Literature review of how fruits and vegetables can be turned into wealth opportunity.

BIOMASS TECHNOLOGY

a. The varieties of available technologies

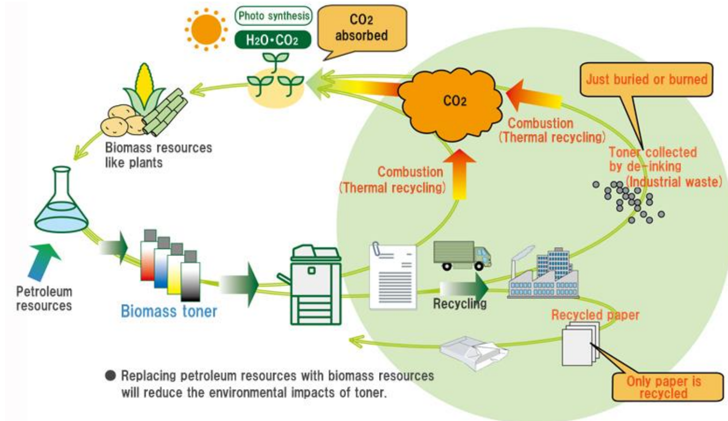

Diagram 1: The diagram shows one example of biomass technology from biomass resources like plants (Adapted from energies-05-04952.pdf)

Two main ways of converting biomass energy (solid fuel) into biofuels and bio-power are biochemical conversion and thermochemical conversion processes (Fischer, 2001). Biochemical conversions convert the biomass into liquid or gaseous fuels by fermentation or anaerobic digestion (Fischer). Thermochemical conversion technologies include combustion, gasification and pyrolysis. While combustion of biomass is the most direct and technically easiest process, the overall efficiency of generating hear from biomass energy is low. Pyrolysis is the heart of the process.

b. The reactions involved

Depending on the operating condition, Bridgwater mentioned that pyrolysis can be classified into three main categories: conventional, fast and flash pyrolysis. These differ in process temperature, heating rate, solid residence time, and biomass particle. Reactions under pyrolysis conditions are complex and not fully understood due to the range of reaction temperatures and the complex biomass composition, but they can be generally classified as a simultaneous mix of dehydration, depolymerisation, re- polymerization, fragmentation, rearrangement, and condensation, as represented by some examples (Bridgwater, 2004). These reactions result in a bio - oil containing over 300 individual compounds. From an applied perspective, bio – oil can be burned directly as a substitute for fuel oil in various static applications such as boilers and furnaces.

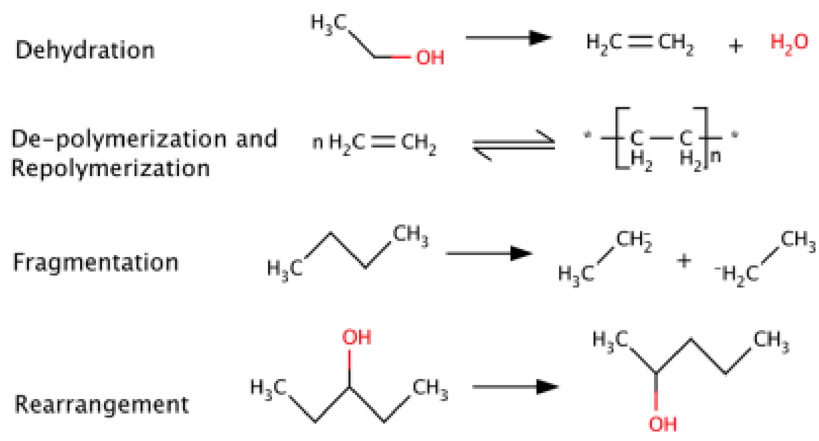

Diagram 2: Representative of pyrolysis reaction (Adapted from energies-05-04952.pdf)

c. The researchers or practitioners that made these technologies successful in their local area

i) American Renewables LLC
ii) Beijing Shenzhou Daxu Bio Energy Technology Co Ltd
iii) Cosmo Powertech Pvt Ltd

d. The pros and constraints of these technologies

Pros (Parikka, 2004):

i) The feedstock for thermochemical conversion can be any type of bio-mas including agriculture residues, forestry residues, by-products of food industry and even organic municipal wastes
ii) The product gas can be converted to a variety of fuels and chemicals as substitutes for petroleum based chemicals
iii) The products are more compatible with existing petroleum refining operations.
iv) User friendly

Cons:

i) High cost associated with cleaning the product gas from tar and undesirable contaminants
ii) Inefficiency due to the high temperatures required

e. The way forward that would help your project

This technology is extremely user friendly which will benefit the consumer in changing their waste such as vegetables and fruits into wealth. It is simple to handle.

BIO- ADSORBENT

a. The varieties of available technologies

There are a variety of existing and available technologies that can be applied to transform waste vegetables and fruits (Biomass) into bio-adsorbent. This transformation is used for wastewater treatment purpose where pollutants are removed or adsorbed onto the modified biomass material (adsorbent) (Patel, 2012). The adsorbents from vegetable and fruit waste are known as BIO-ADSORBENT, which is one of the technologies to be discussed in this project (Laufenberg, 2003).

b. The Reaction Involved

1. Pyrolysis Reaction

In the process of transforming waste vegetables and fruits into bio-adsorbent, the **pyrolysis** reaction needs to take place to convert biomass into oil that can be further refined into valuable fuels, chemicals as well as carbonaceous residues (Patel). Pyrolysis is the thermal decomposition of organic (Carbon-based) materials through the application of heat, without the addition of extra air or oxygen (Hossain, 2012). Hossain stated that pyrolysis can be considered as an alternative to reduce waste volume and a method for obtaining energy from wastes, however, it appears to be best suited for processing organic feedstocks with high heat value (Hanafiah, 2007).The pyrolysis reaction can be represented by the following equation:-

$$CxHyOz + \text{heat} \rightarrow H_2O + CO_2 + H_2 + CO + CH_4 + C_2H_6 + CH_2O + \text{tar} + \text{char}$$

2. Chemically Modification of Biomass Wastes

Pre-treatment of biomass wastes can extract soluble organic compounds and enhance chelating efficiency. Hanafiah stated that the method uses a variety of modifying agents such as base solutions (Sodium hydroxide, Calcium hydroxide, Sodium carbonate) and organic acid solutions (Hydrochloric acid, Nitric acid, Sulphuric acid, Tartaric acid), oxidizing agent (hydrogen peroxide) for the purpose of removing soluble organic compounds, eliminating colouration of the aqueous solutions and increasing efficiency of metal adsorption.

c. The researchers or practitioners that made these technologies successful in their local area

i) Almond shell - ISCA
ii) Qualigens Fine Chemical Company
iii) Clow Corporation

d. The Pros and Constraints of these technologies

Pros (Ashraf, 2011)*:*

i. Low cost materials originated from agriculture sources and by products(fruits, vegetables)
ii. Eco friendly as these biomass material used does not bring any harm to the environment.
iii. Bio-adsorbent has proven to be more effective in heavy metal uptake. In other words, bio-adsorbent has higher adsorption capabilities than super-adsorbents

Constraints (Argun, 2006):

i. The production process is complex and thus, the cost is high in producing bio-adsorbents.
ii. The researches up-to-date only concentrate on single metal ion treatment using bio-adsorbent which is limited if it were to be used in industries.

e. The way forward that would help your project

To make sure that these wastes can be turned into wealth, further researches should be done to ensure that the technology mentioned can be applied with high efficiencies and simultaneously, low operating cost to convert the wastes.

ANAEROBIC DIGESTION

a) The varieties of available technologies

Diagram 3: The process flow of waste to products through anaerobic digestion (Adapted from http://www.energy.ca.gov/biomass/anaerobic.html)

These technologies can be applied to transform waste vegetables and fruits (Biomass) into three principal products which are biogas, digestate, and water. Biogas can be used as vehicle fuel after further treatment and also used to run a gas engine to produce electrical power (Graves, 1972). Moreover, Graves also stated that the digestate can be used as a soil conditioner to increase the organic content of soils.

b) The reactions involved

The four key stages of anaerobic digestion involve hydrolysis, acidogenesis, acetogenesis and methanogenesis (Mudhoo, 2012). The overall process can be described by the chemical reaction, where organic material such as glucose is biochemically digested into carbon dioxide (CO_2) and methane (CH_4) by the anaerobic microorganisms.

$$C_6H_{12}O_6 \rightarrow 3CO_2 + 3CH_4$$

c) The researchers or practitioners that made these technologies successful in their local area

i) BioDrill, New York
ii) Robet Boyle at Hampton, London
iii) Stephen Hales, Exeter, England

d) The pros and constraints of these technologies

Pros:

i) Truly a renewable fuel
ii) Widely available and naturally distributed
iii) Generally low cost inputs
iv) Can be domestically produced for energy independence

v) Reducing or eliminating the energy footprint of waste treatment plants
vi) Reducing methane emission from landfills
vii) Displacing industrially produced chemical fertilizers
viii) Reducing electrical grid transportation losses

Constraints:

i) Energy intensive to produce. In some cases, with little or no net gain.
ii) Land utilization can be considerable. Can lead to deforestation.
iii) May compete directly with food production (e.g. corn, soy)
iv) Heavy feedstock require energy to transport.
v) Some methane and CO_2 are emitted during production

f. The way forward that would help your project

The processes of transformation from waste vegetables and fruits to products through anaerobic digestion are very simple and have high efficiency. These processes are very helpful in my project in managing waste and turn into wealth.

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