Message from the President ................................................................. 1
Message from the Editor .................................................................. 3
PEGASUS – PHYCOMORPH European Guidelines for a Sustainable Aquaculture of Seaweeds, a co-designed creative white paper .............................................. 4
Development of novel methods for the extraction of lipids from marine microalgae................................. 8
News and Views .............................................................................. 14
International Society for Applied Phycology (ISAP) Newsletter Article Submission Guidelines........ 17
ISAP Contacts and Officers ................................................................ 20
Message from the President, Dr. Céline Rebours

Dear ISAP Members,

May the new year bless you with health, wealth and happiness.

With this year ending and the new one beginning, I am happy to introduce the second issue of ISAP Newsletter for 2019. Since 2017, the Members of the Executive Committee in charge of editing the Newsletter have succeed in publishing two issues per year. I would like to thank particularly our editor-in-chief, Sasi Nayar for his steady efforts which resulted in such accomplishments and provide our members interesting articles in each of the issues. Thanks to Sasi Nayar and the involved members, we also have a dynamic presence on Facebook (with almost 1300 followers) and LinkedIn. We also have a new and active website thanks to the dedication of Valeria Montalescot (Secretary/Treasurer) and Rémi Nghiem-Xuan (Webmaster).

All ISAP members can participate in the activities of the society. We would appreciate your ideas, feedback on ISAP, news, and announcements of interest for ISAP members. We would also be delighted to receive articles that could be published in our next Newsletter during spring or winter 2020. For details, please contact either the Editor of the Newsletter, Sasi Nayar, or the ISAP Secretary/Treasurer, Valeria Montalescot whose contact details can be found at the end of the newsletter.

Further, it is my great pleasure to announce that I am in discussion with Springer to prepare an agreement in which our members will have facilitated free access via the society webpages to both the Journal of Applied Phycology and Marine Biotechnology. The final agreement will be signed over the new year and will be announced on our webpages. If you are not yet a member, please do not hesitate to sign up and take advantage of this upcoming offer.

The payment of ISAP membership is essential for the life of ISAP, particularly for maintenance of the website, supporting workshops and training programs in algal biotechnology for its members, and Student Travel Grants. I will sincerely appreciate it if all members can ensure that they are up to date with membership payments, particularly before the ISAP2020 conference. Also, if you are in a position to add a donation to support the participation of young scientists in ISAP2020, that would be very much welcomed. For this issue, please consult our webpage or contact either the ISAP Secretary/Treasurer, Valeria Montalescot, or myself. Contact information is given at the end of the newsletter.

Further, during the second half of the year, the MC members have also been working on several activities:

1. Some of our members have been enthusiastically sourcing additional sponsors for ISAP2020. Special mention go out to Qiang Hu, Vitor Verdelho Vieira, Job Schipper and Ioannis Tzovenis. I would also like to acknowledge the outstanding efforts in finding financial support from one of our active member Avigad Vonsak.

2. I would like to mention the intensive work of the Committee for selecting which Training Courses should be supported by ISAP, chaired by Roberto De Philippis. The next workshop will be organized by Eugenia J. Olguín in Xalapa (Mexico) and will address the Challenges and Applications in Microalgal Technology. For further information, please consult the workshop webpage.

Ultimately, the organization of the 7th ISAP conference is actively ongoing thanks to the unremitting activity of the LOC. I am having frequent and fruitful interactions with the Chair of the Congress, Makoto M. Watanabe, as well as with the Scientific and Administrative Officers Emi Kusuda and Masaki Yoshida. I would like to thank them, as well as the other Members of the LOC, for their dedication to the organization of the conference. I would also like to thank our secretary Valeria
Montalescot and two vice Presidents, Roberto De Philippis and Qiang Hu, for the several fruitful discussions we had required to make important decisions regarding the conference.

Several milestones have already been achieved in the preparation of the conference and you can find all the information on the conference webpage to commence your travel arrangements:

1. Full provisionary programme is available and will be regularly updated until the starting day of the conference.
2. Plenary speakers are confirmed.
3. Panel discussion on current progress, opportunities and challenges of algae for human and animal health and nutrition will be co-chaired by Qiang Hu and Makoto M. Watanabe.
4. Several companies are supporting ISAP2020! If you also wish to sponsor the conference, don’t hesitate to apply!
5. Travel Grants are available for all!
6. Student grants will be open for application in January 2020 and several student activities have been prepared. Remember to register for the Student Night and the author workshop on the preparation of a paper for submission to a peer reviewed journal.
7. Mid-congress tours to see seaweed farm and microalgae facility will be organized. Remember to select one and register!

You will find detailed information and the latest updates to the programme and events under the ISAP2020 conference webpage, Facebook and Instagram (#isap2020japan, #isap2020) pages.

Please save the date for your attendance to the 7th ISAP Conference in Chiba, Japan from the 19th to the 24th of April 2020. The deadline for abstracts submission, early bird registration, special session submission is still open until the 17th of January 2020.

Look forward to meeting you soon in Chiba!

With my warm regards,

Céline Rebours

President, International Society for Applied Phycology
Dear Colleagues,

With the end of the year and festivities just around the corner, most of us are too preoccupied tying up the loose ends with all our projects and jobs at hand. The editorial committee was no different and we worked actively to get this issue out in time. I must specifically thank Céline and Fiona Moejes for making themselves available and assisting with getting this issue finalized. I must also thank the two lead authors of the two articles in meeting the tight timelines.

The Editorial Team is therefore pleased to bring out this issue with two excellent articles whilst continuing to maintain our balance on ‘macroalgae’ and ‘microalgae’ science! We also started preparations for 2020 issues and our guidelines for submission hopefully make the process a lot easier for you as potential authors of our Newsletter to submit articles. Should you have some material to contribute, please do not hesitate to contact us.

The first article by Barbier and Charrier is a very timely article on the recently published European guidelines for sustainable seaweed aquaculture. The recently published technical document PEGASUS – PHYCOMORPG has been conceived to be a one-stop reference document for the industry, researchers, policy makers, regulatory and legislative authorities focussed on production and consumption of seaweeds as food or nutritional supplements.

The second article by Geyer et al., is a review of novel techniques in extraction of lipids from microalgae. A major techno-economic bottleneck in commercial microalgal production for high value products is a technology that is not only effective but also economically viable, non-toxic and environmentally safe. This review investigates techniques such as cell disruption using mechanical or chemical means, use of flash hydrolysis and sub-critical fluids, super-critical fluids, conventional solvent extraction as well as enzymatic disruption and extraction. Although enzymatic techniques are novel and effective in cell disruption without altering the structure of lipids, more research is required to optimise this process. We hope you find these two articles as informative as we did when we prepared them for publication.

Together with our dedicated team from the Editorial Committee, I take this opportunity in wishing all a very Merry Christmas and a Happy and Prosperous New Year 2020. This holiday season is a good time to reflect on the year, as many have suffered loss in floods, earthquakes, volcanic eruptions, including the ongoing devastating bushfires in Australia.

Best wishes for the festive season,

Sasi Nayar

Editor of the ISAP Newsletter and Social media administrator
Abstract

Macroalgae play a key ecological role in coastal ecosystems and can be used for a variety of applications. Indeed, seaweed aquaculture can help address global challenges related to human consumption, health, development and management of aquaculture, and can contribute to a sustainable circular bioeconomy. Alongside the growing economic interest and business development, it is necessary to ensure the environmental and economic sustainability of the future development of seaweed aquaculture. The scientific, technical, environmental, legal and socio-economic dimensions have been taken into account in publishing the European Phycomorph guidelines for sustainable seaweed aquaculture, PEGASUS, in a participatory and co-designed way.

Context

Seaweeds are plant-like organisms and include red, brown and green species featuring a wide range of sizes, chemical compositions and lifecycle features (Charrier et al. 2017). They play a key ecological role in coastal ecosystems by supporting food webs, coastal defence, uptake of carbon, nitrogen, phosphate, and other environmental contaminants. Other applications include food, health products, cosmetics, agriculture, and environmental management. They are a promising bioresource for the future and the demand for high-value seaweed-derived compounds (cosmetics, food) is on the rise in Europe.

The net worth of the global seaweed-production industry is estimated to be ~€10B (for 31Mt) and is continuing to expand (FAO 2016, Buschman et al. 2017). However, the production in Europe represents only 1% of the total global production (Carmia et al. 2018). European industries need support in the development of seaweed aquaculture both at economic and environmental levels to become a sustainable business.

To meet this need, a network of multidisciplinary scientists specialised in seaweed (Phycomorph COST action FA1406) has recently published the PHYCOMORPH EUROPEAN GUIDELINES FOR A SUSTAINABLE AQUACULTURE OF SEAWEED (PEGASUS, Barbier et al. 2019a). This 200-page technical document has been conceived to bridge the gap between industry, policymakers and scientists. About 50 international experts have been working together to present the current state of European production, as well as national legislation and regulations currently applicable to the production and consumption of seaweed as food or food supplements.

Design of PEGASUS

The idea of writing a guide like PEGASUS came from the observation that the sector was booming economically but lacked legislation to specifically regulate the sector. Within European projects, researchers are in contact with SMEs and have stressed the lightness with which some companies wanted to set up and develop a seaweed business. This concern is perfectly illustrated by the rapid development of Spirulina cultivation, whereby anyone can start a business regardless of the crop quality (as examples: Al-Dhabi 2013, Jinhu et al. 2019). The marketing of poor-quality products, therefore, hinders the overall development of a sector. For these reasons, it was timely to anticipate any potential risks associated with the development of seaweed aquaculture.
The writing was based on the expertise of an existing network, COST Action Phycomorph. COST (European Cooperation in Science and Technology; https://www.cost.eu/) is a funding agency for research and innovation networks. COST Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. The main aim of PHYCOMORPH (2015-2019) was to unify a scattered European research landscape to enable a step-change in the basic knowledge of macroalgal reproduction and development, and to ensure appropriate and efficient transfer of knowledge to R&D and Innovation Institutes dedicated to the development of aquaculture techniques, in tune with current needs in Europe and worldwide (Charrier et al. 2018). Within this network, chapter coordinators were chosen to lead the drafting of their sections, under the coordination of a non-expert scientist to ensure that overly technical formulations are not used.

Different dimensions were taken into account in drafting this white paper with the economic aspect quickly considered through the participation of several SMEs that were able to share specific problems of developing a business, the cost of installation and maintenance, facing a market with uncertainties, the strategy to adopt and maintain the production and make it grow. It was also important to clarify current legislation, as Europe includes different member countries with different approaches, cultures and regulations. The impact of seaweed farming on the environment was also considered as significant. The scientific explanation regarding potential risks associated with the use of exotic species was necessary to clarify gene flow and the risk of losing local biodiversity. A specific focus was undertaken on one of the fast-growing markets, food with the need to review current legislation, nutritional values and knowledge of seaweed dedicated to the food sector.

PEGASUS quickly established itself as a white paper facilitating participation by experts with the intention of being useful and usable to everyone. Invitations to participate have often been extensively advertised with many choosing to participate. This new approach, in which non-experts collaborate with experts, is expected to develop in the coming years (Barbier et al. 2018). While some have misunderstood the content of these guidelines, others have provided their support and knowledge. In all 18 months was necessary to gather, analyze, synthesize different contributions (Barbier et al. 2020). PEGASUS was written by 50 experts and was widely distributed. Nine months after release, PEGASUS was read by over 1,000 scientists globally, received many recommendations probably because it is useful for farmers who want to start a business, for students who want to understand all the dimensions of this sector, for policymakers, as well as bankers, insurers, and other entities.

Challenges in seaweed aquaculture

The challenges and bottlenecks identified for the seaweed aquaculture development include market size, environmental constraints, preservation of local genetic diversity, the need for more research – both fundamental and applied, regulations on food quality, environmental contaminants, alien species, and cultivation constraints such as automation, epiphytism and other issues as outlined in Figure 1.

Figure 1: The different challenges that the aquaculture sector has to overcome (Barbier et al., 2019)
One important challenge in cultivation is the risk of introduction of alien species as well as the risk of transmission of parasites and pathogens to wild populations. Non-indigenous species can act as vectors for the introduction for new pathogens or pest organisms and can modify the local genetic diversity. Consequently, the choice of the species for farming is essential.

The loss of the best cultivar and the management of waste are additional challenges. The cultivars are plants obtained by artificial selection (breeding). To obtain the best cultivar, strains are chosen for their traits of interest, yield as well as their robustness for farming. Well-planned and -designed breeding and selection programmes will help to achieve the goal of long-term sustainability but require further research to determine the appropriate conditions for cultivation given the high risk of genetically modified individuals escaping into the wild.

**Recommendations for the preservation of the local genetic diversity**

To boost the sustainable development of seaweed aquaculture in Europe, PEGASUS calls for pan-European harmonization of legislation and management frameworks on cultivation rules, environmental protection, evaluation of the risk of loss of wild biodiversity and marine-water quality.

The different actions to promote the preservation of European marine biodiversity are detailed in PEGASUS and summarized in Figure 2. The sourcing is important as well as the location for cultivation. More research needs to be funded to gain more knowledge on pests and disease, on breeding and selection programmes on seaweed reproduction, gene flow etc. Finally, European regulations need to be updated.

![Fig. 2: Actions to preserve marine Biodiversity (Barbier et al., 2019)](image)

Regarding the development of the Integrated Multitrophic Aquaculture (IMTA) which is a promising co-cultivation system, further research to optimise the technique is required. A framework, as an integral part of local Maritime Spatial Planning, should be set up for guiding the spatial organisation of open-sea aquaculture to maximise production while minimising impacts on the environment.

The guidelines also provide an excellent overview of current scientific knowledge on the biology of seaweed and threats from pest and disease. In addition, they indicate the need for both fundamental and applied research programmes requiring future support to meet industry needs.

Finally, the expert advice in the PEGASUS guidelines aims to help all stakeholders in the sector to understand the different aspects of seaweed aquaculture and identify the key points and critical steps requiring action. Within this context, PEGASUS was presented to the European Parliament (February 2019).
Conclusions

To support the sustainable development of seaweed aquaculture, all stakeholders in the sector, such as farmers, suppliers, users, researchers and decision-makers, should establish a collaborative network along the value chain to guide strategic development plans. In this context, these guidelines should be considered and used as scientific advice to help all stakeholders in the sector to understand the different aspects of seaweed aquaculture. The recommendations of the guidelines could be extended and adapted to all seaweed producing countries.

Acknowledgements

The guidelines are based on work undertaken by the COST Action FA1406 “Phycomorph” (2015-2019; http://www.phycomorph.org/), supported by the COST Association (European Cooperation in Science and Technology) (https://www.cost.eu/actions/FA1406/#tabs|Name:overview).

COST (European Cooperation in Science and Technology; https://www.cost.eu/) is a funding agency for research and innovation networks. Their Actions help connect research initiatives across Europe and enable scientists to grow their ideas by sharing them with their peers. This boosts their research, career and innovation.

Copyrights

Diagrams and schemes were designed by Michèle Barbier.

References


Development of novel methods for the extraction of lipids from marine microalgae

NATHAN GEYER 1, ADARSHA GUPTA 2 AND MUNISH PURI1, 2

1Centre for Marine Bioproducts Development, College of Medicine and Public Health, Flinders University, Bedford Park, Australia
2Bioprocessing Laboratory, Medical Biotechnology, College of Medicine and Public Health, Flinders University, Bedford Park, Australia

Corresponding author: munish.puri@flinders.edu.au

Abstract

Marine microalgae are regarded as rich reservoir of producing high value bioactives such as lipids/oils, proteins and carotenoids. The conventional technology used for lipid extraction from microalgae is by solvent extraction. The use of organic solvents (n-hexane) for extracting lipids is not energy efficient and has biosafety concerns. To improve extraction efficiency of lipids, the cell disruption based on mechanical and enzymatic methods should be pursued. These methodologies have the advantage that these are eco-friendly, can obtain higher lipid yields, and cost-effective. Hence, this review is focussed on prospects of developing novel methods to replace the conventional methods of lipid extraction from marine microalgae.

Introduction

In recent years, biotechnology research into marine microalgae has increased significantly as the potential of these organisms to grow rapidly and produce large quantities of high value lipids such as polyunsaturated fatty acids (PUFAs) and carotenoids has been realised (Qu et al., 2018). These PUFAs that include alpha-linolenic acid (ALA), eicosapentaenoic acid (EPA), and docosapentaenoic acid (DPA), and docosahexaenoic acid (DHA) possess great relevance to the prevention of sudden death from ventricular fibrillation and are essential for the development of infant’s brain (Gupta et al., 2017; Horrocks and Yeo, 1999). These PUFAs are produced by various marine microalgae and because of their interesting lipid profile have been considered as a potential feedstock for biodiesel production and food additives as functional foods (Puri, 2017). Significant advances have been made in upstream processing to increase lipid yields from microalgal biomass. However, the large-scale extraction of lipids from microalgae biomass is currently not environmentally friendly due to the necessity of using solvents that are hazardous in nature (Kumar et al., 2017; Sitepu et al., 2018). In general, solvent extraction methods containing polar (methanol) and non-polar (chloroform) solvent mixtures (Folch et al., 1957; Bligh and Dyer, 1959) has been employed for lipid extraction from a variety of marine biomass. The use of organic solvents is characterised by slower performance, being labour intensive and has concerns about biosafety, health and environmental implications (Kumar et al., 2015). For a solvent to be effective and suitable for intended use, it must extract the products efficiently from a dried cell biomass. Drying of the microalgae biomass, a prerequisite before solvent extraction, is an energy intensive process which directly escalates downstream processing cost. An alternative to this approach could be cell disruption (Prabakaran and Ravindran, 2011; Byreddy et al., 2015) that promotes direct solvent access to lipids, allowing for faster extraction and recovery.

Thus, development of a process/methodology that utilises wet microalgae biomass for lipid extraction will largely benefit industry. In this write-up, various methods of cell disruption such as mechanical and non-mechanical that potentially leads to better lipid yields are documented in-brief.

Methods of cell disruption

Current cell disruption processes involve the use of detergents, high temperature treatments, organic solvents or highly acid or basic buffers. There are various cell disruption methods that have been
investigated in the literature (Harris et al., 2018) and can be separated into one of two classes as shown in Figure 1 (Byreddy et al., 2015; Halim et al., 2012).

**Mechanical methods of cell disruption**

Mechanical (bead beating, milling, ultrasonication, high-pressure homogenisation and spray-drying) methods break cells open or to cause a change in the cell wall to increase permeability. Bead milling and high-speed homogenization are examples of solid shear mechanical disruption methods that have been used for algal disruption in which bead milling with 0.3-0.5 mm beads was found to disrupt >90% of cells (Doucha and Lívanský, 2008; Günerken et al., 2015). The use of high-speed homogenization has been used to extract lipid (38%, w/w) from Nannochloropsis sp. (Balasubramanian et al., 2013). The use of a high shear mixer has been tested for algal cell disruption and lipid extraction, achieved high lipid yields and is economically feasible at an industrial scale (Kwak et al., 2019). Liquid shear mechanical techniques include high pressure homogenization and ultrasonication which have been found to be very effective for disruption of microalgal biomass. The use of high-pressure homogenization has disrupted Chlorococcum sp. (Halim et al., 2012), and Nannochloropsis sp. with increased lipid yields (Grimi et al., 2014). High pressure homogenization was found to be much more
energy efficient than the ultrasonication treatment despite optimizing the concentration of solids being sonicated (Yao et al., 2018). Algal biomass that has been ultrasonicated has shown a many fold increase in lipid yield over untreated cells in Chlorella sp., Nostoc sp. and Tolypothrix sp. (Prabakaran and Ravindran, 2011). Ultrasonication of biomass was found to be most effective when higher solids loading (>20%) resulted in ultrasound attenuation and lower than 20% solids wasted energy due to heat (Yao et al., 2018). The use of a probe sonicator was investigated and was found to be a more effective treatment of the biomass rather than an ultrasonic bath (Abo El-Enin et al., 2018). The disruption of algal biomass by microwave and ultrasound were compared and found to offer similar cell disruption yield (24.6% and 24.2% w/w lipid yields), respectively (Nogueira et al., 2018). The ultrasound cell disruption method required less energy than the microwave treatment to achieve very similar lipid yields (Nogueira et al., 2018). Pulsed electric field when tested on Synechocystis PCC 6803 was found to cause cells disruption and reduces the volume of solvent required to extract all lipids (Sheng et al., 2011).

Other methods of cell disruption

Methods of cell disruption such as sonication, grinding, bead milling and osmotic shock have been investigated and bead milling was found to be the most effective for lipid extraction from dried biomass (Byreddy et al., 2015). Osmotic lysis of biomass was used on a strain of Schizocytrium and Thraustochytrium and extracted 48.7% and 29.1% total lipids, respectively (Byreddy et al., 2015). However, osmotic shock is difficult to use at an industrial scale due to the time and saltwater that are necessary for the process. The use of potassium hydroxide has been used to disrupt Chlorella sorokiniana and C. vulgaris cells and was found to increase protein yields by up to three-fold (Phong et al., 2018). Chaotropic agents such as urea and guanidine hydrochloride have been investigated for cell disruption as they cause lysis of the cells and reduces hydrophobicity allowing for extraction of products from the biomass (Lohia et al., 1984; Haddad et al., 2015).

Flash hydrolysis and subcritical fluids for extraction of lipids

The use of flash hydrolysis as a treatment of the biomass has resulted in lower extraction times while also increasing the lipids yield from an alga (Teymouri et al., 2018). The flash hydrolysis method utilizes 280°C subcritical water for nine seconds and is very environmentally friendly (Kumar, 2015). A further benefit to using the flash hydrolysis method is that the lipids remain in the solid phase while nutrients such as sodium, phosphorus and potassium are extracted into the hydrolysate and could be used as a nutrient source for growing further biomass (Kumar, 2015a). Subcritical water extraction of lipids from Nannochloropsis gaditana has found the method to be competitive with current solvent extraction processes, however, more work is warranted to optimize extraction of EPA (Ho et al., 2018). A study that investigated the use of subcritical propane and dimethyl ether found them to have very similar yields to super critical carbon dioxide but had a faster rate of extraction (Catchpole et al., 2018). Pressurized liquid extraction of wet biomass using hexane and ethanol as solvents yielded fractions consisting of varying compositions. This method can extract lipids in a shorter span of time, yields slightly higher lipid yields than Folch extraction method while also avoiding the need for chloroform and methanol (Castejón and Señoráns, 2019). The pressurized liquid extraction of lipids from wet biomass using hexane at 120°C resulted in the greatest yield of EPA (Castejón and Señoráns, 2019).

Supercritical fluids for extraction of lipids

The use of supercritical fluids to extract lipids from biomass is very promising due to the higher lipid yields and the lack of residual solvent within the lipid extract (Nagappan et al., 2019). Studies on the use of supercritical carbon dioxide for lipid extraction have found that by adding a small volume of methanol, the extraction yields of the lipid is higher and more environmentally friendly than other solvent extraction methods (Liu et al., 2018). The addition of methanol is due to the non-polar supercritical carbon dioxide and by using methanol in combination allows for the extraction of better amounts of lipid (Liu et al., 2018). The combination of supercritical carbon dioxide and ethanol increased the lipid yields compared to supercritical carbon dioxide alone (Mendes, Reis and Palavra, 2006). Further, combining super critical carbon dioxide with hexane and ethanol mixture, increased lipid yields from algal biomass (Patil et al., 2018). Optimization of the supercritical carbon dioxide extraction process can result in greater neutral lipid extraction and reduced phospholipid extraction compared to...
the Bligh and Dyer method (Elst et al., 2018). Supercritical methanol extraction is also efficient for retrieving lipids from algal biomass and avoids using solvents such as hexane or chloroform (Kumar et al., 2017; Sitepu et al., 2018).

**Extraction of lipids using organic solvents**

Solvents are necessary to recover lipids from biomass and ideally the solvent used should have properties including low boiling point, not soluble in water and approval for food grade processing (Law et al., 2018). Dimethyl ether has been approved in Australia and New Zealand for general food use and due to its chemical properties may provide an alternative solvent that is suitable for food grade processes (Food Standards Australia New Zealand, 2012). N-ethyl butylamine, another solvent with great potential, was utilized to achieve lipid yields comparable to the Bligh & Dyer method without the need for drying or disruption of the biomass (Du et al., 2016). Fractional extraction method utilizing both hexane and ethanol would retrieve 30% more lipid after three extraction cycles than the common Bligh and Dyer method (Ju et al., 2018). Polar solvents including chloroform-methanol and ethanol were found to be more effective for the extraction of lipids than non-polar solvents like hexane (Abo El-Enin et al., 2018).

**Enzymatic methods of cell disruption**

Enzymatic methods of disruption have shown promise due to the effectiveness and the economic feasibility compared to the mechanical and chemicals methods of cell disruption. The use of cellulase on *Neochloris oleoabundans* achieved 64.4% cell disruption (Wang et al., 2015). Cellulase and other enzymes such as pectinase and proteinase have also been found to greatly increase oil yields from pumpkin seeds and when used in combination with microwave treatment can extract more oil than soxhlet extraction using hexane (Jiao et al., 2014). The use of pineapple juice to extract oils has been investigated on *Jatropha curcas* seeds and this method achieved an extraction efficiency of approximately 45% (Martínez Herrera et al., 2019). Enzymatic use of pineapple extract is a low-cost method of disruption that is much more environmentally friendly and reduces the need to use hazardous solvents (Martínez Herrera et al., 2019). The benefit of using enzymatic methods of disruption is that the process has no effect on the chemical structure of lipids and the hydrolysis of cell walls allows for increased lipid yields (Jiao et al., 2014).

**Conclusions**

The disruption of cells before extraction of lipids from wet biomass offers potential to retrieve the high value lipids/oils from biomass without the need for expensive and time-consuming drying process which is currently required to achieve reasonable lipid yields. The use of greener solvents such as supercritical fluids may also provide an alternative to current petroleum derived solvents that are unsuitable for use in large scale production to mitigate negative effects on the environment. The disruption of microalgal cells can increase lipid yields, however the most effective and efficient methods of disruption vary depending on the cell wall composition of microalgae that is being disrupted. Enzymatic methods of cell disruption could provide alternatives to current chemical, mechanical and physical techniques, however, further investigations are warranted with respect to enzyme-to-biomass ratios and reusability to achieve cost-effectiveness.

**References**


Castejón, N. and Señorán, F. 2019. Simultaneous extraction and fractionation of omega-3 acylglycerols and glycolipids from wet microalgal biomass of Nannochloropsis gaditana using pressurized liquids. Algal Research, 37, pp.74-82.


Kumar, S. 2015a. Flash hydrolysis of Nannochloropsis spp. for Nutrients Recycling and Biofuels Production.


The 7th International Society for Applied Phycology conference will be held in Chiba, Japan from the 19th to 24th April 2020

Prof. Dr. Makoto M. Watanabe, Mitsuru Izumo and the ISAP Executive Committee are pleased to invite you to the next international applied phycology conference bearing the theme ‘The benefits of algae to all humankind’. Full provisional programme is now available.

Confirmed plenary speakers include:

- **Mr. Osamu Inoue**  
  Chairperson of Ina Food Industry Co., Ltd. (Japan)

- **Prof. Michele Suzanne Stanley**  
  Scottish Association for Marine Science (UK)

- **Emeritus Prof. John Beardall**  
  Monash University (Australia)

- **Dr. Danxiang Han**  
  Chinese Academy of Sciences (China)

- **Prof. F. Gabriel Acién Fernández**  
  University of Almeria (Spain)

- **Prof. Christine Edwards**  
  Robert Gordon University (UK)

- **Dr. Alan T. Critchley**  
  University of Cape Breton, Nova Scotia (Canada)

- **Dr. Pi Nyvall Collén**  
  OLMIX (France)

- **Dr. Jean-Paul Cadoret**  
  Greensea (France)

- **Dr. Michele Barbier**  
  Institute for Science and Ethics (France)

**Travel Grants** are available through the GlobalSeaweedSTAR programme – a four year, multidisciplinary programme with a vision to grow the research and innovation capacity of DAC-list countries engaged in seaweed farming. This programme is supported by UK Research and Innovation – Global Challenge Research Fund and directly addresses key UN Sustainable Development Goals (SDGs). The Travel Grants will provide funding for travel and subsistence of up to a maximum of £2,000 each (approx. USD 2500) to applicants from the UK and DAC-list countries.

**Student grants** will be open for application in January 2020 and several student activities have been prepared. Remember to register for the Student Night and the writing workshop “Publishing Your Research: Writing a scientific paper and submitting to the right journal” organized by Springer.

**Mid-conference tours** to see seaweed farm and microalgae facility will be organized. Remember to select and register!

**Deadline for abstracts submission, early bird registration, special session submission is the 17th of January 2020.** Standard registration closes on the 16th of March 2020.

You will find more detailed information and the latest updates to the programme and events under the ISAP2020 conference webpage, Facebook and Instagram (#isap2020japan, #isap2020) pages.

We look forward to seeing you all in Chiba!
Seimineáir Feamainne (Seaweed Seminar), January 15th 2020 in Furbo (Ireland)

The event is being organised by Údarás Na Gaeltachta who are a regional state agency responsible for the economic, social and cultural development of Irish-speaking regions of Ireland. The event aims to gather key players in the seaweed industry to discuss the developments, improvements and routes to market in the industry.

Further information: https://www.eventbrite.ie/e/83585890649.

The 3rd India International Seaweed Expo and Summit 2020, January 30th – 31st 2020 in Chennai (India)

The aim of this meeting will be to further facilitate efforts to develop strategies and policies which both promote and strengthen a sustainable seaweed industry in India. The Summit and Expo is “a must attend” for all players related to the existing and future expanded seaweed industry in India and the rest of the world.


The 28th European Biomass Conference & Exhibition, April 27th – 30th 2020 in Marseille (France)

The 28th EUBCE will expand its portfolio from energy related biomass production and conversions of bio-based feedstock to other sectors of the economy and will now integrate the bioeconomy into its conference programme. In 2020, the conference will include key sessions that will dig deep into the structure, components and role of the emerging bioeconomy in Europe and across the world.


The 10th European Algae Industry Summit, April 29th – 30th 2020 in Reykjavík (Iceland)

Following the success of its nine previous editions and to mark our 10th year anniversary, the next European Algae Industry Summit will take place in Reykjavík, Iceland. There will be an exclusive site visit at the Algalif production plant and the event will once again bring together key players within the algae industry including leaders from cosmetics, food, feed, nutraceuticals and pharmaceuticals across the globe.

Further information: https://www.wplgroup.com/aci/event/european-algae-industry-summit/.

The 2nd US Microalgae Industry Summit, May 27th – 28th 2020 in Orlando, Florida (USA)

The event will bring together key players from the industry to discuss the latest technical developments, challenges and research breakthroughs across the microalgae value chain. The two day event will not only give the participants an insight on the current challenges and opportunities the industry is facing but also provide the opportunity to network and discuss solutions to keep the industry thriving as a whole during the numerous Q&As, and the extended networking breaks.

Further information: https://www.wplgroup.com/aci/event/us-algae-industry-summit/.

The 11th European Workshop on the Biology of Cyanobacteria, May 31st – 4th June 2020 in Porto (Portugal)

This meeting will be an excellent opportunity to present and discuss the scientific advances in the world of cyanobacteria. This time with a broader theme to promote more interaction within the cyanobacterial community, and it provides an opportunity to visit the charming city of Porto that was elected the best European Destination three times in the past few years.

Further information: http://11ewbc.i3s.up.pt/
The 10th International Conference on Alga Biomass, Biofuels and Bioproducts (AlgalBBB2020), June 14th – 17th 2020 in Pittsburgh, PA (USA)

The conference will cover all areas of emerging technologies in all areas of algal research, including microalgae, macroalgae, and cyanobacteria. AlgalBBB2020 will have focus on seaweed based systems, engineering advances, molecular characterization technologies, strain engineering technologies for biofuels and high value products and pharmaceuticals, biomaterials, photobioreactor design and control systems, among others.

Further information: https://www.elsevier.com/events/conferences/international-conference-on-algal-biomass-biofuels-and-bioproducts

The 2nd Seaweed for Health Conference, June 21st – 24th 2020 in Galicia (Spain)

The 2nd Seaweed for Health Conference is bringing together knowledge and experience for research and business within nutraceutical, bioactive and pharmaceutical compounds in seaweed. In order to favour exchange between academia and industry, a small local industry exhibition will be held during the conference. The conference will include a cooking show, seaweed collection and a one-day tour along the Galician Coast.

Further information: http://www.seaweed4health.org/

Aquaculture Europe 2020: the Blue and the Green, September 29th – 2nd October 2020 in Cork (Ireland)

Aquaculture can take the lead in the Blue - Green BioEconomy and is well placed to lead by example with new technologies such as land-based marine aquaponics, large-scale recirculating marine farms and innovative, integrated freshwater initiatives on brown field sites. This conference will bring together stakeholders from many diverse disciplines to discuss and debate cross cutting issues such as new circular economies, life-long health and environmentally sustainable production.


The 19th International Conference on Harmful Algae, October 11th – 16th 2020, La Paz, Baja California Sur (Mexico)

The 19th ICHA will include all topics related to understanding the causes, evolution and impacts of harmful microalgae and cyanobacteria. At the meeting scientists will present their research, share new ideas, and establish new collaborations and friendships. La Paz, a place where many academic institutes are found, is an ideal city for the meeting.


The 12th International Phycological Congress (IPC2021), March 21st – 26th 2021, Puerto Varas (Chile)

IPC 2021 will be a 5-day Congress and it will include a mid-Congress break to visit the natural attractions surrounding Puerto Varas. The event is intended for scientists and professional organizations with an interest in phycology. Aim is to elaborate a solid and innovative scientific program that will include invited speakers, oral presentations and posters.

Further information: https://ipc2021.com/
International Society for Applied Phycology (ISAP) Newsletter Article Submission Guidelines

Contributing an article to the ISAP newsletter
Members or non-members of ISAP are welcome to contribute articles, news clips or announcements to the newsletter. We do particularly encourage undergraduate and graduate students to contribute.

Past issues of the newsletter
Archives of the newsletter can be accessed on our website:
https://www.appliedphycologysoc.org/newsletters

Frequency of publication
Biannual.

The audience
The newsletter is read by about 600 members of the ISAP who are applied phycologists from universities, research institutes, industry, policy makers and other algae enthusiasts. It is also read by those who frequent our Facebook and LinkedIn in page where the newsletter is uploaded. The newsletter can also be accessed through National Library of Australia (NLA), as part of the agreement for the issue of the ISSN number.

Type of articles
We solicit and publish technical articles pertaining to applied phycology from any type of ecosystem. Each issue typically comprises two articles, one on microalgae and the other on macroalgae.

Other types of contributions may include announcements pertaining to conferences, workshops, symposia, training courses and events, project updates, book reviews as well as review of technology and services.

Article formatting
All submissions should be in MS word (.doc or .docx) format typically of 250 – 2500 words. Word files should be named with the surname (family name) of the corresponding author e.g., Camello.docx.

Please format your article in plain font ideally using Times New Roman, font size 11. Please bold titles and italicize sub-titles. Use appropriate symbol font for units. Please avoid the use of excessive space between characters or words. ISAP newsletter adopts metric unit of measurement. Scientific names should be in full, with genus and species in italics.

The manuscript should be organized as follows

- Title
- Author list with affiliation and corresponding author
- Summary or Abstract
- Main body of the manuscript
- Conclusions and/or recommendations
- Acknowledgments (optional)
- References
- Tables (optional)
- Figures (optional)
- Figure captions (optional)
Title
Typically **100 characters**, in bold.

Authors and affiliation
Each article should list all authors with their first name and middle name abbreviated. Superscripts may be used to indicate the institutional affiliation of the authors. An asterisk symbol is used to highlight the corresponding author and their contact email ID. For e.g.,

N.V. Thomas¹, K. R. Roman² and A. R. Camello³*
¹Affiliation of first author with institutional address
²Affiliation of second author with institutional address
³Affiliation of third author with institutional address

*Corresponding author: camello.a@aad.gov.au

Summary or Abstract
A summary or abstract, typically **100-150 words** should summarize what the article is about and the salient findings.

Main body of the manuscript
The articles must be written in plain English with the broad objective of conveying technical information that can be understood by non-specialists and the general public. Technical jargon should be avoided. Figures and tables may be cited in the main body of the manuscript, but must not be embedded. Similarly, in-text citation of references must be adopted. In-text citations should follow the author-year format. For e.g., (Roberts and Emilio, 2003).

Conclusions / Recommendations
**No more than 50 – 100 words** with closing opinion with recommendations for further work.

References
Citations need not be extensive and may be restricted to pertinent reviews or those applicable to the subject matter. Only literature cited in the main body of the manuscript should appear in the reference list. The citations should be listed **alphabetically and chronologically**. The format adopted by the newsletter is as below:

Journal article

Book

Book chapter

Report

Tables
Small, concise tables that complement the data in the text are encouraged. Tables may be created using the word table tool. Tables must **be submitted separate to the main manuscript** and must contain the title.
Photos / Figures / Images / Line art
Photos or image files should be of high resolution (typically >300dpi), in colour or Black and white (B&W) and should be supplied in .jpg or .tif or .png format. Up to 15 figures or images can be included with each article. Image or photo files should be labelled with the surname (family name) of the corresponding author followed by the Figure number for e.g., McTierFigure1.jpg

Figures or photographs used in the manuscript should have in-text citation. Please do not embed photos or images into the main body of the manuscript. Figure legends or captions should be in word format with the description of each of the figure used. The photographs or figures used must be original and must have been taken by one of the co-authors. If not, the owner, the source of the photograph or figure must be acknowledged.

Copyrights and ownership
All materials submitted must belong to the authors. If not, contribution from other parties must be clearly acknowledged in the article. The corresponding author takes all responsibility pertaining to compliance with copyrights and permission to publish the material, when an article is submitted to the newsletter for publication.

Submitting an article
If the complete submission, that includes the manuscript, tables and figures, are <10Mb we encourage the corresponding author to attach the manuscript and the supporting files to an email message and email to the Editor at sasi.nayar@sa.gov.au. If the files are too large to be communicated over email, please let the Editor know. We will then create a secure folder on OneDrive and share it with you for the files to be dropped and shared with the Editorial team.
# ISAP Contacts and Officers

**President:** Dr. Céline Rebours  
Møre forsking Ålesund AS  
Postboks 5075, Larsgården, 6021 Ålesund, NORWAY  
E-mail: celine.rebours@moreforsk.no  
http://www.moreforsk.no/

**Vice President (Outgoing President):** Prof. Roberto De Philippis  
Department of Agrifood Production and Environmental Sciences (DISPAA)  
Florence University, Piazzaledelle Cascine 24; I-50144 Firenze, ITALY  
Tel.: +39 0552755910  
E-mail: roberto.dephilippis@unifi.it  
http://www.dispaa.unifi.it/

**Vice President (President-elect):** Dr. Qiang Hu  
Professor  
Institute for Advanced Study  
Shenzhen University  
Shenzhen, Guangdong  
CHINA 518060  
Tel.: +86-138-1140-6745  
E-mail: huqiang@ihb.ac.cn

**Secretary/Treasurer:** Dr. Valéria Montalescot  
Senior Project Manager for Global SeaweedSTAR  
Scottish Association for Marine Science  
Oban, Argyll PA37 1QA, UK  
Tel.: +44 1631 559205  
E-mail: applied.phycologysoc@gmail.com

**Editor, ISAP Newsletter & Social media administrator:** Dr. Sasi Nayar  
Algal Production Group  
South Australian Research and Development Institute - Aquatic Sciences  
2 Hamra Avenue, West Beach, SA 5024, AUSTRALIA  
Tel.: +61 8 84290785  
Fax: +61 8 8207 5415  
E-mail: sasi.nayar@sa.gov.au  

This Newsletter and other information on ISAP can be retrieved from the ISAP website: http://www.appliedphycologysoc.org/