Project name: iMad Africa

Title: Waste management -Recycling of waste plastic, animal and plant matter using synthetic biology approach

Introduction

40% of the health related challenges in Zimbabwe are caused by poor disposal of waste materials. Most of these materials are from the industries and household. The problems which are generated are quite amplified by the poor processing capabilities of the waste resulting in land, water and air pollution. Waste management is not only a problem of Zimbabwean cities but it's quite common in many high density cities of Africa and the world.

Upon realizing that the towns of Harare, Bulawayo, Mutare and Masvingo, which are found in Zimbabwe, were facing many pollution crisis as a result of poor waste management we initiated a bio-friendly waste management start-up quite eco-friendly and efficient. Our main goal was to reduce the waste by 80% and allow the waste to be recycled, and reused for other productive purposes for example as nutrition in agriculture, blanket manufacturing in the textile industry.

Fig 1: High level of waste poorly disposed in the city of Harare Fig 2: Dumpsite

We suggested and utilized synthetic biology approach which is very scalable and have a production capacity of more than 100% in product safety. Poor disposal of plastic generate radicals which can play a role in greenhouse effect and affect the health of the local inhabitants, in contrast, synthetic biology allows the production of safe products like polyhydroxy butyrate (PHB) which is bio degradable and can be recycled into other important substances.

Our synthetic biology approach towards recycling of waste reduces water and air borne diseases which have been so prevalent in Zimbabwean towns. We realized that just deploying bins around

the city is not enough but we have to couple this with a tech tracking system which signal when

the bins need attention and employing synthetic biology will inhibit accumulation of waste at dumpsites, parking lots , terminuses, and industrial spaces.

This project is sure to be eco and bio-friendly, as well as creating jobs for young people. Health-wise, our environments become more healthier and innovative through the alarm tech system which stands to be a warning system on plastic amount

Materials and methods

- PET (Poly Ethlyn Terephthalate)
- HDPE (High Density Poly Ethylene)
- LDPE (Low Density Poly Ethylene)
- LLDPE (Linear Low Density Poly Ethylene
- PP-Poly propelene
- PS-Poly Styrene-Kayelite
- E. Coli/ *Microcytisis qeruginosa*/ *Microcystis* sp/ *aematococcus pluvialis*
- PHB

Our approach of waste recycling is to convert polyethylene and polypropylene into polyhydroxy butyrate which is quite biodegradable. PHB is non-toxic and bio-based so it can be metabolized by natural and synthetic microbes and enzymes to other non-toxic forms., it does not require industrial compositing. As iMad Africa, our approach is to turn waste-based feedstocks into PHB using synthetic biology approach, that is, engineered enzymes.

In our processing channel we employ microorganisms/enzymes which act on plant and animal based matter, and synthetic materials like plastics into PHB. In the city of Mutare where we have started our operations, we have deployed labelled bins where locals can put waste materials accordingly. We are working with 10 young people who have duties of collecting plastics in industrial areas and high density areas. We have coupled our synthetic biology processing plant with a tech tracking system which reports if bins are full.

Imad is incentivizing the collection of polystyrene waste and our main goal is to increase the effect of synthetic biology on PHB whilst reducing the foot print of the PHB feedstock and its absolute life cycle

In our phase one operations, we have shown a proof of the production of polyhydroxybutyrate (PHB) from plastics using engineered E.Coli TG1 strains. To show that our enzymes had a capacity to convert plastics into PHB (polyhydroxy butyrate) we demonstrated that using quantitative immunoblotting. To show the degradation rate of plastics (styrene) to PHB plasmid libraries were utilized.

To analyze the degradation pathways of the enzymes and the genetic variants of enzyme species Indigo formation was used as an indicator. Finally, the production capacity of PHB from plastics, plant and animal matter was measured using Nile red staining together with gas chromatography

spectroscy, and extracted using aqueous-based extraction methods

Fig 5 : Mobile bins in high density suburbs

Fig 6 : Mobile bins in low density suburbs

Our startup has been advertising our work to locals, taking time to teach them safe disposal of waste as well as visiting industrial areas to create synergies. Shown below is our flyer.

Fig 7 : iMad Africa flyer for waste collection

Results

Microcystis sp produces the highest quantity of PBH/ L

Our model shows a 60% yield in PHB production/g styrene and approximately 2 grams PHB/L/hr which can keep our streets, parking lots, industrial areas less of plastics using *Microcystis* sp.

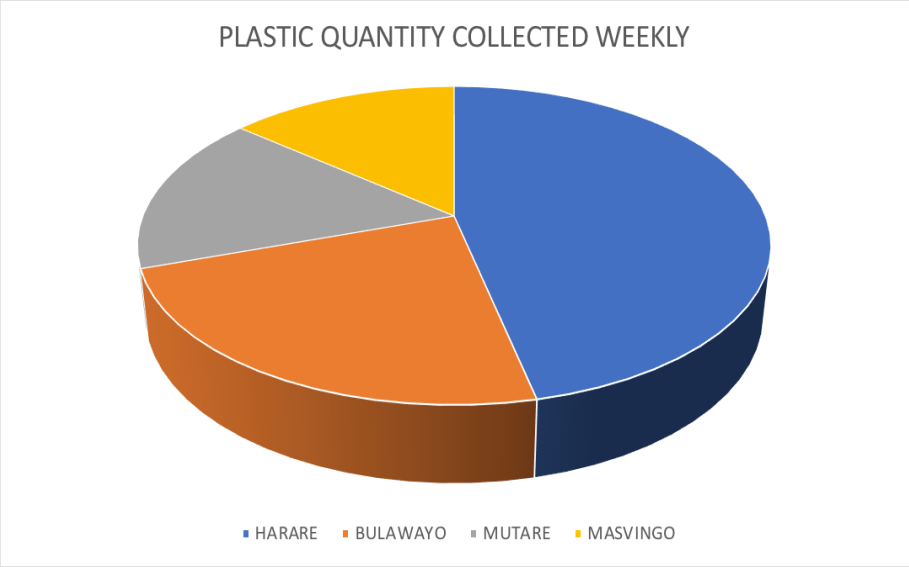
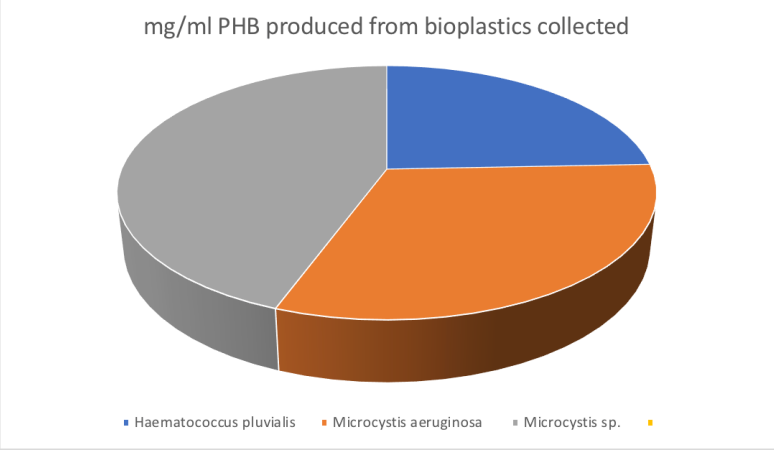


Fig 8. Plastic Quantity collected weekly

The pie chart above shows the amount of plastics which we collect each and every week in 4 different cities in the past 3 months weekly. The values are as follows

Harare: 1000kgs
Bulawayo: 500kgs
Mutare: 350kgs
Masvingo: 300kgs

We are managing to collect 2100kgs of plastics every week which we recycle into poly hydroxy butyrate which we sell further to different industries where it is used to manufacture different products like fertilizers, and packaging materials We are intending to employ more advanced synthetic biology approaches which can increase the % yield of PHB in the minimum possible time, and more young people in a way to create employment.



Fg 9. PHB amount produced in mg per hour

Using the most efficient enzyme, *Microcytis Sp,* our startup iMad Africa is managing to produce an approximate amount of 2100kgs of PHB weekly which we are selling to different industries at a price of $1 per kg.

We have deployed enough bins in cities which can support the different type of waste materials which can be produced per time shown below. Shown below is the city of Mutare after we have started our operations

Fig. 4: Mutare City

Conclusion

The reason we are using a conversion pathway which generates PHB is that PHB is bio-degradable by natural microbes both aquatic and terrestrial. In addition to that PHB can be used in the food industry, cosmetic industry, packaging purposes, agriculture industry as fertilizer, medical and textile industry. In a nut shell, synthetic biology allows an efficient recycling approach of wastes.

Since this approach solves local challenges, we believe that authorities are capable of supporting such initiative financially and other means.

Currently in our organization we are 11, myself as an innovator and 10 workers. We are open for any

synergies or investments in form of ideas or financial one which can increase our production capacity whilst solving a problem in our towns

Picture sources: Herald Zimbabwe.