Black Soldier Fly: Agents for Transformation of Sanitation Crisis into Opportunity for Enterprise Development

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Present State of Toilets in India

Poor Infrastructure
Inadequate Superstructure
Maintenance Issues

Many toilets don’t get used because they smell bad. I believe this is a problem we can solve through innovation.
Distribution of Sanitation Systems in India

- 46% septic tanks
- 13% pit latrines
- 15% other latrines
- 26% without latrines

(Data Source: WHO/UNICEF 2015)

Ineffective Treatment

Quality Sanitation: A Human Right

How to ensure quality? Who will pay for it?
Dismal Condition of Public Toilets

Even we pay, cleanliness and hygiene is not assured

[Hindustan Times April 26, 2016]
Highly impaired with pollutants, high Fecal coliform concentration.

A FRESH LOOK AT USE OF WATER IN DOMESTIC SECTORS

**Water Supply**
110-130 L

**Toilet Flushing**
50 L

**Wash Basin, Washing machine, kitchen WW**
60-80 L

**Sewage System**

**Sewage Treatment Plant**

**Water Distribution Network**

**HUGE INFRASTRUCTURE AND MAINTENANCE COST**

**CAN THINGS BE MADE BETTER?**

**BLACK WATER**

**GREY WATER**

Low pollutant load, low level of contamination.
CHARITY BEGINS AT HOME – RECYCLING AT THE HOME LEVEL

Water Supply

80 L / 135 L

Water Distribution Network

Can it be totally avoided? It is the root cause of all problems

Sewerage System

50 L

DECENTRALIZED ONSITE TREATMENT

GREY WATER

50 L / 100-110 L

BLACKWATER

Sewage Treatment Plant

50 L

LANDSCAPING

30 L

HUGE SAVINGS IN CAPITAL AS WELL AS OPERATING COSTS

Can it be totally avoided? It is the root cause of all problems
Water-flushed Toilets – Is there a need to think otherwise?

Human Excreta

Urine (2 L)
- almost no BOD
- Full of nutrients
- no or very less pathogen/contamination

Feces (~250 g)
- volume-~ 300 mL
- High BOD
- Full of nutrients
- loads of pathogens
- root cause of all troubles

How wise it is to dilute the problem contained in max 300 mL of excreta, and to disperse into 100 L of wastewater and spread the contamination?

Conventional Sewerage systems are bigger culprits in the spread of contamination
Almost all the existing treatment processes convert the waste ultimately into carbon dioxide. There is almost no recycling of nutrients. Recycling is the order of the nature.
Two processes for disappearance: Consume or Degrade. Which one is quicker?
Black Soldier Fly (BSF)

The pupae has high content of protein and fat.
Experimental Protocol

Environmental conditions:  
- Temperature, $T = 20, 25, 30, 35, 40, 45$ deg C
- Humidity = 55, 65, 75 and 85%

Polyvinyl plastic box
- Lid of polyvinyl plastic box
- Holes for air circulation
- Weight of substrate = 200 gm
- 50 nos. of BSFL
Results: Substrate Reduction
Results: Larval Weight Gain
### Results: Human Feces Treatment and Larval Weight Gain

Number of larvae required and weight gain will be more favorable if a mixture of human feces and organic waste is used.

<table>
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<th>TEMP.</th>
<th>R.H. (%)</th>
<th>Substrate consumption per larvae (in grams)</th>
<th>Weight Gain (in mg/larva)</th>
<th>Number of larvae reqd. For consumption of 1 Kg human fecal waste</th>
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<td>55</td>
<td>1.0935</td>
<td>46.832</td>
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</table>


Result: Biochemical analysis

Dry content: 40%
Moisture content: 60%

Protein
Bichichoninic Acid assay

Fat
Vanillin Assay

Carbohydrate
Anthrone assay

Fertilizer

PROTEIN
FAT
CARBOHYDRATE

50%
45%
5%

Chitin

BioDiesel
Results

• Across the various environmental conditions, average number of larvae required for the consumption of 1 kg of human feces is 800-1500. A typical egg cluster from a fly produces about 800-1200 neonatal larvae.

• 1 kg of human feces can also produce 130-170 g of pre-pupae which has a market value

• Present market value of BSF pupae as a fish feed is approximately $2000/ ton

• Poultry and fish-feed market in India do not have nutritious diet. And, insect-based diet is non-existent in India
Novel Sanitation System using BSFL

Develop Technology to Generate Commercial Values

Sustainable Business Process

Enterprise Development
• Presently, the proof-of-concept study is successful. The BSFL can be used to treat raw human feces in Indian conditions at around 15-40 deg C and various levels of relative humidity

• For practical implementation, design and development of alternative infrastructure would be required

• Implementation and commercial activities at this stage is very much feasible for community and public toilets.

• Further studies will be needed to check whether the pathogens are transferred through the food chain.

• A major challenge is to artificially breed the indigenous flies. One or more environmental cues play major role, light spectrum being one of them.
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THANK YOU!

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