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Hyaluronic Acid and its Applications

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Commentary

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Introduction

Hyaluronic acid is a naturally obtained non-immunogenic and non-adhesive glycosaminoglycan that is most prominently used in wound healing. Hyaluronic acid has a simple structure, but its properties make it most concerning commercial product. In a cell, it plays an important role in both mechanical and structural functions. Based on the region of presence in body its function varies, when present in synovial fluid it provides lubrication to the skeleton and in extracellular matrix it provides complex structure to the cell. It has angiogenic property when degraded into smaller fragments. Hyaluronic acid plays a vital role in the process of inflammation. Hyaluronic acid has a very unusual path of biosynthesis where two moles of glucose with five moles of nucleoside triphosphate and 1 mole of acetyle coenzyme A will be converted to a hyaluronic acid during glycolysis [1]. In this paper I would like to discuss about the various applications of the hyaluronic acid, in medical and cosmetic fields.

Hyaluronic acid

Hyaluronic acid is naturally present in all vertebrates higher animas in various regions, it is a common component of body fluids, synovial fluid and it maintains inter-cellular gap giving structure to cell and it retains the moisture content of the skin [2]. It plays vital role in various processes of the body like, homeostatis, longterm inflammation, forming extracellular matrix, angiogenesis. Hyaluronic acid was first time isolated in the year 1934 by Karl Meyer from vitreous humor of bovine eyes. In the early stage, it was described as an uronic acid molecule and an amino sugar. All carboxyl groups dissociate at one particular physiological pH and thus it is called as hyaluronate. But now it is mostly known as hyaluronan, which describes its polysaccharide nature [3,4].

Molecular structure of hyaluronic acid

Hyaluronic acid is a linear polysaccharide that is un-branched with a repetitive structural unit of disaccharide N-acetyl D-glucosamine and D-glucuronic acid. It has molecular weight of 105 -107 Da. It forms a negatively charged polysaccharide chain in secondary structure of Nano-dimensions in solution [5]. The high viscosity and excellent lubrication with in the body is due to its weight. Hyaluronan contains thousands of those disaccharide units that synthesized by a single enzyme termed hyaluronic synthase.

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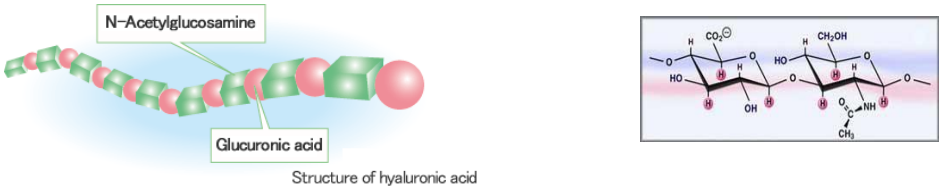

Figure 1: Structure of Hyaluronic acid showing N-acetyl D-glucosamine and D-glucuronic acid.

Physical and chemical properties

Stability: Hyaluronic acid is stable due to disaccharide components and the bulkier parts of the molecules are spaced far between them [6].

Water absorption: In hyaluronic acid, a water absorption property is the most relevant due to the presence of many carbohydrate subunits.

Lubrication: Hyaluronic acid has lubricant nature that helps cartilage so resilient to compressions and also gives skin for its elasticity.

Production and degradation: Hyaluronic acid is composed of certain enzymes and to this enzyme additional disaccharides subunits helps in pushing the polymer out of the cell. Hyaluronic acid is also degraded by many enzymes and those help the growth of blood vessels and trigger inflammation [7].

Medical grade

In medical, hyaluronic acid is used as intra-articular injection to treat early osteoarthritis of the knee [8]. In eye surgical operation, the ball liquid medicine is does with hyaluronic acid supports the stickiness of liquid which reduces the risk in ophthalmology surgeries. In veterinary department, hyaluronic acid injections are used for treating horses in racing and other animal common osseous arthritis. Hyaluronic acid accelerates the wound healing and in joints it helps in lubrication and cushioning [9].

Cosmetic grade

Hyaluronic acid creams boost the skin moisture content, providing maximum nutrition, nourishment, protects from sun light, softening and even colored skin to help fight the signs of aging which gives younger look. In plastic surgeries injections are used for augmentation, as fillers for the treatment of facial wrinkles and depressed scars [10].

Food Grade

Hyaluronic acid is used as additives and it is a dietary supplement which reduces the accumulation of fluid and decrease inflammation in the joints and connective tissues of the body. [11,12].

Industrial production of Hyaluronic acid

Industrial production was first started in 1970 and hyaluronic acid was recognized to be used in the intraocular lens implantation [13]. Initially the production started with rooster comb as a source, but due to lack of global market and high production cost, the process was shut down. Later, healon was introduced by Pharmacia Company, which got approval by the WHO for eye surgeries. Based on certain reasons, like applications, starting material, methodology and global market many companies were established. Thus, after studying these factors and global requirement, we came to a conclusion that, there is space for best production method and this can be done only by decreasing the production cost and increasing the production [14].

Fermentation is the major step, by which, our product of interest will be formed. Fermentation process can be described as an energy-yielding process, where an organic substrate, generally carbohydrate, is oxidized to form an endogenous substrate, in the form of organic carbohydrate which acts as an electron acceptor. When it comes to hyaluronic acid, it is produced in a lactic acid bacterium and based on biosynthesis; we understood that the major priority of this organism is to produce lactic acid. But, our goal was to produce hyaluronic acid industrially. This was really tough because, the amount of final product formed at the end of biosynthesis will be very less. Many studies were made on the production of hyaluronic acid, and after referring different literature, it was declared that, specific process conditions, organism used and equipment used will have a major impact on production rate. Both technically and economically, equipment selected should be, properly analyzed before starting the process [15]. There are several factors such pH-gradient stress including, continuous culture, lysozyme or hyaluronidase addition, agitation and aeration conditions, medium optimization, the type of bioreactor, effect of amino acids and mineral salts and fed-batch operation, were considered before designing the process [16]. While designing a bioreactor in, the impeller used will face viscosity problem, and proper mixing also plays an important role in the production. Thus, The Maxblend impeller can be the best option used for mixing high viscous liquids, and is more preferable for the process [17].

Applications:

In the recent years, hyaluronic acid has become the buzzword in youth, and people seeking for antiaging effect, healing and pain relief. It can be used as targeted drug delivery unit, nano medicine, viscosurgical implants and hydrogels and so on. Some of the important applications of hyaluronic acid have been discussed below.

1. **Ophthalmology:** Hyaluronic acid is used to comfort the eye during visual examination, ocular surgery, and cataract extraction, anterior posterior segment surgeries of the eye, lens implantation, vitreous retinal surgery because of its protective nature towards the exposed tissue, such as corneal endothelium. It is an important mediator in the reconstruction of the surgery area.

2. **Osteoarthritis:** Numerous investigations elaborate the efficacy and safety of hyaluronic acid in treatment of arthritic problems of the knee and other joints. Hyaluronic acid injection by Intra articular administration regains the viscoelasticity of the synovial fluid inhibits its degradation and increases the concentration of endogenous hyaluronic acid relieving from pain.
3. **Healing power:** Hyaluronic acid plays a prominent role in the various biological processes that are central for wound healing. Wound healing is a chain of biological processes like, inflammation, formation of granular tissue, formation of the damaged epithelium and its remodeling. It acts as mediator in whole of these processes and that is the reason why hyaluronic acid is used for healing of wounds like abrasions, post-operative scars, second and third degree burns, pressure sores and external skin injuries.
4. **Cosmetics:** Hyaluronic acid is used for its antiaging property in many antiaging cosmetics available in the market. The concentration of hyaluronic acid declines with increase in age and the metabolic pathways of the hyaluronic acid also alters, which ultimately brings the changes in skin. Lower molecular weight hyaluronic acid is synthesized which penetrates easily through the skin and restores the concentration of hyaluronic acid. It forms a viscoelastic layer on the skin and prevents the external foreign particles penetration and maintains the moisture content of the skin. This is the reason why cost of hyaluronic acid is far higher than the other microbial extracellular polysaccharides.

Conclusion

The hyaluronic acid that is commercially available is extracted from rooster combs or by bacterial fermentation. People use hyaluronic acid for various joint pains, and in plenty of ophthalmic conditions. FDA has given approval to the use of hyaluronic acid for certain eye surgeries including corneal transplantation, cataract surgery, repair or removal of retina and other eye injuries. In plastic surgeries it is used as filler. It is popular as “Fountain of Youth” for its wound healing and moisturizing property but no clinical evidence is available that says administration of hyaluronic acid prevents the skin changes assisted with aging.

References

1. Vasssilis K, Eftychia M, Andreas F, Ivelina B, Charalampos A, et al. (2014) Use of Hyaluronic Acid (Cystistat) for the Treatment of Late Radiation Induced Cystitis in Patients after Prostate Irradiation. J Bioequiv Availab 6: 018-022.
2. Abate M (2013) Hyaluronic Acid and Platelet Rich Plasma in Hip Osteoarthritis: Work in Progress. Surgery Curr Res 3:e110.
3. Arruda LHF, Costa A, Pereira ESP, de Oliveira Pereira M, Assumpção EC (2013) Evaluation of Clinical Safety and Effectiveness of Hyaluronic Acid-based Temporary Dermal Filler Used in Nasolabial Folds. J Clin Exp Dermatol Res 4:196.
4. McGrath A, McGrath AM, ZM Jessop MA, Gandham S, Datta G, et al. (2013) A Comparison of Intra-Articular Hyaluronic Acid Competitors in the Treatment of Mild to Moderate Knee Osteoarthritis. J Arthritis 2:108.

5. S. Nagashima, Y. Morita, T. Miyazaki, E. Ishida, K. Tanaka, et al. (2010) Fabrication of Apatite-Hyaluronic Acid Hybrids. J of Bioceramics Dev and Applic. 1:3
6. Ismail KA, Ahmed SAEG, Elleboudy NAF (2012) Serum Hyaluronic Acid (HA) and Soluble Intercellular Adhesion Molecule-1(Sicam-1) as Non-Invasive Markers of Liver Fibrosis in Viral Hepatitis, Schistosomiasis mansoni and Coinfected Patients. J Bacteriol Parasitol 3:155.
7. Menaa F, Menaa A, Menaa B (2011) Hyaluronic Acid and Derivatives for Tissue Engineering. J Biotechnol Biomaterial S3:001.
8. Saggini R, Di Stefano A, Capogrosso F, Carniel R, Haidar Hassan K, et al. (2014) Viscosupplementation with Hyaluronic Acid or Polynucleotides: Results and Hypothesis for Condro-synchronization. J Clin Trials 4:198.
9. Di Franco R, Muto M, Ravo V, Borrelli D, Pepe A, et al. (2014) Oral Mucositis related to Radiotherapy for Head and Neck cancer: Evaluation of the Effectiveness of a New Anti-inflammatory Product Containing Verbascoside, Polyvinylpyrrolidone, Hyaluronic Acid (MucosyteÂ®). Pharm Anal Acta 5:312.
10. Sahayata Vishal N, Bhavsar Neeta V, Brahmbhatt Nilam A. (2014) An Evaluation of 0.2% Hyaluronic Acid Gel (Gengigel®) in the Treatment of Gingivitis: A Clinical & Microbiological Study. OHDM: 13: 3
11. Vlahova A, Kazakova R, Kissov C, Popova E, Todorov G (2014) Improving the Effect of Aesthetic All-Ceramic Restorations with Hyaluronic Acid Fillers: Clinical Cases. J Interdiscipl Med Dent Sci 2:134.
12. Zinoviev EV, Rakhmatullin RR, Almazov IA (2014) New Bioplastic Material Based on Hyaluronic Acid Hydrocolloid. J Clin Exp Dermatol Res 5:215.
13. Hashizume M, Mihara M (2014) Combination of High-Molecular-Weight Hyaluronic Acid and Cytokine Inhibitor Potently Inhibits Expression of Joint-Damage-Related Genes Induced By Synovial Fluid of RA Patients. J Arthritis 3:117
14. Upadhyay SP, Samanth U, Tellicherry S, Mallick P (2015) Role of Intravenous Dexmedetomidine in Prolonging Postoperative Analgesia and Quality of Block Following Spinal Anaesthesia. A Systemic Review and Update. J Pain Relief 4:175.
15. Paolino S, Botticella G, Fasciolo D, Casabella A, Molfetta L, et al. (2015) Spondylodiscitis in a Geriatric Male. J Osteopor Phys Act 3:125.
16. Baykan EK, Cetinkalp S, Ozgen G, Yilmaz C (2014) Efficacy of Zoledronic Acid Treatment in Paget Disease of Bone. J Osteopor Phys Act 2:120.
17. Zhang Y, Dusad A and Ren K (2014) Drug Delivery Strategies for Treating Osteoporosis. Orthopedic Muscul Sys S2:003.