Review Paper on Seaweed Based Packaging

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Abstract- *Due to its short lifetime food packaging leads to a rapid accumulation of plastic in our surroundings and thereby also has a huge impact on environmental pollution. To reduce these effects and create a more sustainable approach towards food packaging, biodegradable and biobased polymers have been developed and are emerging on the market.the current state of research regarding active packaging and the incorporation of seaweed into food packaging. Further, it summarises the resulting consequences of the seaweed incorporation on antioxidant, antimicrobial and properties, as well as the release of active compounds to show the advantages of the polysaccharides as well as possible shortcomings in current research.*

Keywords- Seaweeds; Polysaccharides ;Active packaging; Oxygen scavenger; Antimicrobial packaging dioxide; Moisture Controlling packaging ; Ethylene scavenger.

I. INTRODUCTION

Seaweeds are macroscopic algae growing in the marine and shallow coastal waters and brackish water habitats. Seaweeds (macro algae) are wonder plants of the sea, the new renewable source of food, energy, chemicals and medicines with manifold nutritional, industrial, biomedical, agriculture and personal care applications.

Seaweed-based packaging as a replacement for plastic will ease the waste management process because it is biodegradable and it will ensure that the packaging waste can return to the earth naturally.

This innovation will help reduce plastic contamination to the water, the land and to the air. Seaweed packaging is not only biodegradable and edible; it can be made to dissolve when water hits it, which is excellent for packaging tea or cereals. According to the Aquaculture Alliance, the growth of this industry is good for the economy and the ocean.

II. CULTIVATION OF SEAWEED

Seaweed cultivation is a highly remunerative activity involving simple, low cost, low maintenance technology with short grow-out cycle.

The simplest and most common cultivation method is to attach pieces of seaweed to rope lines or nets that are suspended in the sea often near the coast. They hang on wooden stakes or on a floating wooden framework dug down into the seabed.

While the majority of seaweed harvesting in the UK is still gathered by hand at low tide, other countries harvest wild seaweed with boats and machinery, using a rake or trawler methods. This is much more efficient than hand collection, but, if used excessively, can have a severe habitat impact as it can pull up other seaweeds and disrupt sea animal homes.

But, seaweed harvesters have given an encouraging amount of thought and attention to this issue. For example, in Norway the rake method only removes the top floating canopy of seaweed, which allows the seaweed to regrow over the next two years and minimises disruption of the seabed.

III. METHODOLOGY

The present invention utilizes algal material in an integral form (including dried) without the need to separate its fibrous elements, and this represents a fundamental aspect of the present invention.

Surprisingly, the non-fibrous parts of the algal material, which are basically made up of fulvic acids and polysaccharides, give improved characteristics to the cellulose fibre paper even when used in small quantities. Particularly, the use of algal material gives the paper better mechanical characteristics (resistance to bursting, stiffness and rupture length) and chemical characteristics (resistance to fats and solvents).

The integral use of algal material has an extra advantage of not producing pollutant by-products, thus circumventing the creation of further ecological problems caused by disposal. Therefore, use of algal material for manufacturing paper according to the present invention represents a particularly advantageous system for the problem of seaweed disposal.

A basic feature of the process according to the present invention lies in the fact that the algal material is reduced to particles smaller than 500 μm in size.

The algal material does not have to undergo bleaching treatment, so that the dispersion of tiny particles of algae in the paper gives the latter a unique appearance. That is, the paper may have greyish-green dots which makes its origin immediately recognizable. In fact, the presence and structure of algae is easily seen even by using an ordinary magnifying glass. This feature of paper obtained by using algal material is especially advantageous because it represents an inner marking of the paper's origin and therefore prevents its counterfeiting. This dotting also gives the paper an attractive look and its smell is that of the sea.

According to a basic feature of the present invention, the algal material gathered from the sea, and possibly washed with water or even sea water to remove the rough materials which are undesired in papermaking, is drained and treated with an antfermentative to prevent putrefaction, then ground by a suitable mill such as a colloid or ball mill to sizes of less than 500 μm. Particles larger than 500 μm are separated by sifting, preferably by a vibrating screen, and recycled in the grinding machine. The material thus prepared, which typically has a green color and preserves the seaweed smell, is placed in a cellulose fiber refiner in order to be homogenized with the cellulose fiber mixture normally used to make paper.

Example:1

1,000 Kg of algal material gathered from the Venice lagoon, mainly made up of Ulva rigida (more than 70% by weight), is washed directly with sea water to remove materials extraneous to the algae and entrapped in its mass, and left to drain. The algae material is then sprayed with 10 liters of 1% by vol. hydrogen peroxide solution.

The algal material is then ground in a colloid mill which reduces the size of the particles to less than 500 μm, filtered through a vibrating screen to remove the larger particles (which are sent back to the colloid mill) and sent to a paper refiner (Walley beater) for final treatment and reduction before mixing with the cellulose fiber mixture to be sent to the paper machine.

The chemical composition of the algal material used, which has is 10.1% by weight dry residue at 105° C., was as follows (all percentages refer to the dry residue):

Calcium	24.5 g/kg
Cobalt	1 mg/kg
Iron	997 mg/kg
Magnesium	24.7 g/kg
Manganese	48 mg/kg
Potassium	7.4 g/kg
Copper	12 mg/kg
Zinc	92 mg/kg
Chloride	3360 mg/kg
Bromide	400 mg/kg
Total carbon	34.1%
Organic carbon	31.48%
Raw fiber	13.8%
Total nitrogen	2.59%
Proteic nitrogen	2.57%
Total phosphorus	1200 mg/kg
Hydrogen	5.02%
Iodide	<20 mg/kg
Sulphur	39.5 mg/kg
Fulvic acid	12.1%

A 760 kg mixture consisting of bleached wood-pulp, 140 kg of finely ground calcium carbonate and 1,000 kg of algal material treated as above, was fed into a 700 kg/h paper machine.

A diketenic-type synthetic glue is added to the mixture to make the paper suitable for writing with aqueous inks, then cationic starch is added to increase the paper's retention powers.

The output belt speed of the machine was adjusted to 65 m/min.

The paper machine was automatically controlled by the Accuray 1180 Micro Plus system for substance, moisture and thickness.

Table 1 gives the characteristics of the paper obtained with algal material (sample B) as compared to the characteristics of paper obtained under the same operative conditions and with the same additives (glues and starch) but without algal material (sample A).

EXAMPLE 2

After washing with sea water, the same algal material used in Example 1, was dried to a fine film in a turbodryer. 100 kg of dried algal material (with a residual water content of about 5%) was ground in a ball mill and the aqueous suspension obtained was filtered through a vibrating screen to remove particles larger than 500 µm in size. 1% by weight of caustic soda in a 20% water solution was added and steam-heated to 70° C. for 20 minutes. After cooling, 1 liter of 2% by vol. hydrogen peroxide was added.

The suspension thus obtained was then cooled in the Beater machine and finally mixed with the same mixture of bleached cellulose and calcium carbonate described in Example 1.

By using the same equipment, operative conditions, cellulose and the same additives as Example 1, paper having the characteristics given in Table 1 (sample C) was obtained.

TABLE 1

	A	B	C
grammage g/m	84	83	84
thickness micron	98	110	105
Cobb sizing			
wire s. g/m	26	30	24
felt s.	27	32	26
Ink Flotation (Pelikan 4001) min	10	5	22 20
smoothness Gurley (100 ml) sec	200	150	200
porosity Gurley (100 ml) sec	15	25	60
bursting strength kg/cm	2.0	2.5	3.5
breaking length			
grain d. m	6500	8000	10000
cross d. m	3500	3700	4500
wax content Dennison N	16	16	20
writing test	good	good	good

IV. WHY SEAWEED AS SUITABLE PACKAGING MATERIALS?

Background

Although commonly consumed in Asia, seaweeds are a largely underutilized food source in the Western world. However, interest is rising, and seaweeds have a major potential as both main and functional ingredients in European markets. The current barriers for seaweeds as food products relate to food safety, quality preservation and optimization, and food neophobia.

Scope and approach

This commentary provides an overview of current challenges to providing seaweed in the European market and proposed solutions to tackle these obstacles, taking inspiration from other food sectors. Processing and packaging concepts for future manufacturing of seaweeds as food are explored and insight into market research and strategies for overcoming the barrier of consumer skepticism are given.

Key findings

Tackling safety issues related to human consumption of seaweeds is required for their widespread use in food applications. Sustainable, multi-target mitigation strategies towards microbiological and chemical (excessive iodine, heavy metals, allergens) hazards are driving the improvement of food safety of seaweeds and derived products. Rapid post-harvest deterioration of seaweeds can be avoided through stabilization techniques, for instance through temporary storage solutions before final processing, direct utilization into food items, and packaging. Innovative drying and alternative processing strategies may reduce energy consumption and processing time, while at the same time improving the safety as well as the nutritional and sensory qualities of the product. Despite the rising popularity of Asian cuisine and the Western-consumers' perception of seaweeds as a "healthy superfood", understanding consumer behavior in relation to new foods and facilitating information-based decisions could reduce potential consumer skepticism. In conclusion, innovation tools discussed in this work can be exploited for further development of a sustainable seaweed food industry.

V. WHY SEAWEED COMES ACTIVE PACKAGING?

Seaweeds are rich sources of polysaccharides and therefore is a promising raw material for active packaging, especially when combined with biodegradable polymers, it offers a sustainable alternative superior to traditional materials.

Active Packaging is a system in which product packaging and environment interact in a positive way to extend the self life , improve the safety as well as the sensory properties and maintain the quality of the product.

Currently there are numerous active food packaging systems developed such as oxygen scavenger, carbon-dioxide generating system, antimicrobial active packaging, moisture control packaging, Ethylene scavenger and flavours and odour absorbent packaging chemical used in these system are:

Oxygen scavenger- Iron powder ascorbic acid, Palladium, Glucose oxidase and catalase.
Carbon Di-oxide Emitter- Ferrous carbonate, sodium Bicarbonate, ascorbic acid.
Ant microbial Packaging-Ethanol ,enzyme, essential oil, Chlorine dioxide, Anti microbial polymers.
Moisture controlling packaging- Calcium oxide, Inorganic salt, silica gel.
Odour absorbing packaging- Nickel, Citric acid, charcoal polyethylene terephthalate.
Ethylene scavenger- charcoal ,nano-TiO2, palladium ,nano silver, potassium permanganate.

VI. LITERATURE SURVEY

1.Seaweeds polysaccharides in active food packaging: A review of recent progress
By- D Carina

This review provides the current state of research regarding active packaging and the incorporation of seaweed into food packaging. Further, it summarises the resulting consequences of the seaweed incorporation on mechanical, physical, thermal, antioxidant, antimicrobial and chemical properties, as well as the release of active compounds to show the advantages of the polysaccharides as well as possible shortcomings in current research.

2. Seaweed Polysaccharide in Food Contact Materials (Active Packaging, Intelligent Packaging, Edible Films, and Coatings)
By- Kalpani Y. Perera, Shubham Sharma, [...], and Swarna Jaiswal

In this review article, we have summarized the current state of seaweed polysaccharide research in active packaging, intelligent packaging, edible films, and coatings. It also highlights the physical, thermal, antioxidant, and other properties of these materials. Finally, the article discusses the relevant legislation as well as the field's future prospects. Research shows that seaweeds polysaccharide looks promising as a sustainable food contact material, but there is always a potential for development to make it market feasible.
icrobial, and antioxidant properties of seaweed based FCMs. Furthermore, it emphasizes the legal aspects of seaweeds as FCMs, as well as future prospects.

3. Micro crystalline bamboo cellulose based seaweed biodegradable composite films for sustainable packaging material
By- M Hasan, TzeKiat Lai, Deepu A Gopakumar, M Jawaid, FAT Owolabi, EM Mistar, Tata Alfatah, NZ Noriman, MKM Haafiz, HPS Abdul Khalil

This study is aimed to fabricate and characterize the seaweed- biodegradable films incorporated with varying concentrations of microcrystalline cellulose (MCC) which was extracted from two bamboo sources: Schizostachyumbrachycladum (BLMCC) and Gigantochloascortechinii (BSMCC). Pure biodegradable seaweed film was directly fabricated from red seaweed (Kappaphycusalvarezii).

4.Seaweed based sustainable films and composites for food and pharmaceutical applications: A review

By- HPS Abdul Khalil, Chaturbhuj K Saurabh, YY Tye, TK Lai, AM Easa, E Rosamah, MRN Fazita, MI Syakir, AS Adnan, HM Fizree, NAS Aprilia, Aparajita Banerjee
This review comprehensively addresses different types of additives and their impact on various functional properties of seaweed based composites, their methods of incorporation, and applications with special emphasis on food and pharmaceutical usage.

5. Seaweed products for the future: Using current tools to develop a sustainable food industry
By-MartheJordbrekkBlikra, ThemistoklisAltintzoglou, Trond Løvdal, GuroRognså, DagbjørnSkipnes, Torstein Skåra, Morten Sivertsvik, Estefanía Noriega Fernández

This commentary provides an overview of current challenges to providing seaweed in the European market and proposed solutions to tackle these obstacles, taking inspiration from other food sectors. Processing and packaging concepts for future manufacturing of seaweeds as food are explored and insight into market research and strategies for overcoming the barrier of consumer skepticism are given.

6. Valorization of alginate-extracted seaweed biomass for the development of cellulose-based packaging films
By- Vera Cebrián-Lloret, Mandy Metz, Antonio Martínez-Abad, Svein Halvor Knutsen, Simon Ballance, Amparo López-Rubio, Marta Martínez-Sanz

These results point towards the potential of a simple alkaline extraction to generate cellulose-based films from seaweed residuals with the best compromise between functional properties and economical and environmental efficiency.

7. Antimicrobial and antioxidant properties of polyvinyl alcohol bio composite films containing seaweed extracted cellulose nano-crystal and basil leaves extract
By- Suman Singh, Kirtiraj K Gaikwad, Youn Suk Lee

Polyvinyl alcohol (PVA) films containing seaweed extracted cellulose nanocrystal (CNC) (5% w/v) and 5, 10, and 20% (w/v) basil leaves extract (BE) were prepared using the solvent casting method, and their physical properties, and antimicrobial and antioxidant activity were analyzed. The addition of 5% (w/v) CNC to PVA improved the tensile strength and water vapor permeability. Addition of BE to film the antioxidant activity and antimicrobial properties of the films were enhanced. Further, increasing the amount of BE slightly affected the color of the bio-nanocomposites. The thermal stability of films was improved with addition of CNC. Due to functional groups and linkage properties of the CNC surface and macromolecular chains of the PVA were responsible for improvement of the interfacial interactions between the CNC and PVA. The dispersion of CNC in PVA were affected with increase in the amount of BE in PVA. This study showed the benefits of the incorporation of CNC and BE into PVA films and the potential for their use as active packaging material for food.

8. Enhancement in the physico-mechanical functions of seaweed biopolymer film via embedding fillers for plasticulture application—a comparison with conventional biodegradable …
By- EWN Chong, Shima Jafarzadeh, MT Paridah, DeepuAGopakumar, HA Tajarudin, Sabu Thomas, HPS Abdul Khalil

This study aimed to compare the performance of fabricated microbially induced precipitated calcium carbonate– (MB–CaCO3) based red seaweed (Kappaphycusalvarezii) bio-polymer film and commercial calcium carbonate– (C–CaCO3) based red seaweed bio-film with the conventional biodegradable mulch film.

9. Bioplastic made from seaweed polysaccharides with green production methods
By- C Lim, S Yusoff, CG Ng, PE Lim, YC Ching

This study aims to analyse the practicability of forming seaweed films and their viability of enhancing the bioplastic market using new green technologies. Seaweeds can form films either directly or using their derivatives like agar, carrageenan, and alginate.

VII. APPLICATION

Seaweed based sustainable films and composites for food and pharmaceutical applications:

Various studies have been focused on seaweeds derived polysaccharidesbased composites because of its renewability and sustainability for food packaging and pharmaceutical applications including tissue engineering, drug delivery, and wound dressing. Alginate, carrageenan, and agar are widely used for this purpose due to their biocompatibility, availability, gelling capacity, and encapsulation efficiency. Essential oils (like oregano, clove, lemongrass, etc.) as antimicrobial and antioxidant agent, biopolymer (like starch, cellulose, chitosan, etc.), and nanoparticles (organically modified and unmodified inorganic nanoclays, nano-cellulose, carbon nanotubes) as reinforcing material are frequently used for the fabrication of seaweed based materials. Composites have an edge over pure polymer based material in terms of mechanical and barrier properties, controlled release of drugs, and adsorption efficiency. This review comprehensively addresses different types of additives and their impact on various functional properties of seaweed based composites, their methods of incorporation, and applications with special emphasis on food and pharmaceutical usage.

VIII. CONCLUSION

With the increasing awareness of the consumer for sustainable products, the incorporation of seaweed into natural polymers shows a big potential use in the future of food packaging. It can decrease the amount of synthetic packaging used and thereby lower the quantity of plastic pollution in our environment. The antioxidant/antimicrobial properties of the seaweed could have a beneficent effect on the shelf life of food and reduce the amount of food waste caused by spoilage. However, there needs to be more research done on the effect of the seaweed on the shelf life of specific food products. For broader use of seaweed in foodstuffs and packaging there should be an overall improvement regarding the legislation of toxic metals and further, possibly harmful compounds which can accumulate, to make the usage of seaweed safe and risk free. The mechanical properties of the film need to be adapted to the specific field of use, this can be done by using a blend of polymers or natural plasticiser. Overall, it shows to be a promising possibility for more sustainable and active films with room for improvement. The use of seaweed as biodegradable packaging which are more feasible and considerable alternative to current methods, leading to further research towards the optimisation of the process to make it a possible competitor on the market. Furthermore, more detailed research should go into the specific fields in which seaweed would have the biggest advantages over common packaging material due to its mechanical, antibacterial, antioxidant and release properties. The improvement of existing polysaccharide membranes by using additives such as lipids, different polymer blends and a higher variety in, possibly modified, polysaccharides are also crucial to create a more sustainable approach for food packaging.

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