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Hydrogen Production Using bacteria of Thermotoga maritime

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ABSTRACT

Hydrogen production from renewable sources such biomass derived from agricultural waste and municipal alternative ways require to reduce energy costs and consumption of oil and methane gas. Subscribe anaerobic organisms in the environment, such as landfills and cow rumen, methane and hydrogen as well as hydrogen sulfide is a gas stream is suitable for hydrogen fuel cells. In this article we examine the production of hydrogen from bacteria Thermophiles Pyrococcus furiosus and particular Thermotoga Maritima. Thermophiles Pyrococcus furiosus is an Arkian marine that produce anaerobic hydrogen and carbon dioxide. Dehydrogenase, one of these creatures can be found in vitro conditions to produce hydrogen from glucose by glucose dehydrogenase. Both enzymes is selected the cofactor NADP, recycling cofactor as substrate glucose produced dioxide and molecular hydrogen. The two enzymes are produced by one mole of hydrogen per mole of glucose. When the proper enzymes such as cellulases are added, the system can be used to produce hydrogen from biomass components such as sucrose.

KEYWORDS: biohydrogen-new methods of hydrogen production-bacteria of Thermotoha maritime

1-INTRODUCTION

Necessity for new method of hydrogen production .Used commercial method for production of hydrogen are insufficient for utilization of hydrogen as a fuel for transportation and electricity production recently . these methods require energy consumption ,and the reformate methods produce carbon monoxide and carbon dioxide while using fossil fuels such as methane or petroleum.by generating hydrogen from renewable resources like biomass which derived from agricultural and municipal wastes an alternative method with lower energy costs would provide and would not require petroleum or methane consumption. Anaerobic organisms fiund in environments such as landfills and cattle rumen produce methane and hydrogen sulfide as well as hydrogen.

2-Enzymatic Hydrogen Production

An anabolic pathway which found in most organisms is pentose phosphate pathway (ppp).two enzymes ,glucose 6-phosphate dehydrogenase and 6-phosphogluconate dehydrogenase that together produce 2mol NADPH and 2mol ribose 5-phosphate from one mol glucose 6-phosphate are the constitutive parts of oxidative branch of this pathway. The non-oxidative branch carries out one and two carbon transfers that convert pentose to fructose 6-phosphate and glyceraldehyde 3-phosphate.since fructose 6-phosphate is isomerized to glucose 6-phosphate by phosphohexose isomerase (glucose 6-phosphate isomerase),this sugars can be recycled back into the pathway generate additional NADPH.12mol H_2 per 1mol glucose 6-phosphate can be acquire theoretically by addition of hydrogenase .by combining mesophilic ppp enzymes and P.furiosus hydrogenase a yield close to the theoretical importance was achieved.

3-Thermotoga maritime as a Source of Thermophilic Enzymes

Thermotoga maritima is an anaerobic hyperthermophilic eubacterium with an optimum growth temperature of 80 ^{0}C ,which has been isolated from geothermally heated sea floors in Italy and the Azores. this bacterium places as one of the deepest and most slowly evolving lineage in the eubacteria by small subunit ribosomal RNA (SSU rRNA) phylogeny . T.maritima is able to grow on many simple and complex carbohydrates including glucose, sucrose, starch, cellulose and xylan, which it ferments to lactate and acetate (Huber et al., 1986; Huber et al., 1992).as a potential source of thermophilic enzymes some advantage offer by this bacterium .the bacterium does not produce H_2S.it produces several hydrolytic enzymes such as cellulases, xylanases and invertase that are essential for hydrolysis of biomass components to glucose and other sugars.

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The complete genome has been sequenced and many of the genes identified, which greatly simplifies construction of expression subclones for recombinant protein expression (Nelson et al., 1999).genes encoding the enzymes constituting the pentose phosphate pathway were identified in the complete genomic sequence. previous studies show that these enzymes are expressed in functional from by T.maritima. cell extracts of T.maritima have been reported to include conventional forms of glucose 6-phosphate dehydrogenase, 2-keto-3-deoxyphosphogluconate aldolase (an enzyme of the Enter-Doudoroff Pathway) and all of the enzymes of the glycolytic (Emden-Meyeroff) pathway (Selig et al.,1997).from this bacterium some enzymes of interest for biomass utilization , such as cellulases, B-glucosidases, xylanases, and xylose isomerase have also been characterized .(bronnenmeier et al.,1995;Vielle et al.,1995).

The T.maritima proteins that have been characterized resemble their mesophilic counterparts, except for their thermal stability and optimal reaction temperature.at high levels in cell extracts of T.maritima the enzyme glyceraldehyde 3-phosphate dehydrogenase was declared following a three-step purification, the enzyme was found to resemble it is mesophilic counterparts in it is properties,except for it is exceptional thermostability. according to sequence analysis the result of the accumulation of several changes in amino acid sequence was thermal stability (Wrba et al.,1997).

4-Synthetic enzymatic pathway for H_2 production from T.maritima

Jonathan wood ward et al in the following simulation reached to design of ppp (pantose phosphate pathway) recombinant.

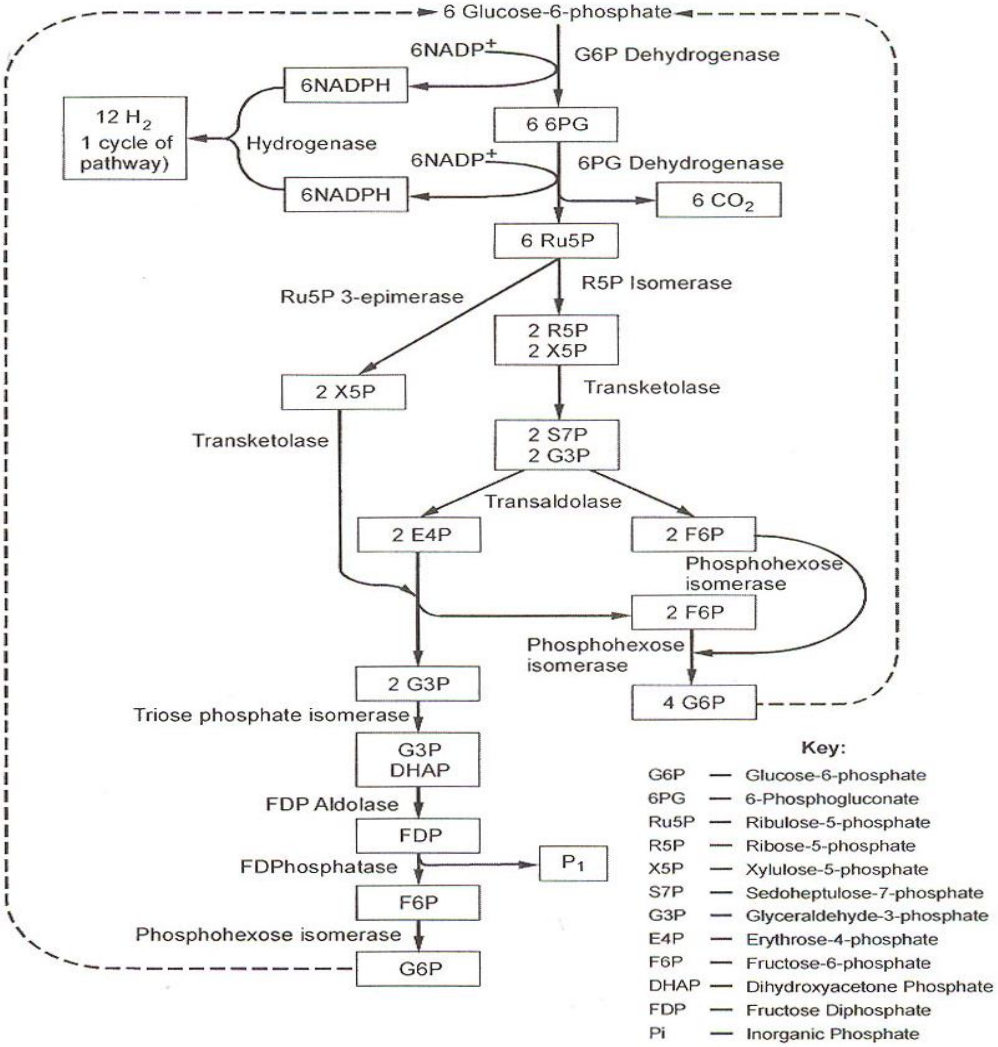

Fig. 1 analysis of production 12mol hydrogen/1mol glucose

Julia S. martin del campo et al in the same action, designed the below simulation in figure 2 .

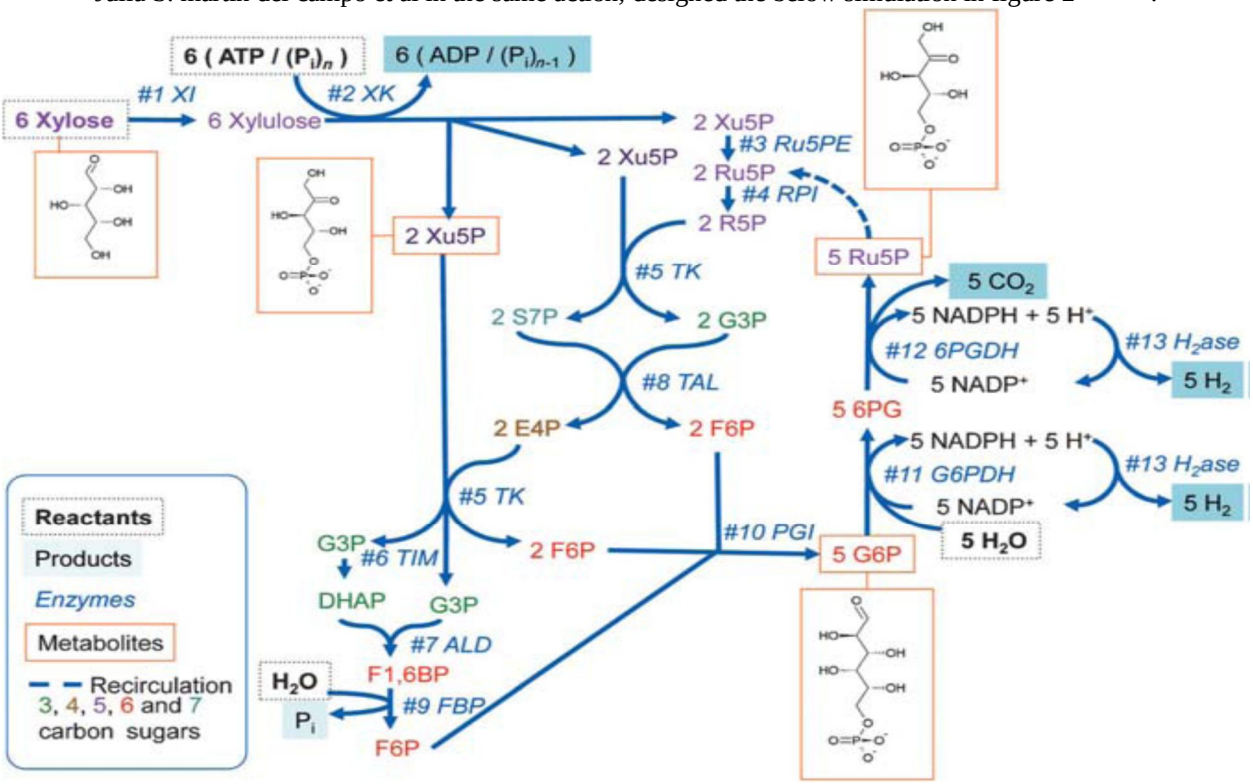

Fig. 2

5-Recombinant GP6 Dehydrogenase

Greenbuam fostered the continuous cultivation of T.maritima for first time in 1984. After that Jonathan wood ward et al on completion of this cultivation to production 131.7µmoles hydrogen at the maximum theoretical efficiency of 1.98% reached to the below diagram .this cultivation can be achieved from 0.5% glucose insolation.
The following chart contains 20 ml of hydrogen production from 0.5 % glucose at 70 ° C is plotted.

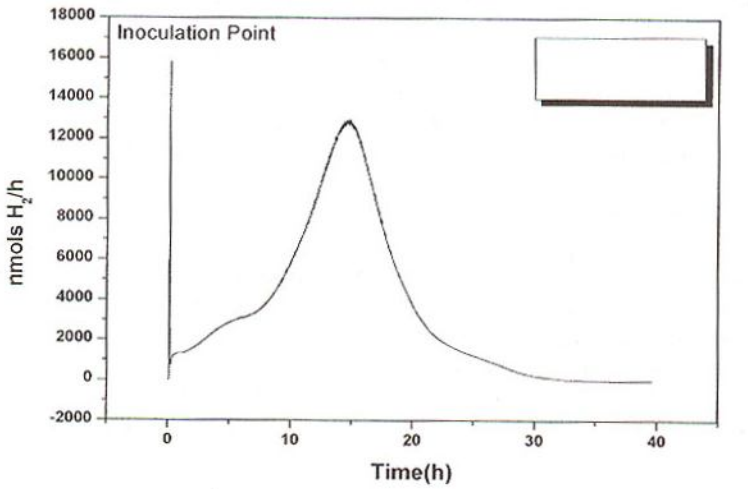

Fig. 3

Julia S. martin del campo et al on completion of this test reached to method that illustrate the rate formation of hydrogen.
In this method compare profile of hydrogen formation from xylose with ATP and polyphosphate in 50°C.as you see in Fig. 4 .

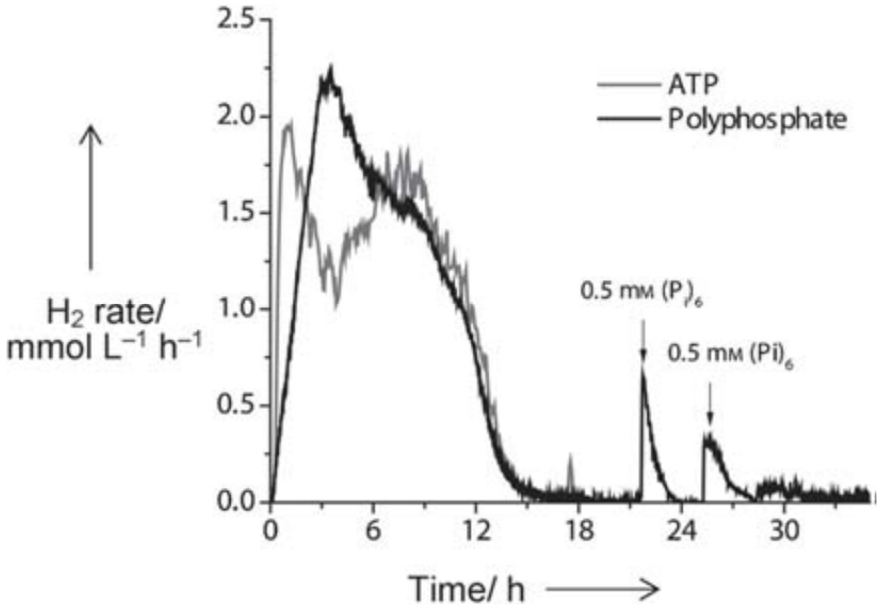

Fig. 4

6-Conclusions

Todays, most of hydrogen production are achieved from renewable resources such as oil and gas in addition, environmental pollution, have high production costs.

In this paper, refers to a method of producing hydrogen using water waste and biomass. That is a suitable method to produce hydrogen, and it's more economical than produce hydrogen from renewable resources.

In addition, according to the result of the analysis in some articles that mentioned in this article can be reached away to produce hydrogen from dehydrogenase.

REFERENCES

[1] Vijayaraghavan, K., Mohd Amin Mohd Soom " Trends in biological hydrogen production – a review " , International Journal of Hydrogen Energy (2004)

[2] Levin D.B., Lawrence Pitt and Murray Love, "Biohydrogen production: prospect and limitations practical application", International Journal of Hydrogen Energy 29 (2004) 173 – 185

[3] http://www.biohydrogen.nl/everyone/20621 [html

[4] koku, Harun., Eroglua, Inci., Gunduz, Ufuk., Yucel, Meral., Turker, Lemi., "Aspects of the metabolism of hydrogen production by Rhodobacter sphaeroides " , International Journal of Hydrogen Energy 27 (2002) 1315 – 1329

[5] Chen, Xi., Sun, Yaqin., Xiu, Zhilong., Li, Xiaohui., Zhang, Daijia., " Stoichiometric analysis of biological hydrogen production by fermentative bacteria International Journal of Hydrogen Energy., Volume 31, Issue 4, March 2006, Pages 539-549.

[6] Julia S. Mart_n del Campo, Joseph Rollin, Suwan Myung, You Chun, Sanjeev Chandrayan, Rodrigo PatiÇo, Michael WWAdams, and Y.-H. Percival Zhang " High-Yield Production of Dihydrogen from Xylose by Using a Synthetic Enzyme Cascade in a Cell-Free System"

[7] Jonathan Woodward, Narinder I. Heyer, John P. Getty, Hugh M. O'Neil Eugene Pinkhassik " Efficient Hydrogen Production Using Enzymes of the Pentose Phosphate Pathway"

[8] Gurpreet Kaur " Synthesis of Boronic Acid Based Sensors forGlucose and Sialic Acid and Synthesis of Novel and Selective PDE4 Enzyme Inhibitors"