International Conference on Recent Innovations in Science, Agriculture, Engineering and Management
University College of Computer Applications Guru Kashi University, Bathinda, Punjab (India)
20th November 2017, www.conferenceworld.in ISBN: 978-93-86171-80-1

Role of Degraded Polysaccharides in Ameliorating the Overall Growth, Physiological and Essential oil Attributes in Various Species of *Mentha.* A Review

Mohammad Afaan Fazili[1], Abdul Hamid Wani[2], Waseem Mushtaq[3]

[1,3]*Department of Botany, Aligarh Muslim University, Aligarh, U.P,(India)*

[2]*Department of Botany, University of Kashmir, Srinagar, J&K,(India)*

ABSTRACT

Marine polysaccharides include chitin, chitosan, alginate, agar and carrageenans. They are highly reactive chemically and are peculiar for thermo-reversible gel formation. Chitosan is a cationic carbohydrate biopolymer derived from chitin, the second most abundant polysaccharides present in nature after cellulose. The main sources of chitin are the shell wastes of shrimps, lobsters and crabs. For its characteristics, chitosan founds particular application as a non-viral vector in gene delivery. Films from chitosan are very tough and long-lasting. Carrageenans are linear polysaccharides from red seaweeds. Alginates are derived from seaweed extracts (Phaeophyceae) and are mainly used in drug delivery and as hydrogels for immobilizing cells and enzymes, due to the mild conditions of cross-linking through bivalent cations (Ca2+). The possibility of chemical modification, blending and addition of biodegradable additives allows tailoring the final properties of polysaccharides and opens the doors to wider applications, particularly in the pharmaceutical area. This issue is intended to explore any new potentiality of marine polysaccharides, as those above mentioned, deriving from chemical or chemical-physical modifications, and the scaling-up of their pharmaceutical applications. Based on these encouraging observations, a great deal of effort has been focused on discovering the role and best effective marine polysaccharides which enhance the crop productivity in aromatic plants.

I. INTRODUCTION

The aroma-yielding plants or their distilled volatile oils are known to have been in use in various human activities, from religious ceremonies and adornments to remedies and personal use, even before the recorded history of mankind (Hay and Waterman 1993). Over 3,000 plants have been identified as essential oil-bearing plants out of a large number of plants belonging to 87 angiospermic families. 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. In 2014-15, India produced over 35,000 Metric Tonne (MT) of Mentha oil and exported over 25,000 MT. The growth rate of essential oil trade normally is of 9% and 25% for domestic and export market, respectively. In India, the supply gap is of about 12,000 tons (Weiss 1997). This pressure is worth attracting the attention of plant scientists to increase the essential oil production of these plants. Recently, a radiation-mediated technique has emerged in connection with increasing the productivity of plants.

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 chemical compound, sodium alginate is the sodium salt of alginic acid. Its empirical formula is $NaC_6H_7O_6$. It ranges from white to yellowish-brown, and available in filamentous, granular and powdered forms. It absorbs water quickly and it is capable of absorbing 200-300 times its own weight in water. Basically, sodium alginate is a polysaccharide and is composed of $(1 \rightarrow 4)$ linked β-D-mannuronic acid and α-L-guluronic acid. Monomers are arranged in three types of block structure. These blocks may be homopolymeric block (M block, G block) or heteropolymeric block (MG block). 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 is also produced by two bacterial genera Pseudomonas and Azotobacter, which played a major role in the unravelling of its biosynthesis pathway. 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 N_2 or O_2 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.

According to this technique, gamma rays irradiation is employed to degrade (lower down) the molecular weight of some of the natural polysaccharides like alginates, chitosan and carrageenan into small sized oligomers.Radiation processing of alginates by Co-60 gamma rays offers rapid, inexpensive, safe and a clean 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 natural polysaccharide, derived from brown algae, with a large quantity of it available in nature. Hu et al. (2004) and Hegazy et al. (2009) investigated that irradiated sodium alginate (ISA), obtained by radiation processing, enhanced not only the growth but also increased the productivity of Zea mays plants. As the oligosaccharides (obtained by degrading the alginate) induce cell signalling that in turn, leads to stimulation of various physiological processes in various plants (John et al., 1997), the application of ISA might stimulate the improvement in physiological attributes in this study. The importance of plant growth regulators (PGRs) has been discussed by many scientists in details while focusing on some important PGRs like Sodium Alginate, Chitosan and Carrageenan which ameliorate the overall growth, physiological and essential oil composition in Mentha.

The ISA has also been reported to induce cell signalling, leading to stimulation of various physiological processes in various plants, including ISA-mediated improvement in the content of photosynthetic pigments and net photosynthetic rate (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.

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.

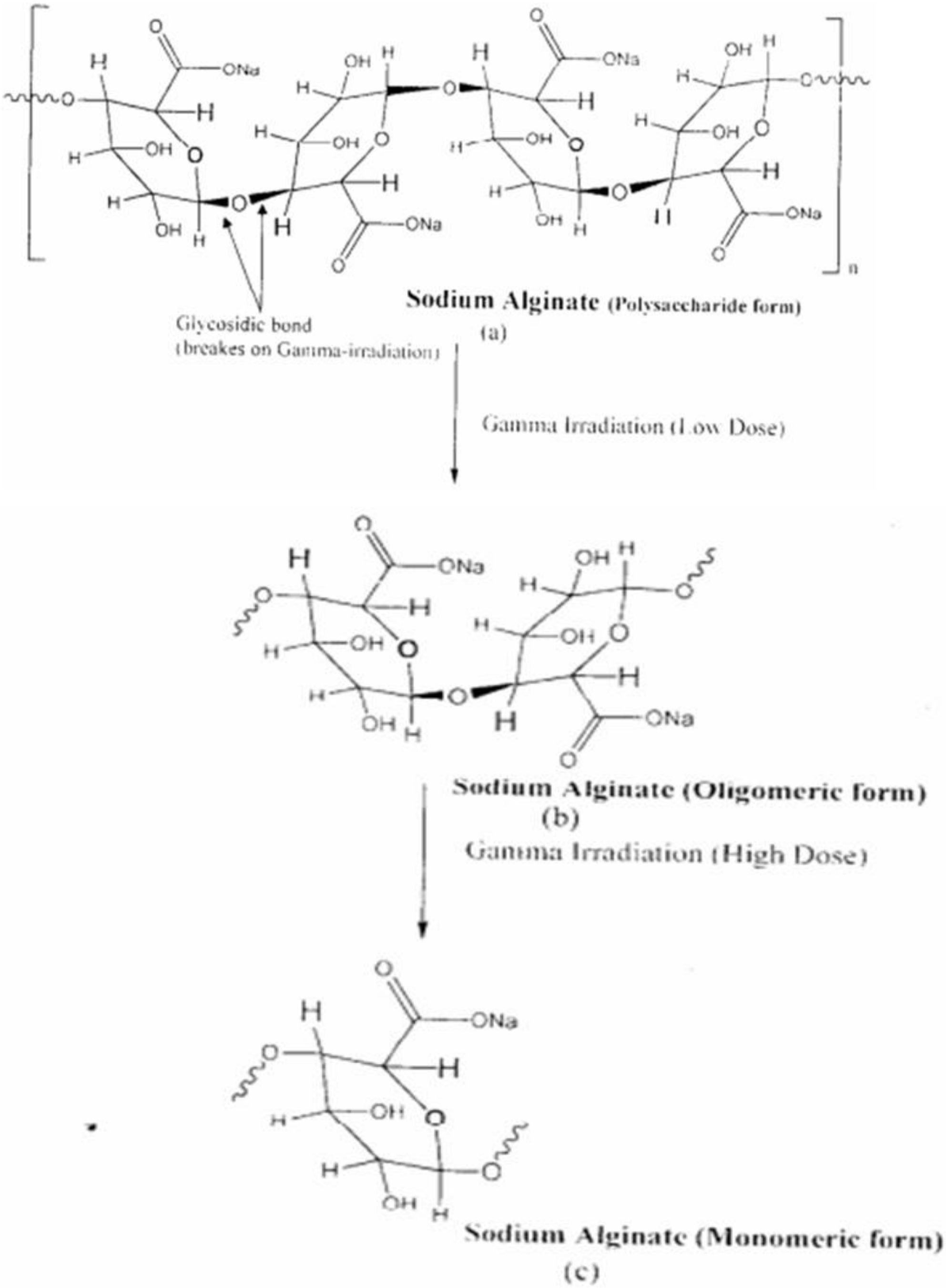

Figure: Structural formula of Sodium Alginate (a) Polysaccharide form (b) Oilgomeric form and (c) Monomeric form.

REFERENCES

[1.] Ahni KJ, Park HJ, Byun MW (2001) The production of chitosan and alginate monomer and oligomer by irradiation. Session 59A, carbohydrate, IFT Annual Meeting-New Orleans, Lousiana, USA.

[2.] Cabalfin EG (2002) Status of radiation treatment of liquid samples in the Philippines. FNCA 2002 Workshop on Application of Electron Accelerator, Takasaki, Japan, pp. 16-20.

[3.] Farmer, E. E., Thomas, D. M., Michael, J. S., & Clarence, A. R. (1991). Oligosaccharide signaling in plants. The Journal of Biological Chemistry, 266, 3140–3145.

[4.] Hadwiger LA (1994) Chitosan as crop growth regulator. Asia-Pacific Chitin and Chitosan Syposium (APCCS), Universiti Kebangsaan Malaysia, 24-27 May.

[5.] Hafeez M, Muhamad O, Muhammad SY, Ahmad MS (2003) Irradiated chitosan as plant promoter. Proceeding Symposium Biologic Gunaan Ke-7, Mines Beach Resort and Spa, Seri Kumbangan, Selangor, 3-4 June.

[6.] Hay RKM, Waterman PG (1993) Volatile oil crops: their biology, biochemistry and production. Longman, Harlow, Essex,UK.

[7.] Hegazy EA, Abdel-Rehim H, Diaa DA, El-Barbary A (2009) Report: Con-trolling of degradation effects in radiation processing of polymers In: Controlling of degradation effects in radiation processing of polymers. Vienna, Austria: International Atomic Energy Agency pp. 64–84.

[8.] Hien NQ, Nagasawa N, Tham LX, Yoshii F, Dang HV, Mitomo H, Makuuchi K, Kume T (2000) Growth promotion of plants with depolymerised alginates by irradiation. Radiat Phys Chem 59: 97–101.

[9.] Hu X, Jiang X, Hwang H, Liu S, Guan H (2004) Promotive effects of alginate-derived oligosaccharide on maize seed germination. J App Phycol 16: 73–76.

[10.] John, M., Rohrig, H., Schmidt, J., Walden, R., Schell, J., 1997. Cell signalling by oligosaccharides. Trends Plant Sci. 3, 111–115.

[11.] Kume T, Nagasawa N, Yoshii F (2002) Utilization of carbohydrates by radiation Luan LQ, Ha TTV, Nagasawa N, Kume T, Fumio Yoshii F, Nakanishi TM (2005) Biological effect of irradiated chitosan on plants *in vitro*. Biotechnol Appl Biochem 41: 49–57 processing. Radiat Phys Chem 63: 625-627.

[12.] Lee DW, Choi WS, Byun MW, Park HJ, Yu YM, Lee CM (2003) Effect of γ-irradiation on degradation of alginate. *J Agric Food Chem* 51: 4819-4823.

[13.] Nagasawa N, Mitomo H, Yoshii F, Kume T (2000) Radiation induced degradation of sodium alginate. *Polym Degrad Stab* 69: 279-285.

[14.] Ohta K, Zaniguhi A, Konishi N, Idosoki T (1999) Chitosan treatment affects plants growth and flower quality in *Eustoma grandiflorum*. Hort Sci 34: 233-234.

[15.] Sangwan NS, Farooqi AHA, Shabih F, Sangwan RS (2001) Regulation of essential oil production in plants. *Plant Growth Regul*. 34:3–21.

[16.] Tham LX, Nagasawa N, Matsuhashi S, Ishioka NS, Ito T, Kume T (2001) Effect of radiation-degraded chitosan on plants stressed with vanadium. Radiat Phys Chem 61: 171-175.

[17.] The Wealth of India (1992) Vol. IV, Publication & Information Directorate, C.S.I.R, New Delhi, India.

[18.] Weiss EA (1997) In: Essential Oil Crops. CAB International, pp. 24–58.

[19.] Zakaria MB, Wan Muda WM, Abdullah MP (1995) Chitin and chitosanthe versatile environment friendly modern material. Penerbit Universiti Kebangsaan Malaysia, Bangi.