalis, and a glucuronano), which correspond together with ulvan 45% of dry biomass (2). Most of the recent work on polysaccharides of the cell wall of the green wings of the ulvan species is concentrated in the ulvan, since it presents several physicochemical and biological characteristics of potential interest for food applications, pharmaceutical, agricultural, and chemical (Figure 1). Ulvan is structurally more complex than other algal polysaccharides due to the complexity of its monosaccharide composition, glycosidic binding, and group modifications. The chemical composition of ulvan will be affected by *Ulva* sp. according to the source of extraction, harvest time, and methods of extraction and purification of ulvan, its composition is more complex (3). However, there are two structural characteristics that are more susceptible to degradation during ulvan extraction: their degree of polymerization and degree of sulfation. Depolymerization of the polysaccharide is easier than desulfation of the polysaccharide under the range of extraction conditions used to extract the ulvan (4). The extraction parameters that influence the degree of depolymerization include pH, temperature, and duration, this research evaluated the effect of these parameters on the ulvan yield of the species *Ulva lactuca*. The extraction yield is largely determined by the extraction method. Adequate selection of extraction conditions is necessary to achieve the compromise between yield, selectivity, and structure integrity of ulvan (5). The extraction parameters do not only affect the composition of the polysaccharide but also its biological activity (6). This research established a relationship between the conditions of extraction in the yield of Ulvan. The following physical parameters, type of extraction, temperature, and time were evaluated.

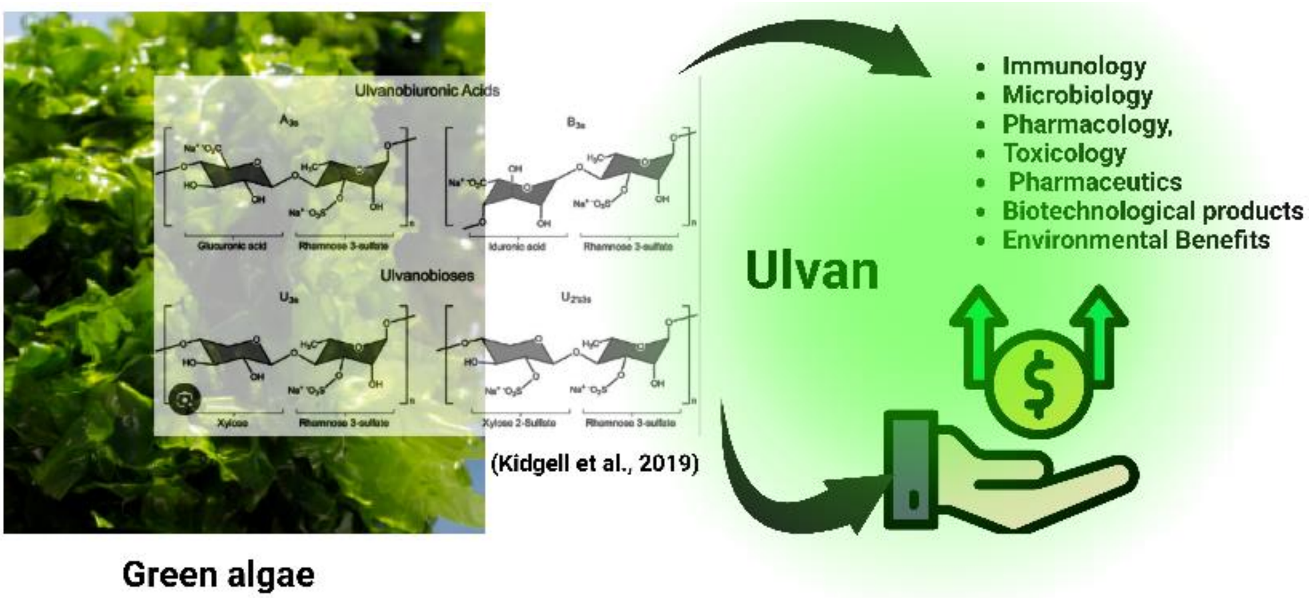


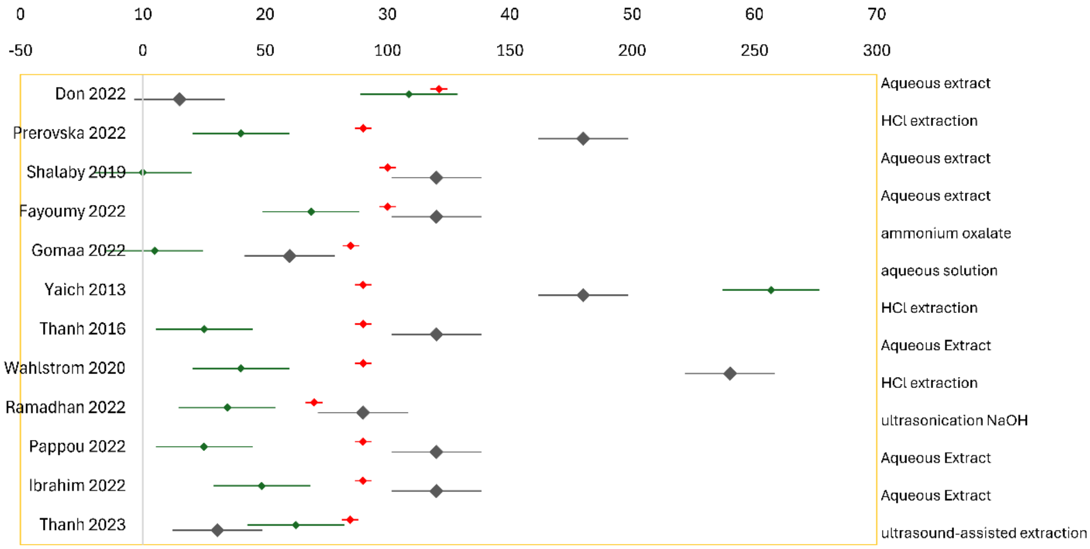
Figure 1 Chemical structure of ulvan and its biotechnological application.

2 MATERIAL & METHODS

This research was based on a systematic review based on metanalise. The searches were performed using the following keywords: "ulvan" OR"ulvan Extraction" OR "ulvan Yield" and "Extraction methods" and resulted in 170 works from PUBMED, 191 from the Web of Science, and 6 from Scopus. A total of 367 papers were selected, of which 12 were used in the meta-analysis. Works from the last 5 years were selected. Excluded are works that did not address the methods of ulvan extraction from *Ulva lactuca*. All studies that address the effect of the conditions of extraction and purification of ulvan of different species of *Ulva lactuca* were included. The data were analyzed using Excel.

3 RESULTS & DISCUSSION

There is a big difference in the yield of ulvan using different extraction methods. The yield of ulvan depends on some parameters the type of species of the *Ulva* and the source of the *Ulva* (it can be wild, cultivated, and the location). In Figure 2 it is observed that a great difference in the yield of ulvan of the species *Ulva lactuca*. Higher extraction temperatures allow greater solubilization of the ulvan and the increase in the extraction duration can increase the ulvan yield, for example, the temperature of 90 ºC and 3 h led to a yield of 61.37 % (5). The acid extraction method produced a better yield and higher molecular weight of the polysaccharide with intense chelating capacity compared to the methods with water and alkalis. In addition to extraction techniques, extraction conditions such as time, temperature, pH, the proportion between the ratio of solids (biomass) and the solvent and the type of elution solvent can affect the chemical composition and function of polysaccharides (7). Although acid extraction at high temperatures and a long extraction period results in ulvan yields, it is necessary to take into account that this decreases the purity and can cause degradation of the polysaccharide. However, extraction with hot water is more sustainable, efficient, and selective. Nevertheless, high-temperature extractions in water generally have low extraction yields due to interactions of ulvan with other cell wall components (8). Microwave-assisted extraction methods demonstrated better performance with the advantages of short operating time, simplicity, low cost, and high efficiency (9)(Le et al., 2019). The extraction of ulvan from *Ulva lactuca* by the assisted microwave extraction method using the temperature of 84.75 ºC and 30.51 minutes led to a yield of 22.5% of ulvan (10). Figure 2 shows that for the acid extraction of ulvan with higher yield the temperature should vary from 80-90 ºC and the time around 1-3 min. However, it is necessary to incorporate the treatment with warm water for salt removal and subsequent extraction of ulvan with hot diluted hydrochloric acid to obtain a high purity material (11).



	Thanh 2023	Ibrahim 2022	Pappou 2022	Ramadhan 2022	Wahlstrom 2020	Thanh 2016	Yaich 2013	Gomaa 2022	Fayoumy 2022	Shalaby 2019	Prerovska 2022	Don 2022
Temperature	84.75	90	90	70	90	90	90	85	100	100	90	121
Time (min)	30.51	120	120	90	240	120	180	60	120	120	180	15
Yield of Ulvan	22.5	19.72	15	16.9	18	15	61.37	10.97	23.75	10	18	31.76

Figure 2 : Results of metanalyses on the effects of temperature, time and type of extraction of *Ulva lactuca*.

4 CONCLUSION

In the process of ulvan extraction the need to consider the following criteria for the definition of the extraction methods used namely: High extraction yield, High selectivity, and Low degradation. Ulvan's biological activity has been influenced by the extraction method that was used. The extraction methods assisted by enzymes and ultrasonic-assisted enzymes have been considered efficient to produce higher ulvan content with the purpose of biotechnology in the improvement of antioxidant activity. Aqueous salt extraction followed by extraction with HCl results in higher ulvan purity compared to $Na_2C_2O_4$ which results from lower ulvan purity and sugar content. However, for the use of ulvan in the concept of biorefinery for biotechnological applications the methods and conditions of extraction of bioactive compounds need to be improved. The variation of the structural composition of the ulvan and influenced by the ecophysiological origin of the algae source, the harvest time, and the extraction procedure. The lack of reproducibility of the chemical composition of ulvan after extraction represents a disadvantage, and this requires much effort to develop isolation procedures that minimize the differences in the chemical compositions of the extracted ulvan, to the extent that small structural changes of ulvan can alter biotechnological properties and functions.

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ACKNOWLEDGEMENTS

CNPq for funding the doctoral scholarship of the MAI/DAI Program.