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The Effects of Degenerated Carbohydrates on Aggregate Development, Physiological, and Pure Characteristics in Various Mentha Species : A Study

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ABSTRACT

Chitin, chitosan, alginate, agar, and carrageenans are examples of marine polysaccharides. Chemically, they are very reactive, and they are unique in that they may produce thermo-reversible gels. Chitosan is a cationic carbohydrate biopolymer made from chitin, which is the second most prevalent polysaccharide after cellulose in nature. Shrimp, lobster, and crab shell wastes are the principal sources of chitin. Chitosan has found great use as a non-viral vector in gene transfer due to its properties. Chitosan films are extremely durable and long-lasting. Carrageenans are red seaweed-derived linear polysaccharides. Due to the moderate conditions of cross-linking through bivalent cations ($Ca2+$), alginates are generated from seaweed extracts (Phaeophyceae) and are primarily employed in medication administration and as hydrogels for immobilising cells and enzymes. The ability to adjust the final characteristics of polysaccharides by chemical modification, mixing, and the inclusion of biodegradable additives opens the door to a broader range of uses, notably in the pharmaceutical industry. This subject aims to investigate any new potentialities of marine polysaccharides, such as those stated above, resulting from chemical or chemical-physical alterations, as well as the scaling-up of therapeutic uses. Based on these hopeful findings, much research has gone into determining the role of marine polysaccharides in increasing crop output in aromatic plants, as well as the most effective ones.

I. INTRODUCTION

Even before the documented history of civilization, aroma-producing plants or their distilled volatile oils were known to have been used in a variety of human activities, ranging from religious rites and adornments to cures and personal usage (Hay and Waterman 1993). Out of a significant number of plants belonging to 87 angiospermic groups, almost 3,000 have been recognised as essential oil-bearing plants. The essential oil in these plants is contained in leaves and reproductive structures and sometimes in the stem and roots, and is usually recovered by steam distillation of the relevant plant parts. Besides this, the essential oils extracted from some of the medicinal plants are used in the synthesis of organic compounds of high economic value (The Wealth of India 1992; Sangwan et al. 2001).Mentha species (Lamiaceae) are known as kitchen herbs from time immemorial. The secondary metabolites of such plants are valued for their characteristic aromatic or therapeutic attributes and are more worth trading than the traditional food, forage or fibre crops (Sangwan et al. 2001). There is good demand for the essential oils from USA, UK, France, Germany, and also from far eastern countries like Japan, Singapore and Hong Kong. The estimated demand for the essential oils for the year 2009-2010 is 28, 900 tons. India produced over 35,000 metric tonnes (MT) of Mentha oil in 2014-15, with over 25,000 MT exported. The growth rate of essential oil trade normally is of 9% and 25% for domestic and export market, respectively. The supply shortfall in India is estimated to be over 12,000 tonnes (Weiss 1997). This pressure should be brought to the attention of plant scientists in order to boost the production of essential oils from these plants. A radiation-mediated approach for improving plant yield has just been discovered.

II. SODIUM ALGINATE

Brown macro algae are the main source of sodium alginate as a major structural component of the cell wall and intercellular matrix. Commercial varieties of alginate are extracted from seaweed, including the giant kelp Macrocystis pyrifera, Ascophyllum nodosum, Sargassum sinicola, and various types of Laminaria. The sodium salt of alginic acid, sodium alginate, is a chemical substance. Its empirical formula is $NaC6H7O6$. It ranges from white to yellowish-brown, and available in filamentous, granular and powdered forms. It is good at absorbing

200-300 times its weight in water and absorbs it fast. Basically, sodium alginate is a polysaccharide and is composed of (1 → 4) linked β-D-mannuronic acid and α-L-guluronic acid. Monomers are arranged in three types of block structure. MG blocks are known due to most flexible chain formation while M block for its strong immuno-stimulating property. Gel formation property of sodium alginate is due to G block which forms stiff chains and cross-linked by divalent cations. The source of alginate determines the relative amount of block type. The monomers composition and its sequence govern the functional properties of sodium alginate. Gel and film forming properties and dietary function of alginate made it the most demanding marine material in food and pharmaceutical industries. It's also made by the bacterial genera Pseudomonas and Azotobacter, which were essential in the discovery of its production process. Bacterial alginates are useful for the production of micro- or nanostructures suitable for medical applications.

III.RADIATION-INDUCED DEGREDATION

Radiation-induced degradation can be carried out by the method of Nagasawa et al. (2000). The solid material of sodium alginate seals in a glass tube with the air atmosphere. The 1 or 4% aqueous solution of alginate in an open glass container irradiates in the air or with N2 or O2 gas bubbling through the solution. The irradiation carries out using gamma rays from Co-60 sources with a dose rate of 10 kGy/h.

IV.EFFECT OF DEPOLYMERIZED POLYSACCHARIDES ON VARIOUS ASPECTS OF PLANT PROCESSES.

Tomoda et al. (1994) reported the effect of sodium alginate depolymerized by treating with alginate lyase on barley root elongation. They found that depolymerised alginate (alginate lyase lysate) has growth promoting effect on the elongation of barley root, and especially that of the radicle. They observed that effective concentration of alginate lyase lysate for elongation of roots being 100-300 µg/mL, with no inhibition at the highest concentration. When a radicle was brought into contact with alginate lyase/lysate responded by initiating elongation within 2 to 4 hours. They noted that elongation rate increased from 2.9 mm/h to 5.3 mm/h. They also observed 2-3 fold increase in the alcohol dehydrogenase activity in treated plants under hypoxic conditions.

Gamma ray irradiation is used in this approach to breakdown (reduce) the molecular weight of several natural polysaccharides such as alginates, chitosan, and carrageenan into tiny oligomers. Alginates may be processed quickly, cheaply, safely, and cleanly using Co-60 gamma rays. one-step method for the formation of low molecular weight oligomers (Nagasawa et al. 2000; Lee et al. 2003). These degraded oligomers when applied in the form of aqueous solution to different plants, stimulated various kind of biological and physiological activities, including promotion of plant growth and yield in general, seed germination, shoot elongation, root growth, flower production, antimicrobial activity, suppression of heavy metal stress, phytoalexin induction, etc. (Hadwiger 1994; Zakaria et al. 1995; Ohta et al. 1999; Hien et al. 2000; Ahni et al. 2001; Tham et al. 2001; Cabalfin 2002; Kume et al. 2002; Hafeez et al. 2003; Luan et al. 2005; Hegazy et al. 2009). Sodium alginate is a polymer formed from brown algae that occurs naturally in significant quantities. Hu et al. (2004) and Hegazy et al. (2009) found that irradiated sodium alginate (ISA), derived by radiation processing, improved the growth and productivity of Zea mays plants. The application of ISA may stimulate the improvement in physiological qualities in this study because the oligosaccharides (obtained by degrading the alginate) trigger cell signalling, which leads to stimulation of many physiological processes in diverse plants (John et al., 1997). Many scientists have explored the relevance of plant growth regulators (PGRs) in depth, with an emphasis on Sodium Alginate, Chitosan, and Carrageenan, which improve overall growth, physiological, and essential oil composition in Mentha.

The ISA has also been shown to stimulate many physiological processes in plants, including an increase in the content of photosynthetic pigments and the net photosynthetic rate as a result of ISA-mediated cell signalling (Farmer, Thomas, Michael, & Clarence, 1991). The main focus of the work is to investigate and isolate the best doses at which the high yield of the plants can be obtained by the foliar application of gamma-irradiated sodium alginate. In the nutshell, five experiments were designed in order to check the effectivity of foliar spray of gamma-irradiated sodium alginate on growth, physiology and yield attributes of three species of Mentha viz; M. arvensis L., M. spicata L., and M. piperita L.

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V. OBJECTIVES OF RESEARCH

1. To prepare the various doses of Gamma Irradiated Sodium Alginate (GISA) using suitable solvents.
2. Characterization of various doses of Gamma Irradiated Sodium Alginate (GISA) using different techniques including Infra-red Spectroscopy or Nuclear Magnetic Resonance (NMR) analysis.
3. To study the effect of foliar application of each dose of Gamma Irradiated Sodium Alginate (GISA) on Mentha arvensis L . with an aim to find out that which dose has the best effect on the plant growth and yield content.
4. To study the effect of foliar application of each dose of Gamma Irradiated Sodium Alginate (GISA) on Mentha piperita L. with an aim to find out that which dose has best effect on the plant growth and yield content.
5. To study the effect of foliar application of each dose of GISA on Mentha spicata L. with an aim to find out that which dose has the best effect on the plant growth and yield content.

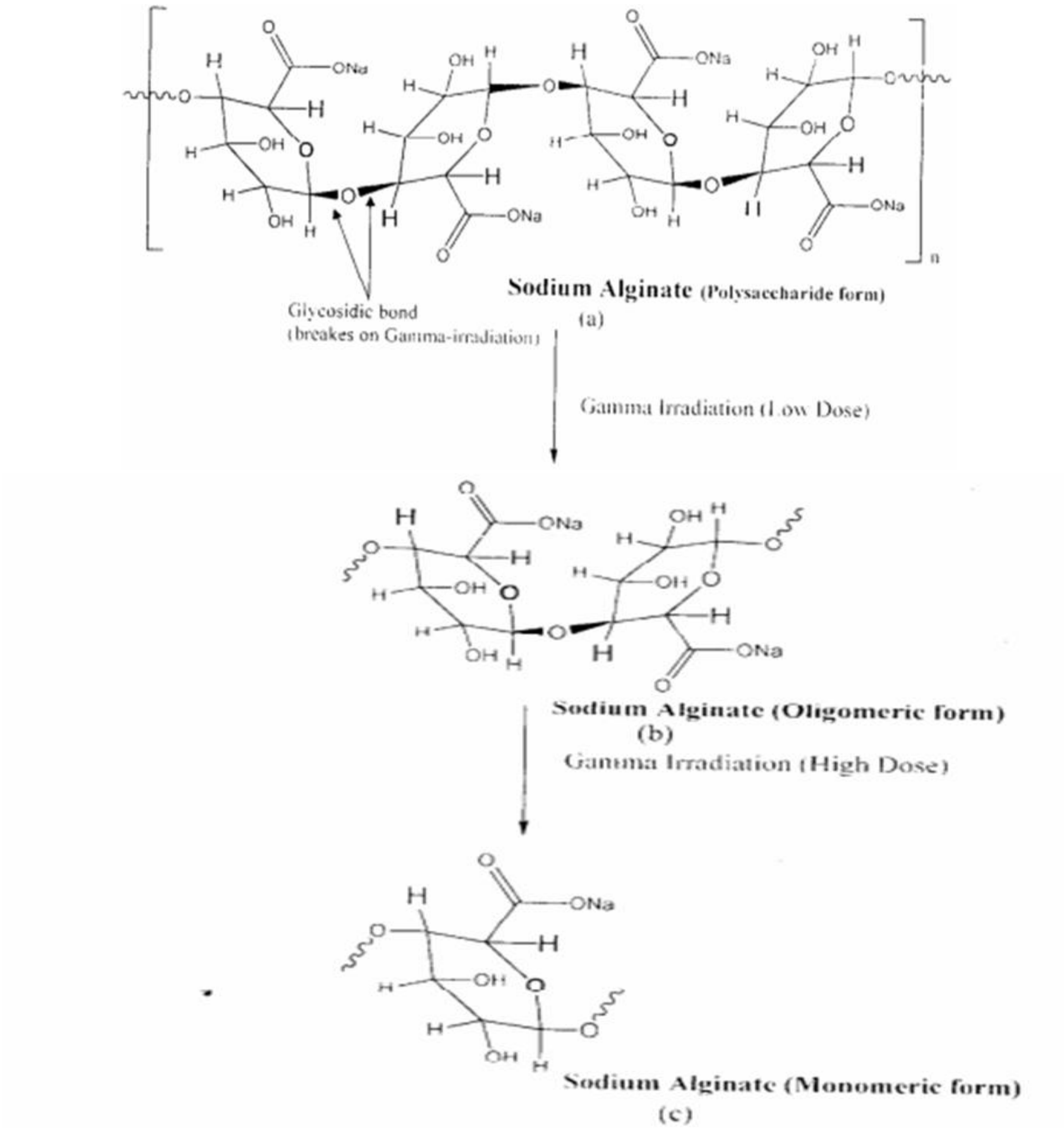

Figure: Sodium Alginate structural formula (a) Polysaccharide form (b) Oilgomeric form (c) Monomeric form

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