Journal of The Gujarat Research Society
ISSN: 0374-8588
Volume 21 Issue 11, October 2019

A Review on Biotechnology and Its Future in Medicine

Dr. Manisha Rastogi, Dr. Shiva Sharma, Dr. Snighdha Tiwari

Shobhit Institute of Engineering and Technology (Deemed to be University), Meerut

Email Id- Manisha.rastogi@shobhituniversity.ac.in, shiva@shobhituniversity.ac.in, snigdha.tiwari@shobhituniversity.ac.in

ABSTRACT: ***Due to their unique metabolic properties, organisms of the genus Gluconobacter have been extensively used in the biotechnology sector for decades. The metabolic properties of Gluconobacter that make it so valuable in biotransformation processes, vitamin production, and as a biological element in sensor systems are addressed, as well as the significance of recent biochemical genetic research to present and future industrial Gluconobacter operations. The effect of recombinant gene technology on the state of Gluconobacter processes is discussed, as well as the possibility for using such methods to explain elements of Gluconobacter physiology.***

KEYWORDS: ***Acetic Acid, Bacteria, Biotransformation, Dihydroxyacetone, Vitamin C.***

1. INTRODUCTION

The capacity of the genus Gluconobacter to generate near-quantitative quantities of partly oxidized metabolites in the solution from carbon substrates including such D-sorbitol, glycerol, D-fructose, or D-glucose makes it biotechnologically important. The polyols D-sorbitol and glycerol are oxidized to produce L-sorbose (a vitamin C intermediary) and dihydroxyacetone, which are both utilized as cosmetic tanning agents. Biosensors for the detection of alcohols, sugars, including sugar alcohols in fermentation medium, air, and medicinal applications have been developed using Gluconobacter fast, partial oxidation of carbon substrates. The metabolic or physiological characteristics of this genus, as well as its application in biotechnology and industry, are discussed in this study[1].

1.1.The Gluconobacter Genus has the following characteristics:

The Acetobacteriaceae family includes the genera Gluconobacter. They are not capable of converting acetate and lactate to carbon dioxide and water, unlike the Acetobacter genus. Gluconobacter, unlike Acetobacter and other Gram-negative bacteria, does not produce ubiquinone-10 (Q10). If motile, Gluconobacter organisms have polar flagella, whereas Acetobacter organisms have peritrichous flagella. The connection between Gluconobacter and Acetobacter has been a source of debate. Traditionally, a high level of catalase production has been utilized to differentiate Gluconobacter from Acetobacter as well as other Gram negative bacteria. Genetic elements may be utilized to identify one species from another, according to recent research utilizing molecular biological methods. Bulygina and colleagues sequenced the 5S rRNA of Gluconobacter, Acetobacter, or Acidomonas bacteria in 1992. The findings revealed that these genera were phylogenetically distinct yet had a similar ancestor, leading to the suggestion that all three genera be classed as belonging to the same family (Acetobacteriaceae). The genome size of G. oxydans subsp. suboxydans was shown to be tiny, which may be related to the organism's limited metabolic activity. This organism exhibits a sluggish growth rate, a low cell concentration in mature culture, and a disrupted metabolism, prompting some to label it a spontaneous auxotrophic mutant. the type (and sole) species of the genus Gluconobacter. The rest of the'species' are variations of the type. Gluconobacter

species have high levels of sequence similarity (97.4 to 99.1%), yet there are enough differences to justify the presence of distinct species within the genus, according to 16S rRNA analyses[2].

1.2.Gluconobacter's Metabolic Characteristics:

Gluconobacter are stringent aerobes that use membrane-bound dehydrogenase enzymes to oxidize different sugars and polyols through alternate routes. The first route includes direct oxidation of sugars, aliphatic and cyclic alcohols, and steroids to nearly quantifiable quantities of oxidation product, whereas the second involves phosphorylation accompanied by oxidation through the pentose phosphate pathway. Only those polyols with the cis configuration of the two secondary alcohol groups adjacent to the main alcohol group may be oxidized by Gluconobacter, according to the pentose phosphate pathway, which is the most significant route for the phosphorylate breakdown of sugars and polyols to carbon dioxide. Bertrand's Rule is the name for this. Many of Gluconobacter's metabolic routes and processes are yet unknown This section examines the literature's frequently contradictory opinions and experimental findings on the metabolism of the species Gluconobacter[3].

1.3.The Entner-Doudoroff and Pentose Phosphate Pathways:

Radio labeling studies revealed that A. aceti (another member of the Acetobacteriaceae family) had a full set of pentose phosphate pathway enzymes, demonstrating that approximately 6% of available glucose was metabolized with the production of carbon dioxide nearly entirely from carbon 1. This is used to support the utilization of the pentose phosphate pathway for glucose catabolism. Because A. aceti has been found to lack pyruvate kinase activity, it's conceivable that the Entner-Doudoroff route might be used to produce carbon dioxide from C-1. Because the essential enzymes of the Entner-Doudoroff route were not found in A. acetic, the pentose phosphate pathway is more likely. All of the carbon dioxide generated from glucose in G. suboxydans is thought to come through the pentose phosphate route, indicating that this organism has a partly functioning TCA[4].

1.4.Gluconobacter's Oxidative Capabilities:

In bacteria, there are two kinds of enzyme systems that may perform dehydrogenation processes. Both kinds of metabolism are represented by these systems, which vary in their location and activities inside the bacterial cell. Membrane-bound dehydrogenases that are found inside the cytoplasmic membrane or cytoplasmic dehydrogenases that do not accumulate by products in the medium are both included. For the oxidation of polyols into ketones and sugars into acids, Gluconobacter uses membrane-bound dehydrogenases. This is the genus's most distinctive metabolic characteristic, distinguishing it from other Acetobacteriaceae members. The following are some of the dehydrogenase enzymes identified in Gluconobacter.

Dehydrogenases of Sorbitol (SLDH) The bioconversion of D-sorbitol to L-sorbose is carried out by three distinct SLDH enzymes in G. suboxydans a. SLDH attached to the membrane This SLDH converts sorbitol to sorbose in a single step and has a pH optimum of 5. The enzyme has not been solubilized in an active state and is not reliant on NADP. The pyrrolo-quinoline quinone (PQQ), which was previously exclusively discovered in Pseudomonas, is an unique prosthetic group in this enzyme. PQQ dehydrogenases are found in large quantities in Gluconobacter, but just one in Pseudomonas. The PQQ prosthetic group may have a role in oxidative bacteria's electron transport system. During fermentation, membrane-bound SLDH is responsible for almost all of the sorbitol conversion to sorbitose. SLDH in the cytoplasm In

Gluconobacter cells, there are two kinds of cytoplasmic SLDH: (1) SLDH that is NADP-dependent. In the presence of NADP, this SLDH generates sorbose. It's brittle, heat-sensitive, and difficult to cleanse. (2) NAD-dependent SLDH; optimal pH of this enzyme is 8.0 to 8.5; In the presence of NAD, this SLDH generates fructose. The fructose is phosphorylated with ATP before being oxidized through the pentose phosphate pathway. This enzyme is heat stable, unlike the NADP-dependent SLDH. Although this enzyme's optimal pH is likewise 8.0 to 8.5, its activity range is considerably wider than that of NADP-dependent SLDH[5].

1.5.Effects Of Gluconobacter Culture Conditions:

Strictly aerobic respiration, the buildup of partial oxidation products in the medium, and the inability to grow rapidly even in a complete media are all characteristics of Gluconobacter. Gluconobacter can quickly dehydrate carbon substrates thanks to dehydrogenase enzymes found in the cell membrane. This is a nongrowth-associated activity since it happens independently of growth. In resting cells, dehydrogenase activity may be higher than in developing cells. However, the energy generated by these activities is insufficient to support a developing Gluconobacter colony. For growth, only glycerol or sorbitol may be utilized as the only carbon source[6].

Nutritional Requirements: Gluconobacter has the ability to synthesize all of the amino acids. They may grow on medium with just ammonium as a nitrogen source. Many strains may use single amino acids as their sole supply of nitrogen, and there are no known ‘essential' amino acids in this species. The vitamins pantothenic acid, para-aminobenzoic acid, and nicotinic acid are also required by the body. D-mannitol and D-sorbitol produce the most biomass. When the pH is regulated, glycerol and D-fructose grow well, as does D-glucose. The tricarboxylic acid cycle (TCA) and glycolytic enzymes are not complete in Gluconobacter. The most significant mechanism for phosphorylative degradation of sugars and polyols to carbon dioxide is the pentose phosphate pathway. Direct incomplete oxidation of sugars, polyols, or steroids happens as well, with one or two distinct stages leading to almost quantitative oxidation product yields[7].

1.6.Concentration of Dissolved Oxygen:

Gluconobacter is very sensitive to soluble oxygen levels (DO). Growing and oxidation processes are stimulated by increasing the aeration rate. Increased DO stimulated the synthesis of enzymes involved in glucose oxidation, according to the findings. This resulted in a rise in gluconic acid, 2KGA, and 2,5-DKGA synthesis, as well as a drop in pH. Above 30% saturation, DO had little impact on acid generation. The induction of membranebound NAD(P)-independent dehydrogenases by elevated DO has a beneficial effect on oxidation.

1.7.Phosphorus:

The optimum pH for G. oxydans growth is reported to be between 5.5 and 6.0. (De Ley and Swings, 1984). G. oxydans may grow in a pH range of 3.5 to 8.0, according to popular belief. G. oxydans reacts slowly to lowering pH in continuous culture. The reaction is accompanied by an increase in oxygen intake and a matching increase in product production.

1.8.Inhibition of a product:

The result of glycerol oxidation, dihydroxyacetone (DHA), is harmful to Gluconobacter cells. It prevents cell proliferation and the production of new products. The viability of Gluconobacter reduces dramatically with time spent in contact with DHA and with DHA

concentrations above 5%. DHA inhibits glycerol oxidation after inhibiting microbial growth, most likely by interfering with the amine functionality at the active site of glycerin dehydrogenase. However, say that product inhibition is not a significant issue since DHA production stays at noninhibitory low concentrations throughout the early stages of the culture, and glycerol transport has been demonstrated to occur even at high DHA concentrations in the later stages of the culture.

1.9.Aspects Of The Genus Gluconobacter From A Biotechnological Perspective:

Gluconobacter has the ability to convert over 80 different chemical molecules into partly oxidized metabolites with near-quantitative yields. These products build up in the medium, minimizing the requirement for downstream processing that is time-consuming, complex, or expensive. The pharmaceutical, food, and cosmetics sectors all utilize a lot of these goods. Optimization of various industrial processes, particularly microbial transformations, is very important economically, therefore it has been researched extensively throughout time. Gluconobacter have been used in a variety of functions within biotechnology & industry, in addition to their considerable economic significance in biotransformations including biochemical synthesis. Four of these industrial processes are described in this section, as well as one additional biotechnological use of the genus Gluconobacter.

1.10. Vinegar Manufacturing:

Acetobacter is a well-known genus for its capacity to generate acetic acid (vinegar). A two-step reaction catalyzes this process:

- Acetaldehyde is formed when ethanol is oxidized.
- Acetaldehyde oxidation to acetic acid. These processes are carried out by the membrane-bound enzymes alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH). The production of acetic acid is estimated to be 100,000 tons per year throughout the globe. Microbial techniques account for more than half of this.

1.11. Benefits:

The human genome sequencing will have significant implications for biology and medicine. Identifying the genes that cause human genetic disorders like Huntington's disease, for example, may be done using very simple methods. One method for identifying disease genes is as follows: The gene for Parkinson disease has been pinpointed to a 1 million base pair region near chromosome 4's tip. We could utilize new computer algorithms created at the California Institute of Technology and elsewhere to identify the 40 or so extra genes that would be anticipated to be encoded in this area if we knew the complete DNA sequence of this chromosome. The expression of one of these genes may then be searched for using nucleic acid and antibody probes in appropriate tissues, such as the caudate of the striatum in the brain (a brain region that degenerates in Huntington's disease). If one of the 40 genes was overexpressed, the matching gene from a Huntington's disease patient might be sequenced to find the mutation that causes this genetic abnormality. Many additional genes linked to or causing genetic disorders may be identified in this way.

Arthi G et al studied about the Materials and manufacturing, nanoelectronics, medicine and healthcare, energy, biotechnology, information technology, and national security are all areas where nanotechnology research offers advances. The mass manufacturing of graphene-based systems is a critical bottleneck for their use in materials research. Graphene oxide (GO) has been generally regarded as a significant precursor and starting material for the production of

this processable material due to its ability to meet the criteria. This paper explains how to make graphene oxide (GO) using Hummer's and Modified Hummer's methods, as well as how to characterize it using XRD, FT-IR spectroscopy, and SEM. The outcomes of the above-mentioned characterisation methods are also discussed. This GO may be used as a basic material for water purification, super capacitors, antimicrobial activities, solar cells, and coatings in the future[8].

The launch of the National Nanotechnology Initiative (NNI) in January 2000 heralded the global development of nanoscale research and engineering, according to Mihail C. et al. At the intersection of physical sciences, molecular engineering, biology, biotechnology, and medicine, recent research on nanoscale biosystems has produced one of the most active scientific and technology areas. This area involves creating a sustainable environment, greater knowledge of living or thinking systems, breakthrough biotechnology processes, the synthesis of novel medicines or their targeted delivery, regenerative medicine, neuromorphic engineering, and more. Many nations are prioritizing nano biosystems research, and its importance within nanotechnology is anticipated to grow in the future[9].

Endolysins are enzymes that bacteriophages utilize at the conclusion of their replication cycle to breakdown the peptidoglycan of the bacterial host from inside, resulting in cell lysis and the release of offspring virions, according to Schmelcher et al. Because Gram-positive bacteria's cell walls lack an outer membrane, endolysins may reach the peptidoglycan and kill them when applied externally, making them promising antibacterial options, especially given the rise in bacterial medication resistance. This article examines these enzymes' modular structure, which separates cell wall binding and catalytic activities, as well as their mode of action, lytic activity, and antibacterial potential. It focuses on single - molecule engineering as a method of optimizing product intended for specific applications, highlights recent innovations that may render these protein active against Gram-negative and intracellular pathogens, and summarizes endolysin applications in medicine, food safety, agriculture, and biotechnology[10].

Mohammed et al. studied about biotechnology is a well-established method in a variety of medical fields, but its use in veterinary medicine has just recently begun to emerge, with the potential to transform veterinary practice. These components are found in other areas of the globe, and it is expected that they will be included into the African delivery framework as a private business in the near future. While it is reasonable to believe that biotechnology and its peculiar evolution will transform veterinary medicine in the near future, there is considerable concern among industry stakeholders about food safety and other civil and ethical concerns that could stymie this novel scientific breakthrough. The Three Rs hypothesis (reduction of wildlife populations, refinement of enactments or farm managements to reduce affliction and despair, and replacement of animals with non-animal surrogates when required) is one of the ethical issues. There is a lot of discussion about the limitations of the applicability to veterinary procedures. This study has implications for the future of veterinary practice's emotionalization as well as the growth of animal protein sources for human consumption[11].

2. DISCUSSION

The metabolic characteristics that make this species so valuable are yet unknown. To fully understand these metabolic processes, further research is needed in this field. Recombinant DNA technology may help us learn more about Gluconobacter metabolism, which could lead to better industrial processes in the future. Before biosensors may be used as routine analytical instruments for fermentation processes, further study into their stability and specificity is

needed. Due to their unique metabolic properties, organisms of the genus Gluconobacter have been extensively used in the biotechnology sector for decades. The metabolic properties of Gluconobacter that make it so valuable in biotransformation processes, vitamin production, and as a biological element in sensor systems are addressed, as well as the significance of recent biochemical genetic research to present and future industrial Gluconobacter operations. Over the last century, Gluconobacter sp. has been effectively utilized in industry for the manufacture of food-related goods, medicines, cosmetics, and, most recently, medical and environmental monitoring. Because of its capacity to quickly and incompletely oxidize a broad variety of carbon substrates, this genus's vast range of applications may likely grow in the near future.

3. CONCLUSION

The metabolic characteristics that make this species so valuable are yet unknown. To fully understand these metabolic processes, further research is needed in this field. Recombinant DNA technology may help us learn more about Gluconobacter metabolism, which could lead to better industrial processes in the future. Before biosensors may be used as routine analytical instruments for fermentation processes, further study into their stability and specificity is needed. New vitamin C manufacturing techniques will emerge from the discovery of ways to generate 2-KGA, the immediate precursor of vitamin C, in one or two stages from glucose, sorbitol, or sorbose. There is still a lot of work to be done in this area in order to reach the high yields that the Reichstein method can provide. Over the last century, Gluconobacter sp. has been effectively utilized in industry for the manufacture of food-related goods, medicines, cosmetics, and, most recently, medical and environmental monitoring. Because of its capacity to quickly and incompletely oxidize a broad variety of carbon substrates, this genus's vast range of applications may likely grow in the near future.

REFERENCES:

[1] D. E. Cameron, C. J. Bashor, and J. J. Collins, “A brief history of synthetic biology,” *Nature Reviews Microbiology*. 2014, doi: 10.1038/nrmicro3239.

[2] V. Fierro, Á. Sánchez-Sánchez, and A. Celzard, “Supercapacitor Electrodes †,” *RSC Advances*. 2014.

[3] A. Saddique, “Pharmaceutical biotechnology manufacturing the future of medicine,” *J. Dev. Drugs*, 2016, doi: 10.4172/2329-6631.c1.013.

[4] P. D. Hsu, E. S. Lander, and F. Zhang, “Development and applications of CRISPR-Cas9 for genome engineering,” *Cell*. 2014, doi: 10.1016/j.cell.2014.05.010.

[5] H. Yabu, “Fabrication of honeycomb films by the breath figure technique and their applications,” *Sci. Technol. Adv. Mater.*, 2018, doi: 10.1080/14686996.2018.1528478.

[6] S. Sundar, J. Kundu, and S. C. Kundu, “Biopolymeric nanoparticles,” *Sci. Technol. Adv. Mater.*, 2010, doi: 10.1088/1468-6996/11/1/014104.

[7] L. Hood, “Biotechnology and Medicine of the Future,” *JAMA J. Am. Med. Assoc.*, 1988, doi: 10.1001/jama.1988.03720120041033.

[8] P. B. Arthi G and L. BD, “A Simple Approach to Stepwise Synthesis of Graphene Oxide Nanomaterial,” *J. Nanomed. Nanotechnol.*, 2015, doi: 10.4172/2157-7439.1000253.

[9] M. C. Roco, “Nanotechnology: Convergence with modern biology and medicine,” *Current Opinion in Biotechnology*. 2003, doi: 10.1016/S0958-1669(03)00068-5.

[10] M. Schmelcher, D. M. Donovan, and M. J. Loessner, “Bacteriophage endolysins as novel antimicrobials,” *Future Microbiology*. 2012, doi: 10.2217/fmb.12.97.

[11] M. Ovais, A. T. Khalil, M. Ayaz, I. Ahmad, S. K. Nethi, and S. Mukherjee, “Biosynthesis of metal

nanoparticles via microbial enzymes: A mechanistic approach," *International Journal of Molecular Sciences*. 2018, doi: 10.3390/ijms19124100.