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MICROBIAL HYDROGEN PRODUCTION'S RECENT ACHIEVEMENTS

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Microbial hydrogen production development of hydrogen production is the approach of cultivating microorganisms for waste decomposition with hydrogen generation. The microbial methods of hydrogen production include dark fermentation (DF), biophotolysis, photofermentation (PF), and microbial electrolysis cells (MEC). Dark fermentation is a special case of anaerobic digestion (four-step) process that stops on the least step, called acidogenesis. In acidogenesis besides acids, the gaseous phase contains hydrogen; a desired product. A more exact description of the processes and feeds we deliver in Figure 1 shows anaerobic digestion and dark fermentation as two processes. Biophotolysis is a process similar to photosynthesis but these plants by contact with Solar light split water into hydrogen and oxygen. Biophotolysis uses cyanobacteria and algae (macro and micro). Due to the high applicability of these organisms as feed or raw materials are more assessed as feed for other hydrogen generation ways. We can reduce the greenhouse effect by employing biophotolysis organisms that capture carbon dioxide. At the same time, algae can produce materials for the chemistry, pharmacy, and energy industries. Photofermentation is a process that later was substituted by photosynthesis; transfers organic matter like organic acid into hydrogen during Sun radiation exhibition. Microbial electrolysis cells during the digestion of organic matter produce a voltage that can split some compounds like ammonia to hydrogen. DF and MEC are easier controllable than others and therefore are relevant parts of newly designed waste management plants both in industrial and municipal waste sectors. All earlier mentioned methods are sustainable methods for replacing and closing the loop of fossil waste also with the addition of biocenosis waste see Figure 1. The figure shows potential feed.

We showed that an important issue of microbial decomposition is their ability to pollutant removal, produced during fossil fuel combustion. Besides preserving modern life levels, the developed biological hydrogen production methods could allow for removing litter from lingering landfills. After the addition of some sugars DF can utilize fossil wastes like asbestos [21] and glycol ethylene [27] (see Table 1). Thermal decomposition like pyrolysis allows for utilized wastes, including plastics, resulting in faster and higher conversion but with the emission of pollutants. We can enhance thermal plastics conversion by mixing with lignocellulose waste. Therefore there is a necessary combination of biological methods with thermal decomposition for the efficient solving of a problem.

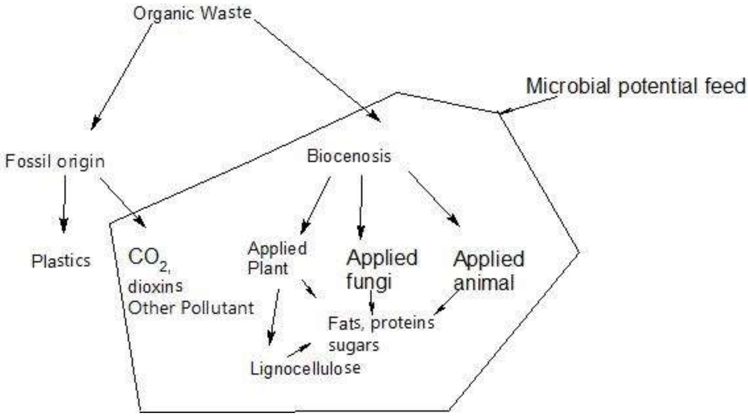

Figure 1. Pathway of organic waste

Table 1. Development of microbial decomposition in 2018-2023

	Dark fermentation		Biophotolysis		Photofermentation		Microbial electrolysis cell		Anaerobic Digestion	
Feed	2018	2023	2018	2023	2018	2023	2018	2023	2018	2023
Composed	Some started science mixtures besides hydrolysates of lignocellulose [2]	Most viewed substrates due to trials of industrial applications. [8]	Mostly as for pharmacy and hydrogen generation [20]	They are part of mixed substrates. The organic matter is important for splitting water into hydrogen [10]	There were attempts to combine with DF [14]	Lots of combinations of other types of microbial and thermal due to wider potentials substrates with limited work time [13]	Mostly limited to water [3]	There are wide mixtures after finding other substrates that water [31]	Biolayer packing upgrading using nanomaterials [12]	Many solutions improved with complex and changing feed [28]
Sugars	Much modelling attempts sugar-based substrate [19]	Allows as codigestion on even utilization of hazardous material as asbestos.	Extracted sugars are potential for wound healing and some attempts for using as additive for improving water	Sugars are more efficient part of pharmacy [35]	Low interest [33]	The sugars extended lists of substrates besides acids [18]	Water splitting only partly without extra chargine [29]	The digestion helps gaining energy for splitting molec	As part of lignocllulose wastes [11]	Combining with DF important for upgrading methane product

		Genetically modified can omit theoretical limitations [9]	splitting [23]					ules [34]		ion [24]
Fats	Trials of checking pathway [4]	Important part of mixture especially of processing of algaes used after biophotolysis [1]	NA	Fats of microalgaes are significant content of biodiesel and biolubricants. [7]	-	Additional processing after DF or biophotolysis	NA	NA	Usual for olive industry	
Proteins	Very seldom only theoretcially potential [6]	Change theory of DF, thus new approaches after successful processing [25]	No interest	Source of pharmacy and polymers	-	NA	NA	NA	Some interest of butchery industry	
Others	Mostly batch [22]	Attempts as part of management plant for upgrading anaerobic digestion or preparing earlier feed [5]	Process tried to intensify biophotolysis hydrogen production with increasing of phytopharmceuticals [15]	Hydrogen production is additional to carbon dioxide capture, and pharmacy and green polymers source [16]	Method widely tested for different feeds [32]	Part of combinations of future wastes utilization [13]	The limited mostly to water started to extend substrate [25]	Industrial attemps for ammonia splitting are common after discovery of approach of Haber process here [30]	Industrial available looking for solving problem of low concentration of chemical industry purposes	Modeling is change from ADM-1 to ANN allowing for more complex [17]

Therefore after looking at Table 1, the researchers combined methods for closing waste loops as tightly as possible. Therefore there are technologies that quite efficiently replace traditional, fossil-sources-dependent lifestyles. The recent achievements are unsupported by legislators. The leaders should prioritize energy transformation as a major goal. The governments of every country should educate and convince all citizens of unity and solidarity in changing lifestyle into zero waste style and sustainable lifestyles, removing the desire for a Hollywood lifestyle. These changes should people rationalize for thinking as one body all population, for avoiding degradation of human living and even extinction by his ‘own wish’.

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