International Society for

Applied Phycology

NEWSLETTER

ISSN 2208-3146

ISSUE 2-2022 **December, 2022**

Message from the President

Dear ISAP Subscribers,

I am delighted to present to you the second issue of the ISAP Newsletter for year 2022. Once again, I would like to thank the Newsletter Working Group members i.e. Céline Rebours, Andrew Ward, Eugenia Olguin and Priya Pollard for their hard work in the publication of this issue.

To give you an update on the latest developments since the last issue of the ISAP Newsletter,

- ISAP financially supported a one-week training workshop on "Algal Ecology and Biotechnology" to be held between 21-25th November 2022 by the Institute of Botany, University of the Punjab, Qaid-i-Azam Camus, Lahore, Pakistan. Prof. Ghazala Yasmeen Butt and her team have successfully completed the training course.
- I am also pleased to inform that ISAP has recently signed a Memorandum of Understanding with the International Seaweed Association and Algae Biomass Organization to promote interactions between these entities and the dissemination of information on topics of common interest, and some other MoUs are currently being negotiated and once these are signed, we will share the good news in due course.
- The ISAP Executive Committee is in the midst of developing a directory on the webpage and we hope to get it up and running soon.

I sincerely appreciate it if all subscribers can ensure that they are up to date with subscribership payments given that your support goes a long way in enabling the activities of the society. Subscriber fees support the maintenance of the website, funding workshops and training programs in algal biotechnology as well as sponsoring student travel grants. Sponsorships and donations are most welcomed to support the participation of young scientists in the triennial congress and more importantly ISAP's cause to promote research, education, and the dissemination of knowledge about algae, applied algal research and the utilization of algae. For further details, please consult our webpage or contact our ISAP Assistant President Sze Wan Poong.

Please take the time to read and enjoy this newsletter and share it with your colleagues and friends. Your contribution to this Newsletter is most welcome, thus please do not hesitate to send in your ideas, feedback on ISAP, news and announcements of interest for ISAP subscribers. We would also be delighted to receive articles of various types for our upcoming issues of the newsletter. Kindly contact either the Editor-in-chief of the Newsletter Céline Rebours, myself or the ISAP Assistant President Sze-Wan Poong whose contact details can be found at the end of the newsletter. We look forward to hearing from you.

Warmest regards,
Qiang Hu, Ph.D.

President, International Society for Applied Phycology

Message from the Editor

Dear Colleagues,

We are pleased to present the second issue of the ISAP Newsletter in 2022! In this issue, we have two main articles, four short articles, and views and announcements including the announcement for the 8th ISAP congress in Portugal!

I would like to warmly thank the authors for the preparation and submission of very interesting manuscripts. I would also like to acknowledge our communication manager, Priya Pollard, and the editorial review team for their kind assistance in the preparation of this second 2022 ISAP Newsletter.

The first article by Daneshvar and Bhatnagar highlights the potential of using microalgae biomass in aquafeed. The second article by Menaka and Wijesekara evaluated the sensory characteristics and content to use "Ceylon Moss" *Gracilaria verrucosa* as a source of jellies in food application.

Then the first short article is an epitaph to honor the life work of Prof. Mario Tredici. The two last are short reports on two workshops: the ISAP training workshop conducted in 2021, and the workshop on WebApps Applications to manage Harmful Algal Bloom.

We hope you will enjoy reading this issue of the newsletter!

As always, please do not hesitate to contact one of us from the editorial team, if you have any ideas of contributing an article in the next issue of the newsletter. **The deadline for submission is March 30th, 2023**. You will find the guidelines at the end of the newsletter.

On behalf of the 2022-2024 Editing committee, I wish all the ISAP subscribers, a safe, healthy, and prosperous new year!

Warm regards,

Céline Rebours,
ISAP Vice President and Editor of the ISAP Newsletter

Microalgae as a promising alternative for fish meal in aquafeed

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Abstract

For the sustainable growth of modern aquaculture, there is a need to find more sustainable ingredients to replace fish meal (first generation) and current plant derived components (second generation) used in fish feed. In this regard, use of microalgae as the third generation of fish feed ingredients has gained remarkable attention in aquaculture industries. Recently, different microalgal-based products such as dried whole cells, defatted (after lipid extraction) cells, pigments, and fatty acids have been applied as salmon feed ingredients. Applications of microalgal-based products as potential replacement of fishmeal, as source of color and essential fatty acids are discussed in the following sections.

Microalgal application in aquafeed production

Microalgae with a great diversity of shape, size, characteristics, and ecological functions are found in fresh and marine aquatic ecosystems (Menegazzo and Fonseca, 2019) and other environments such as soil. These unicellular photosynthetic microorganisms are able to synthesize organic molecules in the presence of light by consuming dissolved nutrients and carbon dioxide. As compared with the other microorganisms and terrestrial plants, microalgae possess several advantages such as higher growth rates, excellent environmental adaptability, and no competition with food and fertile lands (Ho et al., 2018). The captured carbon by microalgae is utilized for the biosynthesis of value-added compounds, such as protein, lipid, carbohydrate, cellulose and pigments for the cell structure and functions (Subhash et al., 2017). The yield of these major compounds in microalgal biomasses can be different depending on the microalgal species, cultivation conditions, and chemical composition of cultivation medium. Because of these valuable compounds, socio-economic importance of microalgal biomasses have gained wide attention in different sectors (Kim et al., 2016). Both freshwater and marine water microalgae can be utilized as substrates and precursors of human food, animal and aquafeed, pharmaceuticals and biofuels (Menegazzo and Fonseca, 2019). Cultivation of microalgae in aquaculture hatcheries of finfish and shellfish as aquafeed has been practiced for over a century. In 1910, Allen and Nelson published the first report entitled ‘On the artificial culture of marine plankton organisms’ where they discussed the application of microalgae as feed in aquaculture (Allen and Nelson, 1910). In traditional extensive aquaculture, microalgae are bloomed in cultivation tanks or ponds. Although, in the hatcheries of advanced intensive aquaculture, usually single species microalgae monocultures in designed photobioreactor are produced to be used for feed for the farmed species (Posten and Walter, 2012). Overall, utilizing of microalgae as the base of the aquatic food chain for aquafeed production is a sustainable approach in modern aquaculture, which creates a more efficient, eco-friendly, and profitable bioeconomy. Whole microalgae cells or their extracted products are used in aquaculture for the feeding of various farm raised species. Different applications of microalgae as aquafeed are discussed here.

Whole microalgal-cell

Microalgal biomass containing bioactive compounds and essential nutrients such as high-quality protein, polyunsaturated fatty acids, polysaccharides, minerals, vitamins, and pigments are promising ingredients of aquafeed (Kiron et al., 2016). Recently, Norwegian researchers have investigated the feasibility of

whole microalgal cells as fish meal replacement in the diet of Atlantic salmon (*Salmo salar* L.) (Gong et al., 2019; Sørensen et al., 2016; Gong et al., 2020; Tibbetts et al., 2017). In a study by Sørensen et al., (2016), 3% and 6% of fish meal in Atlantic salmon diet was replaced with dried whole cells of *Phaeodactylum tricornutum*, a marine diatom. The authors reported the effect of formulated feeds with microalga on digestibility of nutrients and growth performance for 82 days. The results revealed that microalgal biomass of P. *tricornutum* had no negative effect on digestibility of lipid, protein (nitrogen), energy, and dry matter. In this study, whole body lipid increased by increasing the microalga inclusion from 3% to 6%. Overall, the results showed that biomass of P. *tricornutum* can be replaced with fish meal up to 6% without reverse effects on feed utilization and digestibility.

In another study, Tibbetts et al., (2017) investigated the feeding of juvenile of Atlantic salmon with Chlorella vulgaris. For this purpose, they replaced 6%, 12%, 18%, 24%, and 30% of the basal diet with whole-cells and ruptured-cells microalgal biomasses. Chemical composition analysis of prepared fish feed showed that the diets with higher microalga percentage had higher dietary carbohydrate levels and lower dietary crude protein levels. The authors stated that the values of carbohydrate, digestible protein (DP), digestible energy (DE), and DP/DE ratio of all prepared diets met or exceeded the minimum recommended ranges set by National Research Council (2011). They observed that whole cells and ruptured cells of *C. vulgaris* had different effects on the apparent digestibility of juvenile diets. Digestibility of dry matter, protein, lipid, and energy in whole-cell microalga meals reduced even at low inclusion levels of 6–12%. In case of meal with cell-ruptured, it did not affect the digestibility of dry matter, protein, lipid, and energy up to 30%, 24%, 18% and 12%, respectively. In addition, different percentages of cell-ruptured inclusion increased starch digestibility and consequently improved the carbohydrate digestibility, while whole-cell *C. vulgaris* inclusion did not affect the starch digestibility at any percentages studied.

The effect of addition of microalgal biomass to salmon diet with low content of fish meal on physical properties of pellets has been reported by Gong et al. (2019). They added *Scenedesmus* sp. (10% and 20%) to fish feed (containing 2.5% and 5% fish meal) to study the application of microalgal biomass as a potential ingredient. The other ingredients of diets were plant protein sources, such as soy protein concentrate, pea protein concentrate, and potato concentrate. They stated that the surface of diet with 20% microalga was oilier, but fat leakage was lowest in this diet. Also, they measured the hardness of prepared feeds and found that diet with 20% microalga was the hardest one. In this study, the pellets with the higher concentration of microalgae had shorter length. Functional components such as starch and non-starch polysaccharides and carbohydrate fractions could affect the hardness of pellets with different microalga content. According to the findings of this study, the stability times of synthesized pellets with 0, 10% and 20% microalga in water were observed as 15 min, 45 min, and 60 min, respectively. By investigating the effect of microalga ingredients on growth rate, feed conversion ratio, weight gain, and nutrient retention in Atlantic salmon after 65 days, authors concluded that *Scenedesmus* sp. can be applied at inclusion levels with >10% incorporated in low fishmeal diets for salmon feeds.

Defatted microalgal-cell

Defatted microalgal biomass is a protein-rich source that can be used as animal feed and aquafeed. In 2016, Kiron et al. (2016) decreased the amount of fish meal in salmon feed from 69% (in control group) to 60% and 51% by the addition of 10% and 20% of defatted microalga (*Desmodesmus* sp.) meal, respectively. Fish in microalga-fed and control groups did not show significant differences of growth factors and survival rate. In addition, it was observed that the chemical composition of whole fish-body (lipid, protein, and ash), protein and lipid digestibility, and physiological status of fish were not significantly different between control and microalga feed groups. The authors concluded that defatted biomass of *Desmodesmus* sp. can be replaced with fish meal up to 20% in the feed of Atlantic salmon.

In another study, Sorensen et al. (2017) used 10% and 20% defatted microalgal biomass of *Nannochloropsis oceania* as alternative of fishmeal in salmon feed. They reported that the chemical

composition of whole body and fillet of fish fed on microalga-free and microalga inclusion diets were not significantly different. The researchers evaluated the effect of microalga containing feed on intestinal health condition of fish through molecular observations. The findings of this study showed that intestinal proteins in fish fed with 20% defatted microalga changed, which can cause systemic physiological disturbances. Accordingly, they recommended replacement of fishmeal with defatted biomass of *N. oceania* in salmon feed not more that 10%.

Microalgae as source of bioactive compounds

Fish feed with low content of eicosapentaenoic acid (EPA, C20:5n-3) and docosahexaenoic acid (C22:6n-3, DHA) is a concern in salmon industry. There is a meaningful correlation between the amount of EPA and DHA fatty acids in diet and their disposal in fish flesh. Data mining shows that since 2006, the amount of fatty acids such as linoleic acid (18:2n-6), γ-linolenic acid (18:3n-6), and oleic acid (C18:1n-9) increased in salmon flesh, but the values of EPA and DHA have decreased. This has raised the concerns around the nutritional benefits of salmon (Gong et al., 2019; Sørensen et al., 2016). Therefore, it is necessary to replace conventional fish meal and fish oil in salmon feed with new resources with high EPA and DHA contents and competitive price. Microalgae as primary producers of EPA and DHA in food chain have attracted attention as sustainable replacement of fish oil in salmon feed.

Sprague et al. (2015) evaluated the replacement of fish oil with DHA-rich microalgal meal derived from *Schizochytrium* sp. They fed Atlantic salmon post-smolts with two types of feeds containing commercial fish oil originated from northern and southern hemisphere (NFO and SFO) and two algal meal (AM) inclusion levels of 5.5% and 11% (11AM and 5.5AM). They measured fatty acids compositions and persistent organic pollutant levels of dietary and salmon flesh fed with four abovementioned diets. Microalgal inclusion diets showed 5.3% and 8.1% of DHA in 11AM and 5.5AM feeds, respectively and low concentration of 1% and 2% of EPA in these diets. NFO and NSO diets contained higher concentrations of DHA (10.2% and 12.3%) and EPA (8% and 8.4%) as compared to algal meals. Accordingly, they found that fish fed on microalgal-based diets, 11AM and 5.5AM, had lower DHA of 8.9% and 7.4% in fillet as compared with fish fed with fish oil-based diets, SFO and NFO, with 10.4% and 11.7% DHA, respectively. Additionally, the concentrations of dietary persistent organic pollutant in commercial fish oil diets were found higher than algal meal in the following order of NFO > SFO > 5.5AM/11AM. Therefore, applications of SFO and NFO is questionable due to contaminations with persistent organic pollutants. They recommended that to increase the percentage of DHA in salmon fillet fed with algal meal, it is necessary to increase the amount of *Schizochytrium* sp biomass higher than 11%.

Global Organization for EPA and DHA Omega-3 (GOED) has expressed that everybody needs to take average dose of 1.75 g DHA per week to get the nutritional benefits of this long chain poly unsaturated fatty acids (LC-PUFA). This amount of DHA can be supplied weekly by eating approximately 125 g of salmon (Kousoulaki et al., 2015). Kousoulaki et al. (2015) added *Schizochytrium* sp. in fish feed to produce n-3-rich Atlantic salmon (*Salmo salar*). For this purpose, they replaced fish oil in salmon feed with different levels of 0% (control), 1%, 6%, and 15% *Scizochytrium* sp. + yeast extract (ScYE). They found that 129 g fish fillet of salmon fed on 0% ScYE diet or 114 g fish fillet of salmon fed on 6% ScYE diet or 136 g fish fillet of salmon fed on 15% ScYE diet can provide 1.75 g DHA per week.

Microalgae as source of color

Natural color of salmon fillet differs from almost white to light orange depending on the feeding diets. Natural pinkish-orange color of salmon flesh has a direct effect on salmon trade as food appearance affect costumer's choice, acceptability, and pleasantness (Zadorozhny et al., 2009). Carotenoids are the most widely distributed class of pigments in nature, which are well known as the main cause of natural color in salmon flesh, ore, and skin. Animals cannot synthesize carotenoids and chemically synthesized carotenoids, mainly astaxanthin and in some cases of canthaxanthin, are commonly added to salmon feed to improve the appearance and quality of fish fillet. In this regard, natural resources of astaxanthin such

as microalgae, crustacea, and their extracts have attracted a remarkable attention to be used for pigmentation in salmon industry. Chlorophyceae are a class of green microalgae that possess astaxanthin as their principal carotenoids. *Haematococcus* with high concentration of astaxanthin in range of 0.2% to 2% is considered as a potential candidate in salmon aquaculture (Johnson and An, 1991). *Dunaliella salina* is another promising source of carotenoids in aquaculture (Zadorozhny et al., 2009). Borowitzka (2013) stated that β-Carotene was the first high-value product derived from a microalga species (*Dunaliella salina*). He reviewed the development and commercialization of potential high-value products from microalgae and emphasized on the marketing value of microalgal pigments such as carotenoids and phycobilins. Additionally, he expressed that microalgae are unique sources of some piments such as allophycocyanin phycocyanin, and phycoerythrin (Borowitzka 2013).

Conclusions

Fishmeal and plant-based ingredients in fish feed, can be replaced by microalgae, but their effects on feed quality, fish health and growth, feed utilization, and nutrient digestibility need to be studied in detail. In addition to whole cell, residual of microalgal biomass after lipid extraction can also be utilized as fish feed ingredients. Microalgal lipids are another valuable derivative that can be used as a valuable replacement of fish oil for enrichment of fish fillet with LC-PUFA. Moreover, microalgae can be used as a natural source of pigments to be replaced with chemically synthesized carotenoids in fish feed.

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Agar from Sri Lankan *Gracilaria verrucosa* and development of food jellies

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Abstract

Sri Lanka has a rich source of underutilized edible red seaweeds. In the present study, agar was extracted from "Ceylon Moss" *Gracilaria verrucosa* and food jellies were developed without the use of gelatin. Agar was added in three different levels such as 4, 8, and 12 g with water and sugar and the control jellies were made out of commercially available gelatin instead of agar. The sensory evaluation results revealed that the best jellies are those added with 12 g agar. The proximate composition analysis including moisture, total lipid, total carbohydrate, total ash, and crude fibre content of the 12 g of agar added jellies were 80.09±0.28%, 0.33±0.03%, 8.54±0.48%, 1.03±0.01%, and 1.00±0.06%, in dry weight respectively. In summary, the "Ceylon Moss" can be utilized to extract agar for the confectionery food industry and the agar-added jellies can be promoted as gelatin-free jellies for the vegans and consumers preferring gelatin-free products.

Introduction

Seaweeds, also known as macroalgae, are among of the prominent primary producers of the sea. Seaweeds generally contain a high content of water, carbohydrates (25-50%), proteins (7-15%), and lipids (1-5%) (Sudhakar et al., 2018). Agar has been commercially extracted from *Gracilaria* sp. and *Gelidium* sp. throughout the world. Between them, *Gracilaria* sp. is the ideal seaweed for manufacturing of food-grade agar, while *Gelidium* is used to make bacteriological and pharmaceutical-grade agar and agarose (Bixler and Porse, 2011). The properties of agar may vary according to various factors such as species and environmental characteristics of the collection or cultivation area (season, life cycle and environmental features, storage, extraction processes, and postharvest storage). On the other hand, agar quality depends on the type, pattern, degree of substitution, molecular weight, chemical composition, and physical properties (Torres et al., 2019). In the present, study, agar was extracted from "Ceylon Moss" *Gracilaria verrucosa* and gelatin-free food jellies were developed.

Methodology

In this study, *Gracilaria verrucosa* was manually collected from Trincomalee beach, Sri Lanka. Prior to being washed carefully and dried at 60 °C in a dehydrator (Figure 1). It was then powdered using a food grinder and sieved through the 355-micron sieve mesh. Finally, the dried seaweed powder was packed in air-tight containers and used for further analysis and processing.

Figure 1: Dried *Gracilaria verrucosa*

Initially, agar was extracted from 10 g of dried seaweed powder sample with 600 mL of distilled water in a hot water bath at 90 °C for 1 hour. Then the solution was filtered into a few large dry petri dishes using a muslin cloth. The filtrate was kept at room temperature until the jellification, and after kept in a dehydrator at 55 °C for 8 hours. The dried agar sample was ground using a food blender.

The agar-based food jellies were developed by incorporating agar extracted from *Gracilaria verrucosa*. The jelly formulation was developed after conducting preliminary trials. Four, eight and twelve grams of agar powder was added with water (250 mL) and sugar (25 g) (the weight of water and sugar for each sample were the same) to produce the jellies. The control sample was prepared using commercially available gelatin powder according to the selected sample from the sensory evaluation. The developed jellies are presented in Figure 2.

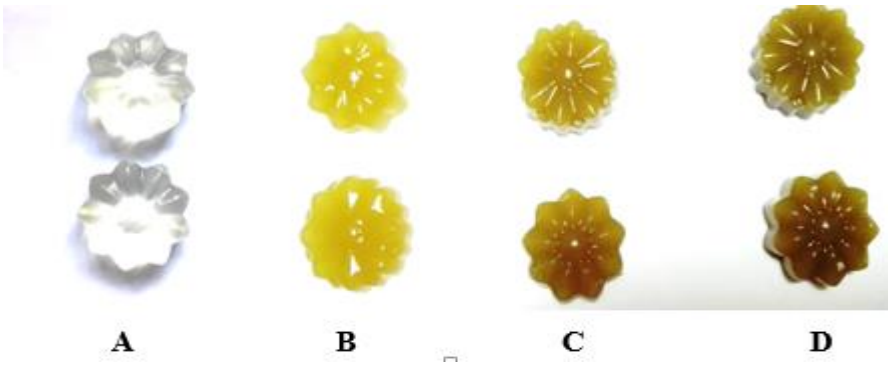

Figure 2: Food jellies. A - Control (Gelatin added jelly), B - 4 g agar added jelly, C - 8 g agar added jelly, D - 12 g agar added jelly

Sensory evaluation of the agar jellies was carried out by a panel of 30 semi-trained panelists with 5 points hedonic scale. Each panelist was given three coded samples with a ballot sheet and was asked to provide points according to their preferences. The arrangement of samples for sensory evaluation is presented in Figure 3. Finally, the highest-ranked agar added sample selected from the sensory analysis was used to compare the proximate composition with the gelatin-based control jellies.

Figure 3: Arrangement of jellies for sensory evaluation (101 - 4 g agar added jellies, 201 - 8 g agar added jelly, 301 - 12 g agar added jelly)

The moisture, total ash and crude fibre contents were determined according to the AOAC (Association of Official Analytical Chemists) 925.10, 923.03 and 962.09 methods. Total lipid and carbohydrate contents were determined according to the previously published method by Sánchez-Machado et al. (2004) and Dubois et al. (1951), respectively. Results were expressed on a dry weight basis and performed in triplicates. The data were analyzed by MINITAB 17 package. The 2-sample t-test and Friedman non-parametric analysis were performed at a 95% confidence interval for the parametric data analysis and the sensory evaluation test, respectively.

Results

According to the sensory evaluation for taste, texture and overall acceptability, 12 g agar-added jellies were ranked the highest average value on 5 points hedonic scale. The web diagram of sensory evaluation is presented in Figure 4. Hence, 12 g agar-added jellies were selected as the best experimental sample among the three samples and the proximate composition were compared with gelatin-added jellies. Results are presented in Table 1. Agar-added jellies displayed higher moisture, total lipid and crude fibre content but lower total carbohydrate and total ash content compared to gelatin (control) added jellies. There was a significant difference in all parameters at 5% significance level between the two products.

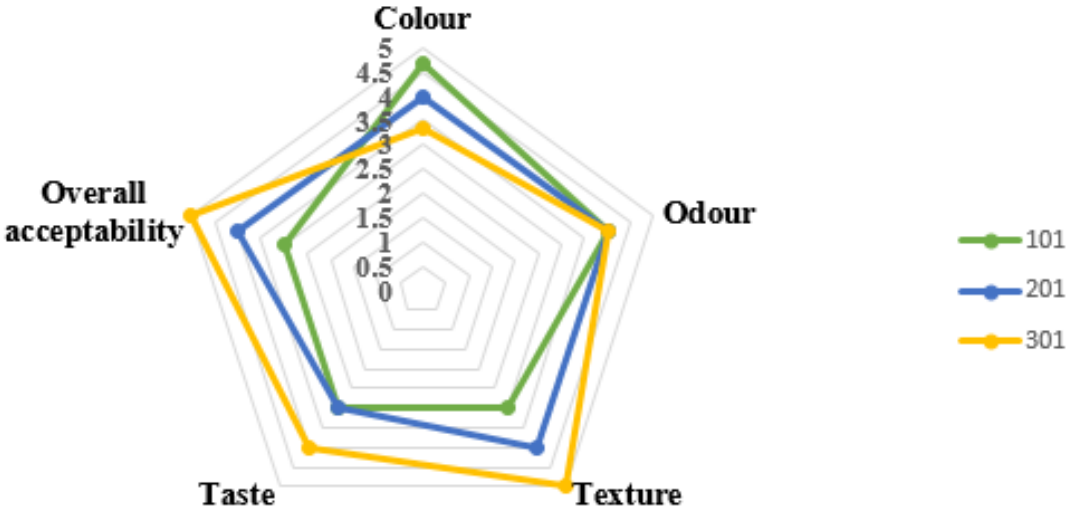

Figure 4: Web diagram of the average rank for the three jelly samples with respect to sensory parameters (101 - 4 g agar added jellies, 201 - 8 g agar added jelly, 301 - 12 g agar added jelly)

Table1: Proximate composition of jellies

Values are in means ± standard deviation, considering n = 3. Different superscripts within the same row indicate significant differences ($p < 0.05$)

Parameter	Control jelly sample (Gelatin added jelly)	Best jelly sample (Agar added jelly)
Moisture (%)	77.69 ± 0.56^{b}	80.09 ± 0.28a
Total lipid (%)	0.16 ± 0.02^{b}	0.33 ± 0.03^{a}
Total carbohydrate (%)	12.42 ± 0.40^{a}	8.54 ± 0.48^{b}
Total ash (%)	2.16 ± 0.11^{a}	1.03 ± 0.01^{b}
Crude fibre (%)	0.20 ± 0.03^{b}	1.00 ± 0.06^{a}

Conclusions and recommendations

"Ceylon Moss" *Gracilaria verrucosa* is a good source of agar and can be used to develop food jellies in place of gelatin. Further studies are in progress to develop other confectionery products such as jujubes, jelly bears, and marshmallows from *G. verrucosa* agar.

Acknowledgements

This research was supported by a grant (ASP/01/RE/SCI/2021/30) from the Research Council, University of Sri Jayewardenepura, Sri Lanka.

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In Memory of Professor Mario Roberto Tredici (1951-2022)

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Biography and main scientific and professional achievements.

Mario R. Tredici (Figure 1) was born in General Roca (Argentina) on 1951.04.22 and passed away in Pistoia (Italy) on 2022.06.17.

Figure 1. Portrait of Professor Mario Roberto Tredici

Mario Tredici graduated in Agricultural Sciences at the University of Florence in 1979 and started his research activity at the University of Florence and then (1985), as a Researcher, at the Research Center of Autotrophic Microorganisms of the Italian National Research Council (CSMA – CNR), which was founded in 1956 by Prof Gino Florenzano with the aim of studying the physiology and the possible exploitation of photosynthetic microorganisms (microalgae, cyanobacteria and photosynthetic bacteria). In the following years, Mario Tredici became first Associate Professor (1992) and then Full Professor (2001) at the University of Florence, where he held courses on Agricultural Microbiology and Microbial Biotechnology for many years, until his retirement in November 2021.

Since the first years, he carried out an intense scientific activity focused in particular on the study of the physiology and biotechnology of microalgae and cyanobacteria for their possible exploitation, in particular dedicating his research to the development of new photobioreactor designs, to the effects of light distribution on the culture system to maximize photosynthetic efficiency and to the massive culture of photosynthetic microorganisms for the production of biomass and molecules of industrial interest, for aquaculture, food supplements, nutraceuticals, biostimulants and bio-fuels. He has published over 140 publications in journals, book chapters and conference proceedings (88 listed in Scopus at https://www.scopus.com/authid/detail.uri?authorId=6603947633), filed 11 patents and participated in a large number of international and national scientific conferences, frequently presenting keynote and invited lectures. In 2019 and 2020 he has been included among the world 2% top scientists according to the PLoS Biology ranking.

The most important scientific achievements obtained by Mario Tredici in his studies concern microalgae mass culture. In particular, conversion of solar energy into microalgal biomass in systems suitable for constituting the basic module of industrial plants, aiming at reaching high photosynthetic efficiency and productivity with high land use efficiency. Among the topics covered were the distribution of light impinging on the photobioreactor and its optimization, the optimization of photobioreactor arrangement in the plant, the evaluation of energy and economic sustainability of microalgae production, including integration of photovoltaic within the photobioreactor, the use of artificial light for high value products, and the effects of different light spectra on microalgal performance.

Photobioreactor design and testing was the other main research interest of Mario Tredici (Figure 2). Among the reactors developed were the Vertical Alveolar Panel (VAP), the Near Horizontal Tubular Reactor (NHTR), the Annular Column (AC), the Green Wall Panel (GWP, Figure 2), the Bright Box and (in collaboration) the raceway pond with reduced water head. Some of these reactors have been deployed and are in use at several Universities and Research Centres as well as companies around the world. The above-mentioned reactors were tested with several microalgae over the years, the most studied of which were *Arthrospira*, *Nannochloropsis*, *Tetraselmis*, *Phaeodactylum*, *Chlorella* and *Nostoc*.

Figure 2. Prof Mario Tredici at the experimental area in Florence behind a Green Wall Panel photobioreactor.

In 2004, he co-founded Fotosintetica & Microbiologica S.r.l., a spin-off company of the University of Florence with the aim of transferring know-how and technology (http://femonline.it/). Mario Tredici has also been scientific advisor for several companies and institutions, among which Antenna Technologies, the Hawaii Natural Energy Institute, the International Energy Agency, Eni SpA (Italy), AlgaeFuels Biotechnology (Chile), Roquette Frères (France), Aurora Algae (USA) and SABIC (Saudi Arabia). He has been member of the Scientific/Technical Advisory Panel of the Algae Biofuels Challenge (Carbon Trust - UK), the International Network on Biofixation of CO_2 and Greenhouse Gas Abatement with Microalgae and of ESFRI (European Strategy Forum on Research Infrastructures), and chair of the ESBF (European Sustainable Biofuel Forum).

He was PI/scientific coordinator in several European projects (among which Aquafuels, BIOFAT, GIAVAP, Nomorfilm, Photofuel), and was also engaged in many dissemination activities, actively operating for a fruitful collaboration between the academic and business world, significantly contributing to the development of the microalgae sector in Europe and worldwide.

In 2009, he co-founded and chaired for the first five years the European Algae Biomass Association (EABA; https://www.eaba-association.org/en) and, at national level, in 2018 he co-founded the Italian Association for the Study and Applications of Microalgae (AISAM; https://www.aisam-microalghe.it/), of which he was president for the first three years.

Mario Tredici and his contribution to ISAP

In April 1996, during the 7th International Conference on Applied Algology (ICAA) held in Knysna, South Africa, the majority of the delegates attending the Conference pointed out the need for an international organization specifically devoted to the promotion of algal biotechnology. Consequently, it was decided to ask Prof Amos Richmond, of the Microalgal Biotechnology Laboratory at Sde Boker, Israel, and an *ad interim* Committee to prepare a draft of Bylaws for this new organization to be discussed and approved at the 8th ICAA, planned for 1999 in Montecatini Terme, Italy. At the 8th ICAA (Figure 3), organized by the Florentine phycology research group, the General Assembly of the participants, held on 29 September 1999 and chaired by Prof. Amos Richmond (Figure 4), approved the establishment of the International Society for Applied Phycology (ISAP), and the bylaws prepared by the *ad interim* Committee chaired by Prof. Amos Richmond were accepted as the provisional bylaws for the new Society. As a first step of ISAP, it was designated the first Executive Committee (EC) composed by 19 members, including Mario Tredici and some of the other most active proposers of the new Society (Table 1).

Table 1. ISAP Office bearers and EC for the triennium 1999-2002

President: Johan Grobbelaar
Vice-president: Mario R. Tredici
Secretary/Treasurer: Roberto De Philippis

The Executive Committee was composed by the following members:
Executive Committee of the ISAP

Amha Belay, USA
Ami Ben-Amotz, Israel
Michael A. Borowitzka, Australia
Sammy Boussiba, Israel
Alan T. Critchley, France
Hiroaki Iwamoto, Japan
Yuan Kun Lee, Singapore
Ralph A. Lewin, USA
Yong-ding Liu, China
Sigetou Miyachi, Japan
Emilio Molina Grima, Spain
Arnaud Muller-Feuga, France
Luuc R. Mur, The Netherlands
Otto Pulz, Germany
Amos Richmond, Israel
Phang Siew Moi, Malaysia
Olav M. Skulberg, Norway
Avigad Vonshak, Israel
Brian A. Whitton, United Kingdom

On 30th September 1999, according to the bylaws, the EC met for the nomination of the President and the President elect for the triennium 1999-2002. Prof Johan U. Grobbelaar (South Africa) and Prof Mario Tredici (Italy) were elected as President and President-elect, respectively. Prof. Roberto De Philippis (Italy) was designated Treasurer/Secretary by the President.

Figure 3. Prof Mario Tredici among the participants to the 8th ICAA.

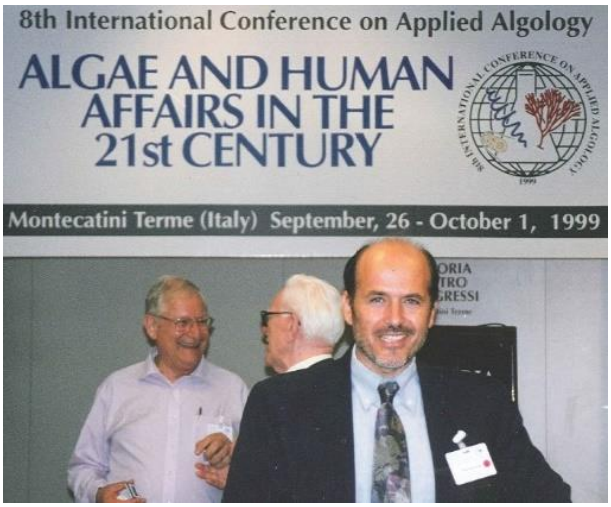

Figure 4. Prof Mario Tredici at the 8th ICAA, during the assembly for the foundation of ISAP. At his shoulders, two of the other co-founders, Prof Amos Richmond (on the left) and Prof Riccardo Materassi (in the middle).

Since the beginning, Mario Tredici was very active in promoting ISAP. In particular during the triennium of his Presidency (2002-2004), which started at the 1st Congress of ISAP held in Almeria (Spain) on 26th-30th May 2002 (Figure 5), many activities were carried out to favor the diffusion and the consolidation of the ISAP worldwide.

Figure 5: Prof Mario Tredici at the 1st ISAP Congress, Almeria 2002, during his talk as incoming President of ISAP. Close to him, Prof Amos Richmond (in the middle), and the outcoming ISAP President, Prof Johan U. Grobbelaar (on the left).

During the General Assembly of the 2nd ISAP Congress, held in Kunming, China, in 2005, Mario Tredici presented the most important results obtained during his Presidency:

- **Membership:** the Society reached a number of 170 full members, 31 student members and one Corporate member. The ISAP Members represented more than 50 Countries all over the World.
- **Web Site:** it was created the Web site of the Society, which was regularly updated with information about the Society life and events, and where the forms for applying to become Member were available.
- **Awards 2005:** ISAP honoured three senior scientists who have distinguished themselves in the applied phycology field. The Awards "Distinguished Applied Phycologist" were given to Prof Claude Gudin (France), Prof Ivan Setlik (Czech Republic) and Prof Carl J Soeder (Germany). The awards were given during the Gala dinner of the Congress.
- **Constitution:** Prof Mario Tredici proposed some amendments to the bylaws for a more efficient functioning of the Society. The amendments were approved by the General Assembly of ISAP Members.
- **Finances:** the triennium of Presidency ended with a positive bank balance.
- **Support to Training Courses and Congresses:** during the triennium ISAP sponsored two training courses (in 2003 the Course "Biotecnologia, Cultivo y Aprovechamiento Integral de las Microalgas", held in Trelew, Argentina; in 2004 the Course "Curso Regional de Postgrado en Biotecnología de Microalgas", held in Puntarenas, Costa Rica) and one Regional Congress (in 2004 the 1st Latin American Congress on Algal Biotechnology, held in Buenos Aires, Argentina).

In 2014, during the 5th Congress of ISAP held in Sydney, Australia, the ISAP honored Prof Mario Tredici with the "Distinguished Applied Phycologist" award (Figure 6) in recognition of his outstanding contribution to the field of applied phycology and of his contribution to the development of the Society.

Figure 6: Dr Susan Blackburn, President of ISAP, during the "Distinguished Applied Phycologist" award ceremony at the 5th ISAP Congress, Sydney, 2014. Prof Mario Tredici was unable to attend the Congress and the plaque of the award was given on his behalf to Prof Roberto De Philippis, incoming President of ISAP.

The authors wish to remember Mario, not only for his outstanding scientific contribution to this field, but also for his unusual and unforgettable energy and enthusiasm and his capability of attracting and transmitting his passion to all those who had the privilege of knowing him and working with him.

Reporting on the online ISAP Training Course "Revealing algae biotechnological potentials to contribute to sustainable blue growth in the Mediterranean", Tunisia, 28th September 2021

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Background

The aim of the online training was to present the state of the art of the algae industry and its potential developments. Particular emphasis was given, through the webinar, to applied aspects and potential biotechnological developments in the Mediterranean region according to its specific biodiversity and environmental conditions.

The course was designed for graduate or undergraduate students in marine science, technicians, engineers, professionals involved with algae, or any person interested in developing knowledge on algae biotechnology.

Organization

The course has been organized by B3Aqua Laboratory of INSTM (National Institute of Marine Sciences and Technologies) in association with ATIS (Association Tunisienne pour l'Information Scientifique) and supported by ISAP (International Society for Applied Phycology) through Global Seaweed STAR (GCRF-funded project) funding. It was coordinated by Leila Ktari from INSTM.

Program

The Webinar have been managed through the platform GoToMeeting that offers the possibility to follow the webinar equally from a computer or a smart phone. The online training duration was 6 hours that started at 9h30 (UTC+1) and ended at 16h30 (UTC+1) with 1-hour break for lunch.

The program included seven lectures given on:

- "Microalgae exploited species"
- "Active molecules from microalgae: structure and function"
- "Seaweed cultivation"
- "Seaweed uses in Pharmaceuticals, Nutraceuticals and Cosmetics"
- "Seaweed uses for Bioproducts and Bioenergy"
- "Seaweed uses for Phycocolloids production"
- "Seaweed associated bacteria and potential exploitation"

Additionally, two videos were prepared and broadcasted respectively in the mid- morning and afternoon sessions, on the themes of "Cultivation of spirulina in Tunisia from the lab to the marketing" and "Revealing Seaweed Potential for Tunisian Blue Economy".

Lecturers

Lecturers from INSTM, with strong background in the cultivation and biotechnological uses of algae presented the state of the art of algal industry and its potential developments.

- Ben Ouada Hatem
- Ben Said Rafik
- Chebil Ajjabi Leila
- El Bour Monia
- Ktari Leila
- Mensi Fethi

Registration and effective attendance

The webinar had a high demand and two hundred and twenty-four expression of interest have been registered from 38 countries (Figure 1): Algeria, Australia, Austria, Bangladesh, Brazil, Cabo Verde, Canada, Colombia, Denmark, Egypt, France, Germany, Greece, India, Indonesia, Ireland, Israel, Italy, Libya, Malaysia, Malta, Morocco, Oman, Pakistan, Philippines, Poland, South Africa, Spain, Sri Lanka, Tanzania, Trinidad, Tunisia, Turkey, United Arab Emirates, United Kingdom, United States and, Uruguay.

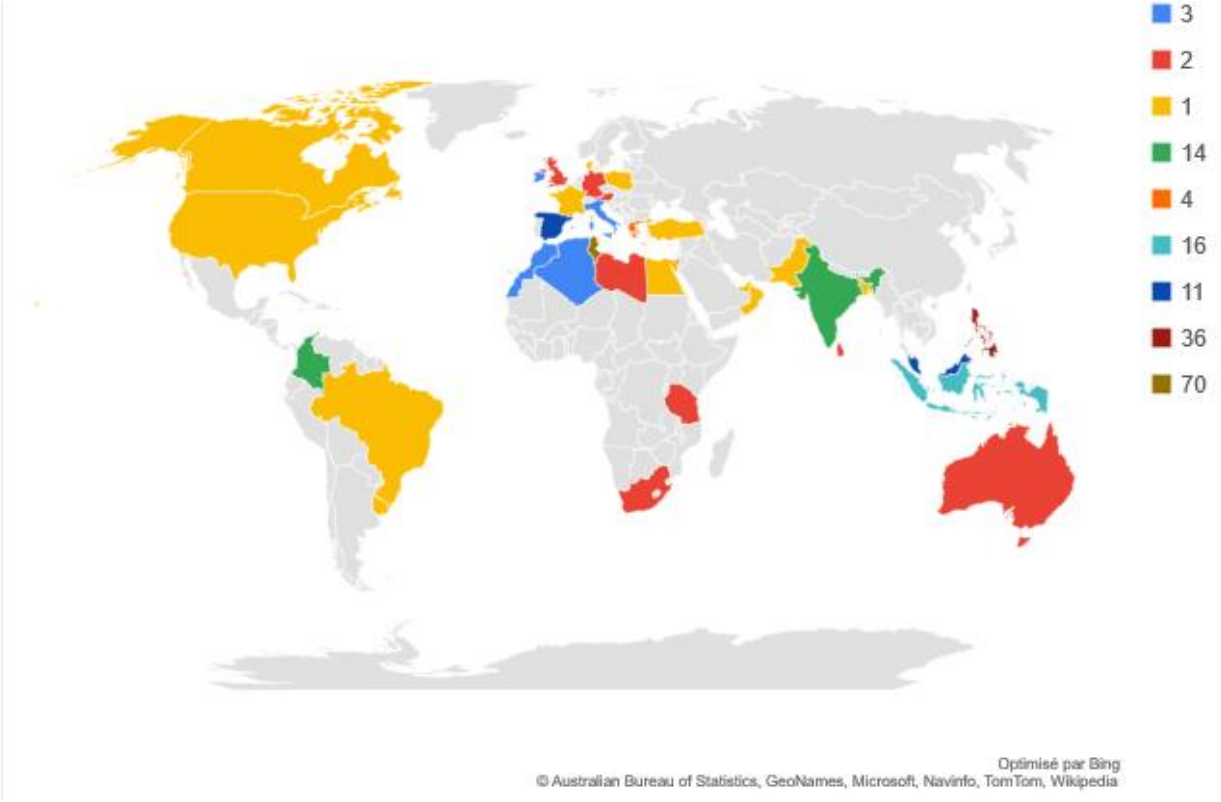

Figure 1: Geographic distribution of number of registrations per country.

A link to the online event has been sent to all registered people. However, several people did not receive the email in their inbox, but in the SPAM box, as reported afterwards.

Effective participation, based on the GoToMeeting report, resulted in at least 90 different attendees who connected and followed partially or completely the Webinar (78 in the morning session and 45 in the afternoon one: Figure 2).

Based on the evaluation form sent to the participants and replies (70 responses from which 15 declared they did not attend the webinar), most of the participant were from Philippine and Tunisia (Figure 3).

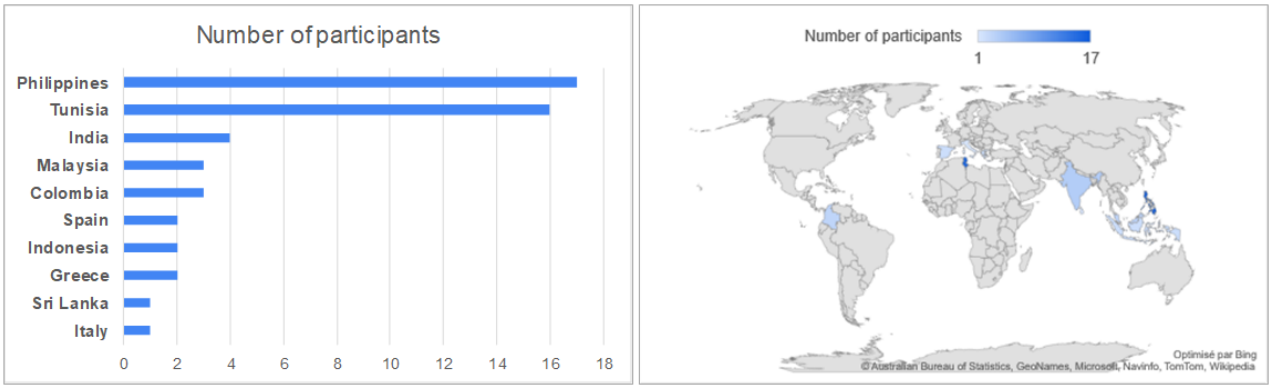

Figure 2: Number of participants according to evaluation form answers.

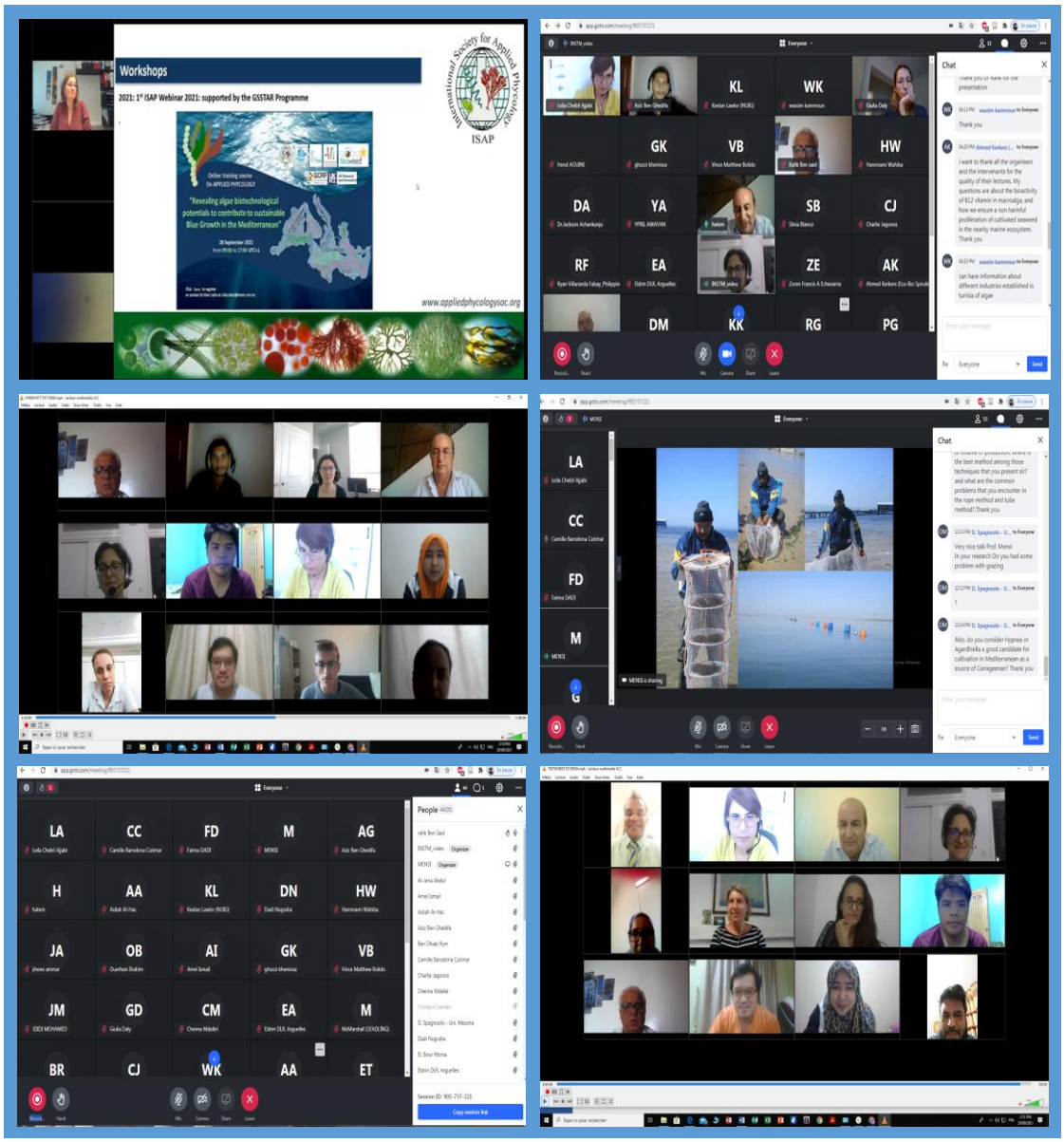

Figure 3: Screenshots of webinar progress and attendance.

Educational Workshop on the Introduction to ArcGIS for Harmful Algal Bloom (HAB) Data Management

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Introduction

Harmful Algal Blooms (HAB) are a yearly problem in Sabah and are caused by mainly 2 important species viz. *Pyrodinium bahamense* and *Margalefidinium polykrikoides*. Since the first reported HAB occurrence i.e. in 1976, the Department of Fisheries Sabah has conducted a monthly environmental monitoring program. However, data collected are not fully analyzed and shared efficiently with the respective shareholders and communities. Therefore, an educational workshop was conducted to train the Fisheries staff to manage and present data collected in a more efficient and informative way using ArcGIS. ArcGIS allows the development of a visual public information map, data can be presented faster and easier facilitating better community engagement and understanding. The workshop was held from 26th July to 28th July 2021 using an online virtual format due to COVID-19 restrictions. This informative event was attended by staff from the Department of Fisheries, Sabah, Fisheries Research Institute, Penang, and students from Department of Marine Science. A total of 17 participants attended the educational workshop.

Organization

The workshop has been organized by the Department of Marine Science, Kulliyyah of Science, International Islamic University Malaysia.

Figure 1 Participants during the workshop

Training workshop

This workshop included four sessions which were:

Table 1 Workshop Session

Session	Session Title	Contents of Session
1	Introduction to ArcGIS WebApps	Definition, functions and applications - Types of WebApps - Opening an Online ArcGIS account and Licensing - Database/Group Authorizations - Software and Requirements
2	Data Preparation	- Formatting and importing data - Red Tide field data arrangement and database authorizations - Secondary
3	Creating Basic WebApps Application	- Selections of WebApps functions - Red Tide and GIS data query form database
4	Publishing the WebApps	- Platform and link sharing - Updating new data into published WebApps

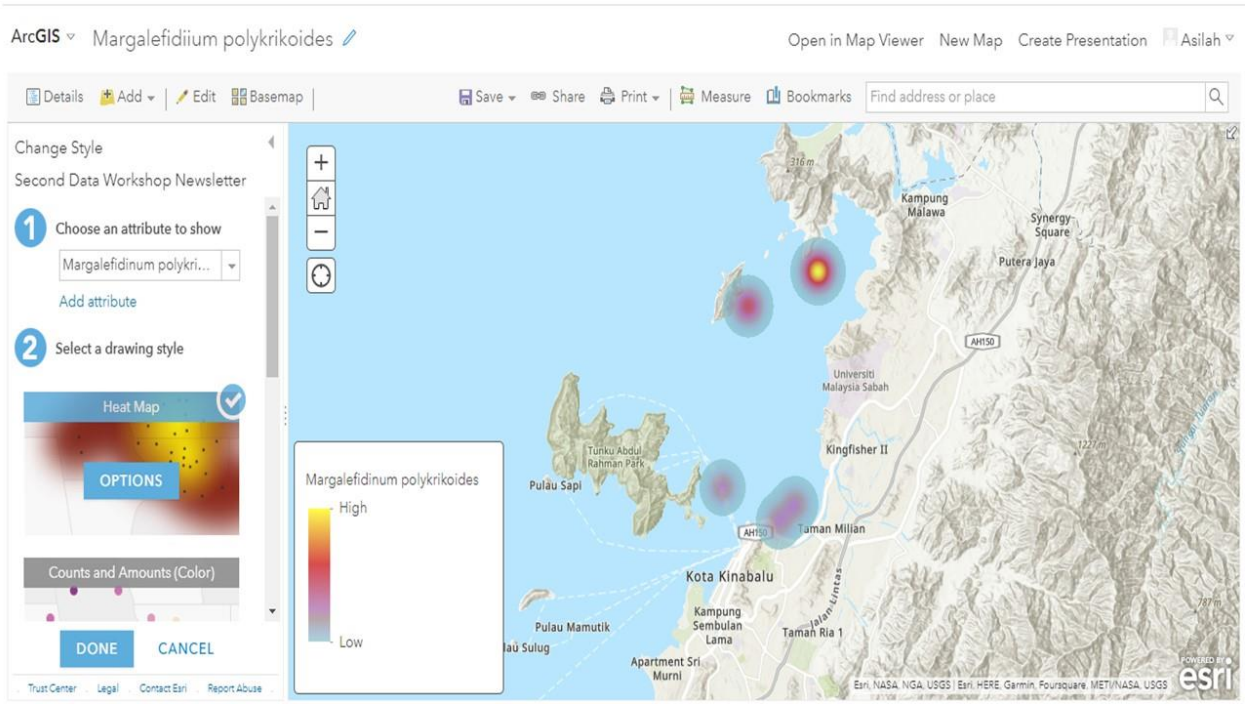

Figure 2 Example of ArcGIS viewer during the workshop

Participant Testimonials

"This was a new and interesting ways to manage HAB data. It definitely will help us to disseminate the HAB data faster than ever!"

"The informative map produced through ArcGIS provide an excellent approach in sharing data to the community"

"This was a simple yet an interesting and easy ways to manage data for the benefit of others. I recommend others to try using this software application."

Conclusions

At the end of the workshop, participants are able to develop WebApps using the data they have collected. This information can be shared through different social media such as Instagram (IG) and Facebook (FB). A formal discussion was also undertaken to develop the way forward for HAB research in Sabah. This also helped to identify mitigation strategies to minimize HAB impact to the fisheries and safeguard human health.

Acknowledgement

The educational workshop was carried out under the Memorandum of Understanding between the International Islamic University Malaysia (IIUM) and the Department of Fisheries Sabah (DOFS), Malaysia.

News and Views

ISAP is on different social media platforms!

To help grow our algae networking community we encourage to follow, like and subscribe of our various platforms. All platforms can be accessed via this Linktree https://linktr.ee/isap_phycology or scan the QR Code below.

The congress is being organised by

Faculdade de Ciências da Universidade do Porto
www.fc.up.pt

CIIMAR

www.ciimar.up.pt

Board Member - BlueBio Alliance

www.bluebioalliance.pt

More details will be posted on the ISAP webpage and all ISAP social media pages

ISAP advertised a funding opportunity for a training course on algae ecology and was held from 21-25th November 2022 in Pakistan. The training was organized by Prof. Dr. Ghazala Yasmeen Butt of the Institute of Botany, University of the Punjab, Qaid-i-Azam Camus, Lahore, Pakistan. This was done in collaboration with International Society for Applied Phycology as well as Pakistan Science Foundation, Higher Education Commission and Punjab Higher Education Commission. The workshop brochure and program can be found on our ISAP webpages.

Conferences and events

The 24th International Seaweed Symposium (ISS2023) | Hybrid
19th – 23rd February 2023, Hobart, Tasmania (Australia)

The International Seaweed Association (ISA) is an international organization dedicated to the encouragement of research and development of seaweed and seaweed products. Their mission is to promote applied phycology on a global basis, and to stimulate interactions among researchers, industrialists and government representatives in all relevant institutions, organizations and industries and in all countries. The 2023 Symposium is being hosted by the University of Tasmania's Institute for Marine and Antarctic Studies on behalf of ISA.

Further information: https://www.iss2023.net/

6th Edition of AquaFarm 2023 | In Person
15th – 16th February 2023, Pordenone (Italy)

International conference & trade show on aquaculture, algaculture and fishing industry. The event is dedicated to sustainable production of food from water. Two days dedicated to professional within the sector of aquaculture, shellfish farming, algaculture and sustainable fishing.

Further Information: https://www.aquafarm.show/en/

5th Algae World Europe | Hybrid
27th February – 01 March 2023, Rotterdam (The Netherlands)

Algae are a highly promising sustainable raw material for the biobased economy. Gaining popularity as a promising nutrient source, algae find many suitable applications in a wide range of markets from fish feed to meat substitutes or even biofuel. Also, the potential of algae as biomaterials in plastics and textiles industry and its role in carbon capture has seen many companies investing in algae as the nature-based solution.

Further information: https://www.cmtevents.com/aboutevent.aspx?ev=221034&

European Algae Industry Summit | In Person
19th – 20th April 2023, Lisbon (Portugal)

Algae Industry Summit (ACI) is pleased to announce the 11th Annual European Algae Industry Summit will take place on 19th & 20th April 2023 in Lisbon, Portugal. The event will once again bring together key companies within the algae industry including leaders from cosmetics, food, feed, nutraceuticals, pharmaceuticals & textiles businesses as well as key algae producers across the globe allowing attendees to gain a deeper understanding of recent industry developments and, most importantly, economically viable applications.

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

14th European Diatom Meeting | In person
9th – 11th May 2023, Meise (Belgium)

The meeting will be organized in collaboration with the University of Antwerp (Belgium), the Dutch-speaking diatom association NVKD and the French-speaking diatom association ADLaF. The conference website will be launched in the first of January opening also then the possibility for registration.

Further questions regarding the conference can be sent to EDM2023@botanicgardenmeise.be.

7th Edition Young Algaeneers Symposium (YAS) | In Person
23rd – 25th May 2023, Faro (Portugal)

The symposium organised by the European Algae Biomass Association (EABA) is organised by young scientists for young scientists.

Further information: https://www.eaba-association.org/en/events/1668650765

International Conference on Algal Biomass, Biofuels and Bioproducts (AlgalBBB) | In Person
11th -14th June 2023, Waikoloa Beach, Hawaii (United States of America)

AlgalBBB places a major emphasis on the latest unpublished technical and scientific results, along with discussion and direct interactions with broad spectrum scientists and engineers, funding sponsors, and leaders in the field from all over the world. The conference presents the work of the algae research community through a set of oral presentations and posters selected from the best submissions to the conference. Our list of keynote and invited speakers includes funding agency, key industry players, and top scientists and engineers from the international community. The conference will cover all areas of emerging technologies in all areas of algal research, including microalgae, macroalgae, and cyanobacteria: biology, biotechnology, biomass production, cultivation, harvesting, extraction, biorefinery, feedstock conversion into fuels, high value products, econometrics, and sustainability analyses.

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

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12th International Seaweed Conference Seagriculture | In Person
21st -22nd June 2023, Trondheim (Norway)

The Seagriculture Conference EU 2023 gathers top speakers, who will share their know-how within seaweed for feed, food, offshore cultivation, biorefinery of seaweed and much more. The two-day program will go into the many different applications of seaweed that exist now and will combine 6 plenary sessions with trade shows and panel discussion sessions. The Seagriculture conference has built up a solid reputation as the leading conference for the seaweed industry, and successfully organized since 2012.

Further information: https://seagriculture.eu/

Aqua Nor | Hybrid
22nd – 25th August 2023, Trondheim (Norway)

Since 1979, Aqua Nor has been an important international meeting place for the aquaculture industry, and it is today the world's largest aquaculture technology exhibition. During Aqua Nor, numerous seminars, mini-conferences, lectures, debates and presentations are held. During the exhibition, visitors and exhibitors alike can participate in various social events both during the day and in the evening. The conditions are perfect for meeting old friends as well as new contacts and customers in an informal setting.

More information: https://aquanor.no/en/

20th International conference on Harmful Algae (ICHA) | In Person
5th -10th November 2023, Hiroshima (Japan)

Harmful Algae Conference aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of Harmful Algae Conference. It also provides a premier interdisciplinary platform for researchers, practitioners, and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered, and solutions adopted in the fields of Harmful Algae Conference.

Further Information: https://icha2023.org/

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. Thomas[1], K. R. Roman[2] and A. R. Camello[3*]
[1]Affliation of first author with institutional address
[2]Affliation of second author with institutional address
[3]Affiliation 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 members of the 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
Thomas, P.A. and Oscar, M.A. 2005. Culture of *Nannochloropsis gaditana* in bubble column reactor. Journal of Applied Phycology 134: 31-38.

Book
Whatman, C.F. 2008. Pond water quality. CRC Press, Boca Raton, FL, USA. 455p.

Book chapter
Michaelis, M. 2008. Bacterioplankton in aquaculture ponds. 48 -52pp In: Pond water quality, Whatman, C.F. (Ed.). CRC Press, Boca Raton, FL, USA.

Report
Roman, H.G. and Pete, G.S. 2012. Seaweed cultivation in ponds. Report no. RD12/0208-1. Environmental Protection Authority, Canberra, ACT, Australia. 80p.

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 tile.

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 **.tiff** 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 celine.rebours@moreforsking.no. 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: Pr. Qiang Hu
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