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Alginate fiber from brown algae

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ABSTRACT

Alginate, a naturally occurring anionic polymer obtained from brown algae has been used for many biomedical applications. Natural fibres comprising of polysaccharides, have been used due to their biocompatibility, non-toxicity, and potential bioactivity at the wound surface. Many commercial wound dressing products such as retention bandages, support and compression bandages, absorbents, gauzes, tulle dressings and wound dressing pads are made from such natural polymers and their derivatives, produced from woven cellulose fibres. The present study was carried out to extract alginate from brown algae namely, Sargassum sp collected from Kanyakumari District in Tamil Nadu. About 350 g of alginate fibre was obtained from 500 g of fresh algae.

Keywords: Marine Alga, Alginate, Sodium alginate, Natural Fibre, brown algae, *Sargassum*

INTRODUCTION

Fibres are a class of hair-like materials that are in discrete elongated pieces, similar to pieces of thread. They can be used as a component of composite materials. They can also be matted into sheets to make products such as paper or felt. Fibres are of two types: natural fibre, which consists of animal and plant fibres, and man-made fibre, which consists of synthetic fibres and regenerated fibres. The earliest evidence for humans using fibre is the discovery of wool and dyed flaxfibre found in a prehistoric cave in the Republic of Georgia that date back to 36,000BP [1]. Seaweed fibre is a renewable, cellulosic fibre taken from the ocean. When blended with other fibre, it can be used to manufacture woven fabrics. Chinese medicine traditionally uses seaweed to protect the skin as it has anti-inflammatory qualities and is said to harness deep-sea minerals even in form of a fabric. Advanced technologies have made this fibre more usable in the production of apparel – seen mostly in knits, underwear and sportswear since early 2000s. The Sioen Industries has revealed plans to commercialize its patented seaweed cultivation substrates, under a collective spin-off division, At Sea Technologies. The products are marketed using the trade name At Sea. Thus seaweed has become an important source for future supply of food and feed, biochemicals, biomaterials and bio energy [2,3,4].

If a fine jet of sodium alginate solution is forced in to a bath of a calcium chloride solution, calcium alginate is formed as fibres. The fibres have very good strength when both wet and dry. Good quality stable fibres have been produced from mixed salts of sodium and calcium alginate, and processed into non-woven fabric that is used in wound dressings. They have very good wound healing and haemostatic properties and can be absorbed by body fluids because the calcium in the fibre is exchanged for sodium from the body fluid to give a soluble sodium alginate. If mixed with cotton, more cloth can be woven and the seaweed fibre product cost will be lower. Meanwhile, the cloth strength of sea weed fibre is stronger than cotton. These wound dressings maintain a physiologically moist microenvironment, minimize bacterial infection at the wound site, and facilitate wound healing [5]. Commercially available alginate is extracted from brown algae (*Phaeophyceae*), eg. *Laminaria hyperborea, Laminaria digitata, Laminaria japonica, Ascophyllum nodosum*, and *Macrocystis pyrifera* [6] by treatment with aqueous alkali solutions, with NaOH [7]. The alginate industry extraction protocol is divided into five steps: acidification, alkaline extraction, solid/liquid separation, precipitation and drying [8, 9]. Bleaching of alginate fibre was done using

formaldehyde solution (0.1-0.4%) for 3-5 hours at room temperature and then washed with water before acid pre-treatment [10].

MATERIALS AND METHODS

Collection of Seaweeds

The seaweed samples were collected from the coastal region of Kanyakumari, Tamil Nadu, India, in 2016. Seaweeds were washed with sea water before sun- drying. The collected sample was identified as *Sargassum sp* (Fig 1).

Fig: 1 Brown algae *Sargassum*

Extraction of alginate

Sodium alginate extraction was performed according to Nishigawa (1985) [11] with slight modifications. Initially it was started with 5 g of sample for a yield of about 30-40% alginate. The algal sample was dried and chopped into small pieces, and treated with 500 ml of 0.2 N sulphuric acid and placed in a shaker overnight, at room temperature in order to remove the acid soluble salt. The mixture was filtered through nylon and washed with 50-100 ml of distilled water and filtered again. The residue was extracted with 500 ml of 1% sodium carbonate solution and the sample was diluted with distilled water to 1L and filtered through nylon in order to recover the alginate extract, 50ml of 0.1-0.2% (m/v) NaCl was added to filtrate and the solution was stirred. The filtrate was then added to isopropanol (2 times filter volume) by addition of small volume continuously and stirred with a glass rod. The precipitate attached itself to the glass rod. The precipitate was washed with isopropanol and dried in an oven at 50º C for 24 hours.

Bleaching of alginate fibre

In order to bleach the alginate the samples were treated with formaldehyde solution (0.1-0.4%) for 3-5 hours at room temperature and then washed with water before acid pre-treatment [10].

RESULTS AND DISCUSSION

The present study was done to extract alginate from brown algae *Sargassum* sp and to prepare the alginate fibres. The alginate was extracted using the following steps acidification, alkaline extraction, solid/liquid separation, precipitation and drying. Figure 2 indicates the separation of alginate after the treatment with isopropanol.

Fig. 2 Separation of alginate

A total quantity of 150-175 g of alginate was obtained from 500 g of *Sargassum* sample (Fig.3).

Fig. 3 Total amount of the alginate

On a dry weight basis, the alginate contents are 22–30% for *Ascophyllum nodosum* and 25–44% for *Laminaria digitata* [12]. Our result also gave an alginate yield of 30-40 %.

Fig. 4 Alginate fibres after bleaching

The alginate obtained was dark brown in colour. It required some bleaching before it can be spun into a fibre. The bleaching was done using formaldehyde. The bleached fibre is shown in Figure 4.

CONCLUSION

In the present investigation alginate was extracted from *Sargassum sp* collected from Kanyakumari. The spinning of alginate into yarn required large quantities of alginate which was not possible in this investigation due to lack of time. The conversion of alginate fibre into a fine yarn after spinning will be carried out in our future work. An alginate dressing is a natural wound dressing derived from carbohydrate sources released by clinical bacterial species, in the same manner as biofilm formation. These types of dressings are best used on wounds that have a large amount of exudate. They may be use on full-thickness burns, surgical wounds, split-thickness graft donor sites, Mohs surgery defects, refractory decubiti, and chronic ulcers.

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