“GREEN CAPS”

Biodegradable alternative for plastic water bottle caps

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PROBLEM
Major threat to our planet PLASTICS, large part of which is “PLASTIC WATER BOTTLES”.

- **78 million barrels** of oil are used in production of water bottles yearly.
- Enough to fuel **1 Million** cars for **1 year**.
- Only **1 in 5** water bottles are recycled.
- The other **4** contribute to the **3 billion** pound of waste from plastic water bottles.
- **30 billion** plastic water bottles are thrown away every year.
- **200,000** tonnes carbon dioxide are produced by plastic bottle industry each year.
- **57,140** trees would be needed to absorb **20,000** tonnes of CO₂.
- It will take **400 to 1,000** years for raw plastic to degrade in the environment.

![Per capita PET beverage bottle wasting and recycling, 1990-2006](image)

- Only **20 %** of the total PET production available for recycling was actually recycled (NAPCOR 2002). The major fraction of this **80% waste plastic** that goes to the landfills is plastic **water bottle caps** due to their difficult recycling process as they are high molecular weight plastics.

- **10% percent** of the plastic produced every year worldwide winds up in the ocean. **70%** of which finds its way to the ocean floor, where it will likely never degrade.
SOLUTION

“Green Caps”

Biodegradable alternative for plastic water bottle caps.

- Made of Cashew nut shell liquid
- Less time to break down
- Renewable
- Environment friendly
- Less energy for manufacturing
- Easily recyclable
- Not toxic
- Reduces dependence on the foreign oil

We are going to use cashew nut shell liquid for replacing the plastic caps. “Green Caps” made of thermoplastic compounds based on renewable resources offer a more environmentally compatible alternative to synthetic petrochemical plastic caps.

- It is a strong thermoplastic formulated from cellulose, cashew nut shells (natural fiber) and wax. Natural fibres can be obtained from flex, hemp, cashew nut shell, etc. Cashew nut shell liquid is our choice of material because it is abundant in the Vellore and nearby regions.
- The trade pattern in cashew in the world suggest that **8 to 9 million** cartons of cashews are traded in the world in an year. The main countries that constitute the world cashew exporting list are: India (**4.5 million cartons**), Vietnam (**2.3 million cartons**), Brazil (**1.75 million cartons**), Tanzania, Ghana.

- The technical yield of processing is **0.21**. That is to say, every metric ton of raw nuts gives 210kg of processed cashew kernel plus 7% of cashew nuts shell liquid (CNSL).

- The chemical composition of distilled technical CNSL is approximately:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardanol</td>
<td>78%</td>
</tr>
<tr>
<td>Cardol</td>
<td>8%</td>
</tr>
<tr>
<td>Polymeric Material</td>
<td>2%</td>
</tr>
<tr>
<td>2-Methyl Cardanol</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Heptadecyl Homologue Triene</td>
<td>2.3%</td>
</tr>
<tr>
<td>Heptadecyl Homologue Diene</td>
<td>3.8%</td>
</tr>
<tr>
<td>Other Homologous Phenols</td>
<td>Very small quantity</td>
</tr>
</tbody>
</table>

- The resulting material achieves a level of **durability** that makes it ideal for thermoplastic.

- Also, by varying the composition of this thermoplastic compound both in terms of quality and quantity it is possible to adjust **strength**, **rigidity**, **dimensional stability** with varying temperatures, and other material properties so as to suit specific product requirements.
EXPERIMENT

- Cashew nut shell liquid is blended with a monomer resin.
- The monomer used was synthesized from phenol, aniline and formaldehyde at a molecular ratio of 1:2:4. The monomer synthesis was based on solvent less synthesis technique. The reactants were physically mixed and heated to their melting point temperature thereafter maintained at a temperature sufficient to complete the interaction of the reactants to produce the monomer. The monomer blended with CNSL was used as a composite matrix and was prepared at temperature of 80 °C.

- This results in the production of CNSL based thermoplastic.
- As it is a thermoplastic it can be molded into the desired shape by injection molding technique.
- But for injection molding a prototype is needed. The prototype cap was produced using rapid prototyping machine. The input for the machine was 3D model of a cap which was made by using solid works software.
- Finally, the thermoplastic is used to produce the biodegradable caps with reference to the prototype.

- This thermoplastic material is 100% from renewable resources. 60% to 90% decomposition can be achieved within 60 to 180 days of being placed in a standard environment - this may be either a composting situation or a landfill.

TECHNOLOGY

Technology employed at the lab scale for the production of the model—“Rapid prototyping”. Rapid prototyping is name given to a host of related technologies that are used to fabricate physical objects directly from CAD data sources.

These methods are unique in that they add and bond materials in layers to form objects. Such systems are also known by the names additive
manufacturing, additive fabrication, three dimensional printing, solid freeform fabrication (SFF) and layered manufacturing.

A RAPID PROTOTYPING MACHINE AVAILABLE IN LAB

INJECTION MOLDING

Injection molding is a manufacturing process for producing parts from both thermoplastic and thermosetting plastic materials. Material is fed into a heated barrel, mixed, and forced into a mold cavity where it cools and hardens to the configuration of the cavity. After a product is designed, usually by an industrial designer or an engineer, molds are made by a moldmaker (or toolmaker) from metal, usually either steel or aluminum, and precision-machined to form the features of the desired part.
A schematic diagram of injection molding machine

**MODEL/PROTOTYPE:**

- **Technology used**: Rapid prototyping
- **Input**: 3-D model
- **Software employed**: Solid Works
**Raw material**: Polycarbonate

**Processing time**: 1 hour

**Cost**: Rs. 515

**Lab used**: VIT- TBI INCUBATOR

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**COST**

- Cashew nuts shells are available for trading from **March** through **June**.
- But, our raw material will be available throughout the year depending on the market situation.
- The raw material is available in gunny big containers of 200kgs which costs around Rs. 5000. Therefore, one litre cost of cashew nut shell liquid is approx **Rs 30**.
- According our field research in some of the villages in **Cuddalore** district and interview with cashewnut sellers the price of the shells has never crossed **Rs.5000/container**.
- Even in future if the demand increases due to more production, the price will not increase.
At the lab scale, manufacturing of model cost us around Rs. 500.
Technology employed was Rapid Prototyping at VIT TBI INCUBATOR.
Raw material used Polycarbonate.
Cost of the chemical which are used for the polymerization of cnsl is as follows:

<table>
<thead>
<tr>
<th>Name of the chemical</th>
<th>pack(kgs)</th>
<th>price(Rs/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aniline</td>
<td>200</td>
<td>85+VAT</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>230</td>
<td>17.00</td>
</tr>
<tr>
<td>Phenol(GI drums)</td>
<td>215</td>
<td>90+VAT</td>
</tr>
</tbody>
</table>

- Cost of injection molding machine: $39,500

Waste disposal cost:
- It requires incineration, recycling, transport to landfills.
- No need, will decompose naturally.

yet to be estimated specifically, but goal is to achieve a lower price

not a chance no economies of scale
MARKETING STRATEGY

Our product “Green Caps” is one which will be produced in bulk quantity targetting the pastic water bottle manufacturers for the branded bottled water companies. Our target customers are plastic water bottle manufacturers. Our initial targets will be plastic water manufacturers in nearby regions of Tamil Nadu.

Our supply chain unlike a retail product is quite simple:

CNSL manufacturers  →  Cap manufacturers  →  Plastic water manufacturers

Right now our primary focus is on replacing plastic water bottle caps, but we have also look forward to replace the plastic items in the area where its use is harmful like baby toys, hospital equipments, medicine bottles, etc.

SWOT ANALYSIS

STRENGTHS:

Ready availability of the raw material, lower cost, environment friendly, easy and low cost techniques, new idea

WEAKNESS:

Lack of R&D thrust, lack of awareness,

OPPORTUNITY:

Exports, government support, market size
OTHER SOLUTIONS

1. Plastarch Material (PSM)

   is a biodegradable, thermoplastic resin. It is composed of starch combined with several other biodegradable materials. The starch is modified in order to obtain heat-resistant properties, making PSM one of few bioplastics capable of withstanding high temperatures. PSM began to be commercially available in 2005. However, concerns have been expressed about the impact of such technologies on food prices.

2. ARBOFORM

   Arboform is manufactured from the waste products of the paper industry. The paper industry separates out the three components of wood lignin, cellulose and hemicellulose.

   To formulate Arboform, scientist’s blended lignin with natural fibers like flax, hemp or jute and mixed it with wax. The mixture heated or conditioned under high pressures resulted in a thermoplastic material-liquid wood or Arboform.

4. BOMBOO FIBERS

   The same biodegradable caps can be made by using bamboo fibers and lignin. But raw material cost will be higher than cashew nut shell.

   Transportation, extraction of bulb will need more labor and its time consuming. Some biodegradable polymers which are used for making implants can be used. But they are expensive.
Cashew Nut Shell

- Our aim is to provide a solution at cheaper cost hence; we prefer cashew shells as our raw material.

- Moreover two of our group members have some agricultural background so it will be easy for to contact people for our raw material.

CONCLUSION

As our aim is to replace the plastic material, our project will get support from the government and industry. And it will be beneficial for the farmers also. Because we are planning to establish our production unit village side we will get labors from the same area. By this the villagers will get employed. Our project will support agriculture by encouraging the farmers to produce more cashew nuts.

The packaged water market constitutes **15 per cent** of the overall packaged beverage industry, which has annual sales of at least $2.6bn. Bottled water industry is worth nearly **10,000 crore rupees**. Quite apparent the market size for the “GREEN CAPS” is same as that of the bottled water which is growing each year at the rate of **30% to 40%** each year. So our business promises huge profits in the near future. Moreover, in the long term prospects of our business we are also planning to manufactures of various size and designs not only for water bottles but also juice-soft drink bottles, pet containers, etc. One we are successful at small scale production, slowly we will move on to replacing the plastic bottles, bags and other plastic materials.

Our product is expected to significantly reduce hazardous waste caused by oil-derived plastics, which remain solid for hundreds of years, and open a new era in packing technology and industry.
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