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An Investigation Into The Use of Biodegradable Utensils at UBC:

A Triple Bottom-Line Assessment

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An Investigation Into The Use of Biodegradable Utensils at UBC: A Triple Bottom-Line Assessment

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GLOSSARY

1. *Biodegradable Plastics* – Traditional plastics such as the common Coke and Pepsi bottles do not degrade naturally. Biodegradable plastics have all the properties of traditional plastics, however, they retain the ability to degrade into their base organic constituents when composted.

2. *Polymer* – A large chain of molecules consisting of a repeating series of an identical, repeating molecules connected by covalent chemical bonds.

3. *Poly-Lactic Acid* – Lactic Acid is a naturally occurring molecule. When polymerized, it forms a plastic that can be shaped into cups, plates, and cutlery. The benefit of poly-lactic acid (PLA) plastics is that PLA plastics have the ability to decompose into organic matter when composted.

4. *Specific Energy* – In the context of the production of specific materials, specific energy refers to the amount of energy (in mega-Joules) to produce one kilogram of that specific material. The higher the specific energy for a particular material, the more energy is required to produce that material.

5. *Compostability* – The ability of an object to breakdown and decompose into its basic organic constituents under natural conditions.

6. *Aerobic* – In the presence of oxygen.

7. *Aliphatic Plastics* – Biodegradable plastics. Examples of Aliphatic Plastics include Poly Lactic Acid (PLA) and Polyhydroxyalkanoate (PHA) plastics.

8. *Aromatic Plastics* – Everyday use, ubiquitous, common plastics such as Polyethylene (PET), and polypropylene (PE). These plastics, do not biodegrade.

LIST OF ABBREVIATIONS

1. SUB – Student Union Building
2. SEEDS – Social, Ecological, Economic, Development Studies
3. APSC – Applied Science
4. GHG – Green House Gasses
5. PLA – Poly-Lactic Acid
6. PE – Polypropylene
7. PET – Polyethylene
8. UBC – University of British Columbia
9. BC – British Columbia
10. USD – United States Dollar
11. kW – Kilo Watts
12. WMPB[1] = what Makes Plastic Biodegradable
13. USEPA[1] = United States Environmental Protection Agency
14. SSINA[1] = Specialty Steel Industry of North America
15. BBS[1] = BSI Biodegradable Solutions
16. RG[1] = Rainwater Goods
17. MMPFW[1] = Microbes Manufacture Plastic From Food Waste
18. WC[1] = Wooden Cutlery

[1] Used in parenthetical references only to abbreviate names in the work-cited section.

ABSTRACT

Each year in the United States, over 39 Billion plastic forks and knives end up in landfills. The University of British Columbia has plans to alter its practices to reflect its vision of sustainability. One of the parameters being studied in this quest towards sustainability is the selection of the appropriate utensils to be used by the UBC Food Services.

A triple bottom line assessment was conducted of using biodegradable PLA plastic, wooden, and stainless steel utensils respectively. A triple bottom line assessment looks at the environmental, social, and economical aspects to a certain problem. In the case of choosing the right utensils, it was found that wooden utensils are the most environmentally friendly, although studies showed people preferring plastics due to the unfavorable taste and texture of wooden utensils, whereas the reusability of stainless steel utensils made them the most appealing in terms of cost.

It was concluded that although stainless steel utensils may be a great choice, the need for disposable utensils would always remain. In such cases, PLA plastics are a clear winner both socially and economically. On the environmental forefront, due to the ethical dilemmas of using food products in producing PLA plastics, alternative feedstocks need to be investigated.

1.0 Introduction

As a reflection of the growing needs of the university and it's students, and a commitment towards building a more sustainability-conscious tomorrow, UBC is in the process of designing a new Student Union Building (SUB). At the beginning of the year, representatives from the SUB project and UBC SEEDS (Social Ecological Economic Development Studies) office presented several project subject options to the students of APSC 262. One of the available projects was to complete a triple bottom line assessment of alternative cutlery choices for use at UBC. Large quantities of waste is generated each year from the disposal of single-use plastic cutlery. In the United States (as of 1999), it is estimated that approximately 39 billion disposable plastic utensils end up in landfills each year (USEPA). The problem here arises from the fact that the disposable plastics in landfills do not breakdown for hundreds of years and contribute to society's ever-escalating garbage problem. Therefore, one sustainable solution to this problem is to provide utensils that can be recycled, or are compostable.

Many food outlets at UBC already use biodegradable plastic utensils; however, there are many questions regarding this product, including the compostability and manufacturing processes. There is some uncertainty on whether it is the most sustainable option for food services at UBC. Three companies who manufacture biodegradable utensils were chosen for investigation from a list provided by the SEEDS office: BSI Biodegradable Solutions (biodegradable plastic based), Aspenware, and Envirocuts (both wood based). Many other companies (not included in this analysis) also supply similar products. Metal cutlery was also examined as an alternative to single use utensils, taking into account an annual replacement rate of 30% due to mostly theft and some accidental disposal.

A triple bottom line assessment was performed comparing biodegradable, wood, and metal utensils. A triple bottom line comparison consists of evaluating the social, environmental, and economical impacts that a product has. This is a more complete method of determining the actual costs of a product, rather than just focusing on the financial details alone (which is the only factor in a traditional bottom line assessment).

Environmental Assessment

There are many environmental impacts of concern in this triple bottom line assessment. The five sub-topics that will be covered in the environmental assessment of the utensils include transportation of products, materials used, their ecological footprint, the overall energy consumption, and the compostability of products in question.

1.1 Transportation

Transportation and distance from UBC is a major factor in considering products. Greater distances travelled result in increased energy usage and greater greenhouse gas (GHG) emissions. Aspenware is based out of Lumby, BC which is about 500 km away from the UBC Campus. Envirocuts, on the other hand, are based out of Greater Vancouver and hence would require to travel a shorter distance to reach the UBC Campus. BSI Biodegradable solutions has a distributor in Vancouver, however their biodegradable utensils are manufactured in China, and thus must travel great distances to UBC. No specific metal cutlery distributor or manufacturer was selected due to the ubiquity of metal utensils. It can be assumed that a local wholesale distributor can be used.

1.2 Materials of Use

Aspenware uses trees (primarily birch) from northern BC that have already been cut down during logging for softwoods and would go to waste. Aspenware is efficient in using materials; their process "can produce 10,000 forks from only one cubic meters of birch wood". Their products contain an edible glue to hold layers of wood together as a laminate, and a confectioner's glaze to coat the product (Aspenware 2010). Envirocuts (who also make wooden utensils), also use birch wood from BC. They claim that their products are made from trees that have been replanted in previously farmed forests, and "matures every season". Their products are petroleum and chemical free, non-toxic, and contain no toxins or glazes (Envirocuts 2010).

BSI Biodegradable Solutions produces bio-degradable polylactic acid (PLA) utensils. PLA can be produced using many different feedstock, however the PLA used by BSI is derived from corn (BBS, 2010).

Metal utensils are primarily made of stainless steel, which contains recycled content and is fully recyclable (SSINA).

1.3 Ecological Footprint

As Aspenware and Envirocuts obtain their materials from waste-wood and re-planted trees, their ecological footprint is relatively low. When it comes to BSI, however, their ecological footprint is definitely larger.

The use of corn (or any other food item) towards producing utensils causes an increase in land and crop use. The dilemma here arises from the fact that both the land and crops being used to produce forks could be used to feed human beings! This is analogous to the use of food crops to produce biofuels. Although the magnitude of land and crop use for producing utensils is significantly less than that of producing biofuels, it is still of concern. Furthermore, BSI manufactures its products and obtains it's crops in China, where food shortage is a serious issue in many areas. With increasing global food costs, using food crops for other uses results in increased fertilizer and water use. In addition, this added demand for food creates the demand for more farmland, resulting in the burning of forests. All of the above outcomes lead to increased energy use and GHG emissions (MMPFW, 2003).

The use of metal cutlery poses an environmental concern that biodegradable utensils don't have: the impact of cleaning the utensils. The utensils must be cleaned after each use, requiring water usage as well as the use of cleaning products (which often contain chemicals that can be harmful to the environment).

1.4 Energy Consumption

The amount of energy that goes into producing the materials of use is important. Comparing the energy requirements to produce different materials of provides insight onto their environmental ramifications. For example, materials

with high specific energy requirements are likely to contribute towards greater GHG emissions as the source of energy is most likely from fossil-fuels. Figure-1 (shown below) compares the specific energy requirements (in mega Joules per kilogram) of different materials.

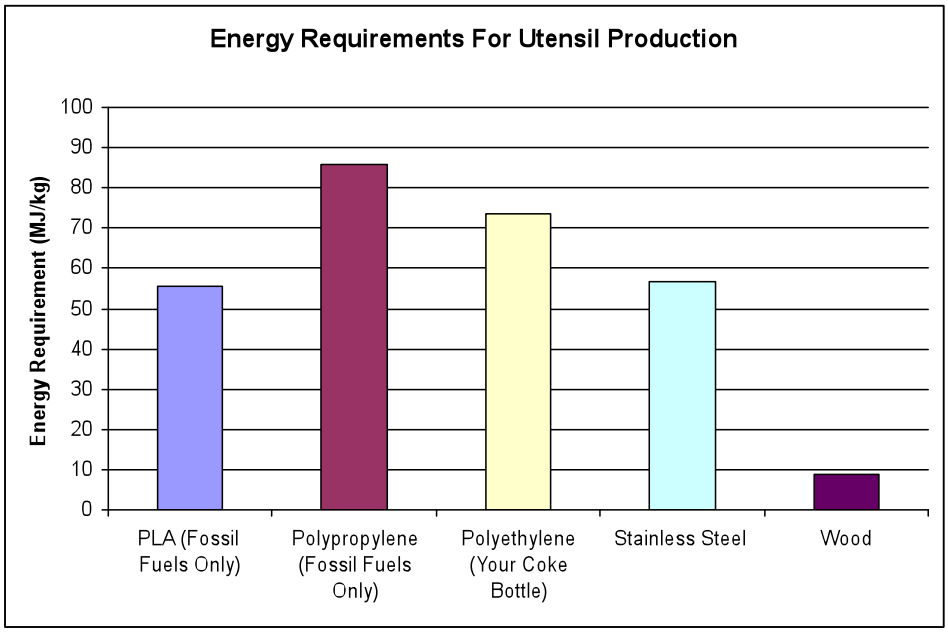

Figure-1: Energy Requirements For Utensil Material Production

This is a comparison between the energy required to produce PLA plastics, wood, and stainless-steel and conventional (non-biodegradable) polypropylene (PE) and polyethylene (PET) plastics. As it can be seen, the production of wood is the least energy intensive of all. Stainless Steel (RG, 2008) and PLA (Gerngross, 1999) have similar energy requirements, whereas PE and PET require the most energy (Frischknecht & Suter, 1996). It should be noted, however, that the energy requirements shown here for the PLA does not include the embodied energy in the food-products if food products are used as feedstock (Gerngross & Slater, 2000).

1.5 Compostability

The main purpose of investigating alternative cutleries is to alleviate the problem of waste accumulation in landfills. Therefore the ease at which the alternative utensils biodegrade are key in assessing their environmental friendliness.

The PLA plastic produced by BSI solution is marketed as a biodegradable plastic. PLA typically breaks down at 60 degrees Celsius and 60-70% relative humidity. In addition, an aerobic environment is needed or else the PLA does not biodegrade (Bohlmann, 2001). The reason for such stringent requirements for compostability potentially include the fact that the biodegradable utensils commercially marketed do contain a blend of both aliphatic and aromatic plastics (WMPD, 2007). Therefore, the typical Vancouver landfill does not meet the necessary criteria for the PLA to breakdown. Industrial composting facilities are required to for PLA to decompose. Given the right conditions, PLA breaks down within 100-days at industrial composting sites. If composting at home, the plastics require 180 days to biodegrade (Bohlmann, 2001).

Wooden utensils biodegrade fairly easily. Aspenware reported that 33% of the wooden utensils biodegraded within 45 days, and 100% of the utensils were composted within 60 days. The conditions of composting wooden utensils are not as selective as PLA, and hence can be composted in regular landfills or at home (Aspenware, 2010).

Metal utensils do not compost, however they can be recycled and used multiple times, indefinitely. Nevertheless, each year roughly 30% of the utensils go missing (through theft, or accidental disposal). Thus a small amount of metal cutlery probably ends up in landfills.

2.0 Economic Analysis

The cost of a product is generally a strong determining factor behind its commercial viability. The same principal applies to the success of alternative utensils used by the UBC Food Services. Therefore, from an economic angle of the triple bottom-line assessment, the costs of PLA plastic, wooden, and metal utensils will be compared.

2.1 The Cost of PLA Utensils

Table-1 (shown below) presents a price list of utensils made of PLA plastics.

Table-1: Price List of PLA Biodegradable Utensils

Description	Material	Weight (g)	Price (USD)	Pieces/Pack	Pieces/Carton
6'' Knife	PLA	3.4	$0.025	50	1000
6'' Fork	PLA	3.9	$0.025	50	1000
6'' Spoon	PLA	4.0	$0.025	50	1000
6.5'' Knife	PLA	4.60	$0.027	50	1000
6.5'' Fork	PLA	4.95	$0.027	50	1000
6.5'' Spoon	PLA	5.62	$0.027	50	1000

The prices shown in Table-1 have been obtained from Xiamen Jaefer Foodservice Solutions Ltd. based in China. It was initially intended to obtain the price quotations from BSI Biodegradable Solutions, however as the relevant data was unavailable, the Chinese data was used. In any case, the price of PLA manufactured in China is most likely to be the cheapest and hence provides the best-case scenario in favor of the 'green' plastic. Therefore, for the sake of consistency in comparison, all the prices quoted and compared in this paper will be corresponding to the prices in China and be reported in US Dollars.

One thing to keep in mind with respect to these prices is that as stated in the trading agreement, prices are subject to change every three months. However this is no different from any other commodity derivatives. Furthermore, in order to purchase the PLA based utensils, a minimum order of 300 cartons (300,000 pieces) must be made per type of utensil (i.e. fork, knife, etc). However, given the fact that the UBC Tim Horton's uses roughly 100,000 utensils a month, and that

there are roughly 30 food outlets at UBC, the UBC Food Services would require approximately 300,000 or more utensils per month. Hence the vendor's minimum order requirements are not a deterring factor. As the utensils are manufactured China, 30 days are required for shipping at a cost of roughly $1,800.

2.2 Comparing Costs

In addition to PLA, the alternative cutlery choices include wood and stainless steel utensils. The cheapest wood/bamboo utensils sell for roughly $0.10 per unit (WC). Therefore, compared to PLA, wooden utensils are more expensive, however the minimum requirements for ordering are a lot more lenient. Only 1,000 pieces need to be ordered as opposed to the 300,000-piece order for the PLA. Therefore wooden utensils may be favorable if conducting small-scale feasibility studies. The average price of steel utensils is $0.52 per unit (Escrow Inc). Regardless of the higher initial investment on metal utensils, it is a one-time cost as they can be reused indefinitely. Nevertheless, it is assumed that 30% of metal utensils require replacement each year due to accidental disposal and theft. An annualized cost for each type of utensil can be estimated and used to compare the costs. Such a comparison can be seen below in Table-2:

Table-2: Annual Cost of Utensils

	PLA	Wood/Bamboo	Steel
Annual Cost	$90,000 USD	$360,000 USD	$5,200 USD
Extra	Shipping cost ($1800 USD/300 Carton)	None	30% replacement ($1,560)
Total cost	$111,600 USD	$360,000 USD	$6,760 USD

The numbers (as reported in Table-2) were calculated based on the following assumptions:

PLA Utensils

- PLA (bought through Xiamen Foodservice Solutions Ltd) costs $0.025/Unit
- Shipping Costs for PLA is $1,800

Wooden Utensils

- Wood/Bamboo utensils cost $0.10 per unit.

Metal Utensils

- One-time fee of $0.52 per unit.

Annual Consumption

- Tim-Hortons on UBC campus uses 10,000 utensils per month.
- There are roughly 30 food outlets on UBC Campus.
- Thus there is approximately 300,000 utensils used each month.
- However, metal utensils are reusable indefinitely. Therefore, assuming that all of UBC uses 300,000 utensils each month, that boils down to 10,000 utensils per day per outlet, on average. Therefore, 10,000 metal utensils are required for all of UBC to meet their utensils need.

Annual Cost

- PLA = $90,000
- Wood = $360,000
- Steel = $5,200 (One Time) + 30% Loss per year $1,560 (recurring)
- A point to note is that metal utensils require approximately 15 liters of water per 1000 pieces of cutlery for cleaning purposes and an energy consumption of 2 kW (Green, 2010). Therefore an annual cost of labor and maintenance for the metal utensils add up to being $480.08 year.
- This bumps the total cost of metal utensils up to $7,240.08

Looking at the costs and comparing them with one another shows that the stainless steel utensils are clearly the cheapest choice. However, if looked at from more than a purely financial perspective and if water consumption and energy use are to be considered, then wooden utensils tend to far outweigh both PLA and steel. Nevertheless, one fact that cannot be ignored is that stainless steel utensils require the users to eat within the premises of the UBC Food Services' facility,

and return the utensils upon use. However, a large portion of the UBC Food Services' clientele is based of people who are on the go, and hence require utensils that are disposable. Also, stainless steel utensils involve either purchasing dishwashers, or hiring labour to wash dishes. If a food outlet does not wish to make these changes to their business, then stainless steel utensils no longer remain an option for them, and PLA and wood automatically become the two remaining contenders.

3.0 Social, Ethical, and Safety Impacts

The social component of the triple bottom line assessment is a relatively newer addition complementing the environmental and economical aspects of the analysis triad. Two companies, BSI Biodegradable Solutions and Aspenware are distributors for PLA and wooden utensils respectively. Many of UBC food outlets have been using the former since 2008 (Liska Richer, 2010). The scope of this section is to analyze any human rights implications, health, or safety issues relating to biodegradable, wooden and metal utensils. The analysis of BSI and Aspenware represent biodegradable plastic and wooden utensils, respectively.

BSI Biodegradable Solutions distributes a myriad of biodegradable disposables including cutlery and plates. The corn needed to manufacture these products is sourced from China, but the actual province from where corn is harvested is unknown (S.Y. Lee, 2009). Although the current state of agricultural affairs in China has improved over the past decade, there are several persisting problems with their farming practices. Arguably the most significant problems to date are the collective farming scheme, unfair taxation, and working conditions.

3.1 Farming and PLA Plastics

Collective farming is a term used to describe the need for farmers to meet a certain production quota and the restriction to sell their goods to the free market (this restriction has been imposed by the communist government of China). By law, the land which the farmers grow their crops legally belongs to the local governments, implying that the governments indirectly manage the crops. A farmer's net income is generally low compared to North American farmers and their taxes are high. In the 1990s, they were taxed by more than half their income due to exploitation of corrupt governments. Examples include taxes from marriage and from burning smoke. This forces the Chinese farmers to rely on government subsidiaries creating a loop of dependence. In addition, Chinese farmers lack paved roads, reliable transportation mediums, and effective machinery to deliver and produce their crops effectively. For example, it can take a Chinese farmer 58 days to produce a ton of rice where an American farmer can

do the same in just a day and a half (Hays, 2008). As the actual conditions of the farmers producing the corn used in PLA is very difficult to trace, these issues are just potential, albeit likely, possibilities that could directly relate to corn farmers serving BSI Biodegradable Solutions. A previous SEEDS report compares the possible use of potato wash from BFS instead of corn from BSI biodegradable solutions (S. Y. Lee, 2009). BFS uses a waste effluent from another industry in creating PLA. It uses 77% the energy that BSI uses and the transport costs are less. This is an option that should be explored further.

3.2 Social Impact of Wooden Utensils

Aspenware has its manufacturing and distributors located in Lumby, British Columbia. Key aspects are that the wood is sourced locally from Northern British Columbia and the trees that are logged for this purpose are replanted. This company also has numerous positive testimonials on its products. In the context of human rights and ethical issues, this company is in accordance with them. For wooden utensils in general, future companies wishing to source our trees or manufacture them in Canada can make use of British Columbia's naturally abundant Birch and Aspen.

3.3 Social Impact of Metal Utensils

For metal utensils, given how long they have been in existence and the abundance of companies that produce them, it was assumed for the scope of this report that any metal utensils produced in Canada abide by their federal and provincial labour laws and safety practices.

3.4 Public Perception and Awareness

The public perception and awareness of the use of biodegradable utensils here at UBC is important in assessing the success of this change. An informal survey conducted by Jason Kwan was performed on 100 students who were sitting in the SUB. These students were asked if they were aware of the use of biodegradable utensils in UBC food outlets and their first impression of how environmentally

friendly it is. Results were organized based on their year of study and based on their faculty. Figure-2 shows the number of people who are aware of the use of biodegradable utensils. 53 out of 100 people surveyed knew UBC used them. Most students who responded yes also stated that they saw it on a sign posted near the food service outlet.

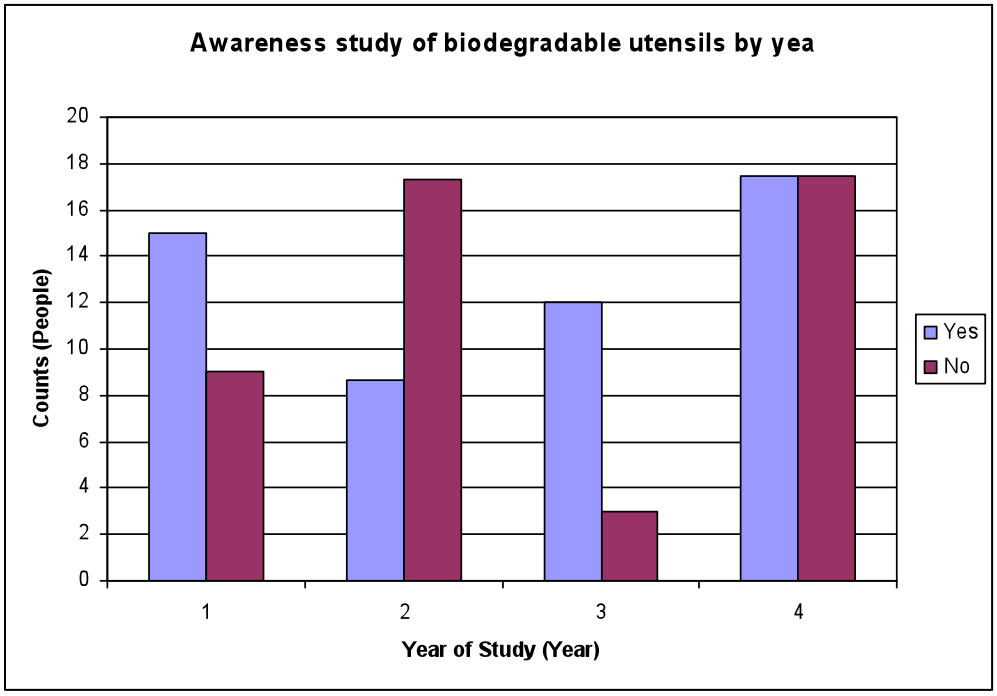

Figure-2: Awareness Study of Biodegradable Utensils at UBC

In terms of how well biodegradable plastic utensils were perceived, there were no negative responses. People either stated that they were helpful to the environment or that they needed more information to judge for themselves. A follow-up question was asked regarding what kind of information they wanted. Statistics and general background information were the most frequently requested. Generally, the attitude towards using biodegradable plastics is positive and people are content with just their use. People are generally showing their support by using the appropriate utensils.

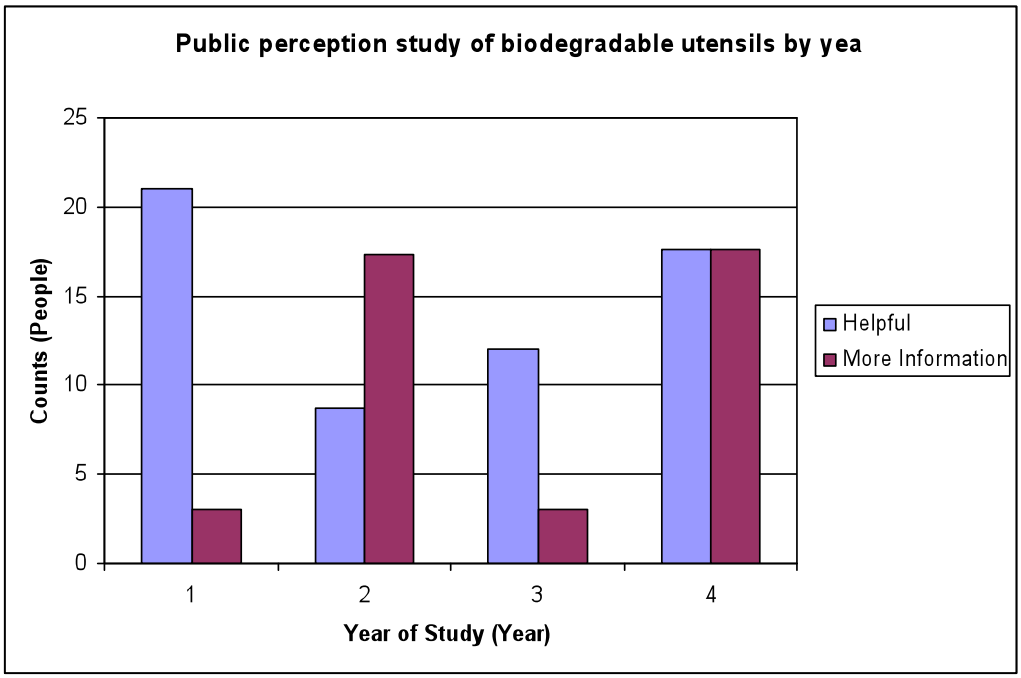

Figure-3: Public Perception Study of Biodegradable Utensils at UBC

From a social impact point of view, it is difficult to assess which of the three types of material is best. But with reference to S.Y. Lee's report and comments given by surveyed students, the use of BSF biodegradable utensils from waste potato starch would be a possible alternative to the corn-based utensils processed in China.

4.0 Conclusion

Upon studying the environmental, the economic, and the social aspects of using different cutlery options at UBC, the only thing that is certain is that there is no single clear-cut solution towards choosing the right type of cutlery at UBC. Environmentally speaking, wooden utensils prevail. Economically, stainless steel is the best solution. Socially speaking, the answer is even more ambivalent!

Therefore, in conclusion, although stainless steel and it's indefinite use may appear to be a good solution, the demand for disposable cutlery will always remain. In such cases, keeping all three factors of the triple bottom line assessment in mind, PLA plastic is the best choice. The ecological footprint of PLA can be reduced using waste products from other industries. Doing so will surely resolve the ethical dilemmas of using food to produce plastics, while potentially driving down the cost of PLA as well.

Editor's Note: Once the research for this paper was completed, Envirocuts reported that they no longer sell wooden utensils as PLA utensils were outperforming them (Kirby, 2010). This is not surprising as it was found during research that people generally prefer plastics to wood, as unlike wooden utensils, plastics utensils are generally taste and odor free.

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