Does Probiotics and/or Vitamin C help mealworms with the consumption of plastic?

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INTRODUCTION:

Plastic is a big debacle in our world. There are many types of plastics like polyethylene terephthalate(PET/PETE), Polyvinyl chloride (PVC), Low density polyethylene (LDPE), Polypropylene, Polystyrene, Miscellaneous plastics. However, by far, polyethylene terephthalate is the most used plastic in the world. PET is used in day-to-day life cases such as plastic bags, film, flexible plastic containers, and polyester clothing. Though we do acknowledge the fact that there has been much development in the world and PET is now mostly recyclable, there are still many problems associated with this. Some places don't have recycling machinery Malaysia due to their floods, Ethiopia for the great mass of plastic, India due to craft villages, and the USA, who has some infrastructure but has to export some of its own plastic because of too much waste. Additionally, even when the plastic is processed or recycled, toxic fumes are released in the process harming the environment gravely. Mealworms have the ability to digest this plastic and turn it into healthy fertilizer for the world.

Mealworms are decomposers in the wild who are, unlike earthworms, a true insect. Even though mealworms are not a world known species, they have a vital role in three main things; ecosystem, agriculture, and nutrition. Mealworms decompose the unnatural waste, both man-made and natural, being the janitor of the environment. They help grow crops by their healthy frass (mealworm feces), decomposing garden waste producing the frass, and being a natural way to manage garden pests. Mealworms also have and provide nutrients protein, fat, fiber, vitamins (B12 and B2), and minerals for not only animals or crops but for humans as well. Mealworms have been actively accepted as a new nutrient source, introduced as powder in pastries, eaten dry, or sometimes eaten raw. They have significant potential of becoming a main food source currently being grown in farms. However, mealworms are catching diseases on farms that obviously mess-up their health. Feeding vitamin C or probiotics may be helpful to the process.

There are 3 main types of mealworms. The Dark Mealworm-Tenebrio obscurus, Superworm-Zhobobas morio (the best plastic eater), and the Yellow Mealworm-Tenebrio molito (most common type of mealworm. For the yellow mealworm, they like to eat styrofoam, moisturized and VERY dry food, decaying organic matter, grains, veggies, animal wastes, other dead insects, NO WATER for they will drown and are able to take out of veggies and the humid air, wheat bran, hen feed, buckwheat, and rye flour. Normally, their diet is 2mg grains and 2g of veggies for 25 mealworms in the span of one week. Out of their normal diet, 70mg of plastic for 25 mealworm in the span of one week

METHODS:

Materials:
Probiotics: BIO Schwartz
Lactobacillus, acidophilus LA-14 (17 billion CFU, 85 mg)

Lacticaselbacilius parecasel LPC-37 (2.0 billion CFU, 5mg)
Bifidobacterium animalis subsp lactis BL-04 (o.6 billion CFU, 1.2mg)
Lactiplantibacillus plantarum Lp-115(0.4 billion CFU, 1mg)
Inulin (Agave tequilana stem and base leaves) — 22.5 mg / 45 mg
Non-Medicinal Ingredients:
Hypromellose, Microcrystalline cellulose, Dicalcium phosphate dihydrate, Magnesium stearate, Silicon dioxide, Asparagus root extract.

Affects:

- Kidney health
- Affects energy regulators
- Helps chronic kidney disease
- Makes skin tone vibrant
- Balances skin microbiome

Vitamin C: Sports Research

- Vitamin C (ascorbic acid) 1000 mg

Uses:

- Antioxidant for good health
- Contributes to maintaining general health
- Helps support immune function

Affects:

- micronutrient, vital to functions in body (produce neurotransmitters)
- Creating collagen, a protein essential for
- Maintaining healthy skin, tendons, ligaments, and blood vessels, all repaired
- The vitamin also helps maintain strong bones, cartilage, and teeth. In addition, it boosts the body's ability to absorb iron from plant-based foods.
- Immune system
- Neutralizes free radicals — unstable molecules that can damage cells and contribute to aging and diseases like cancer and heart disease

Plastic: Kirkland signature plastic waterbottle

- 21mg of plastic
- Light weight, 100% recyclable PET/polyethylene terephthalate

Oatmeal: Quaker Quick Oats

- 100% roiled oats

Lettuce: Romaine lettuce

- Costco

Containers: Amazon Petri Dishes
Mealworms: 1000 mealworms, 500 each in two boxes

BASE: 2-3mg of oatmeal, two pieces of 2cmx2cm lettuce, 25 mealworms
G1: Base
G2: Base + 0.115mg of plastic
G3: Base + 0.115mg of plastic + vitamin C
G4: Base + 0.115mg of plastic + probiotics
G5: Base + 0.115mg of plastic + vitamin C + probiotics
G6: Base + 0.115mg of plastic + (vitamin C + probiotics) x 2
G7: 25 mealworms + 0.115mg of plastic + 2 pieces 2cmx2cm lettuce

1. Buy ingredients
2. Sort into groups

Vitamin c: 1 capsule, 1000mg of Vitamin C
Probiotics: 1 capsule,
    a. Lactobacillus, acidophilus LA-14 (17 billion CFU, 85 mg
    b. Lacticaselbacilius parecasel LPC-37 (2.0 billion CFU, 5mg)
    c. Bifidobacterium animalis subsp lactis BL-04 (o.6 billion CFU, 1.2mg)
    d. Lactiplantibacillus plantarum Lp-115(0.4 billion CFU, 1mg)
    e. Inulin (Agave tequilana stem and base leaves) — 22.5 mg / 45 mg
    f. Non-Medicinal Ingredients:
    Hypromellose, Microcrystalline cellulose, Dicalcium phosphate dihydrate, Magnesium stearate, Silicon dioxide, Asparagus root extract.

3. Take notes every day on what changed
4. Take close description when: FIRST DAY, SECOND DAY, FOURTH DAY, SEVENTH DAY
5. Day 7 is last day with the most detailed descriptions

Description:
- Colour of oats
- Amount of oats
- Feces - colour, texture,
- Weight (scaled by whole)
- Average length/width (measured by the most average looking mealworms)
- Amount of dead mealworms
- Colour of mealworms
- Amount of lettuce eaten

RESULTS

Key findings:

1000mg of Vitamin C and Probiotics are not healthy for 25 mealworms over the span of one week. Vitamin C makes mealworms have white and sandy feces while probiotics cause them to have sticky and thick feces.

Mealworms did not eat any plastic. Even the group with force fed plastic, did not eat any of the plastic even after countless attempts.

The healthiest group was the first and second group that had nothing special added to them, except for some plastic that took place in group 2.

Vitamin C is more healthy for mealworms compared to probiotics

ASAP put in: activity scale-
G6-most active
G3-second most active
G4 - third most active
G5 - fourth most active

DAY 1:
G1- No change (just put in) Contains:lettuce, oatmeal,mealworms
G2- No change (just put in) Contains:lettuce, oatmeal,mealworms, plastic
G3- No change (just put in) Contains:lettuce, oatmeal,mealworms, plastic, vitamin C
G4- No change (just put in) Contains:lettuce, oatmeal,mealworms, plastic, probiotics
G5- No change (just put in) Contains:lettuce, oatmeal,mealworms,plastic, vitamin C, probiotics
G6- No change (just put in) Contains:lettuce, oatmeal,mealworms,plastic,(vitamin C, probiotics) x2 (two times amount of vitamin C and probiotics than G5)
G7- No change (just put in) Contains:lettuce,mealworms, plastic

DAY 2:

- Major activity crash in G6,4,3,2
- No difference in plastic
- Less oats and lettuce

LOTS of feces
DAY 3:
G1:
Poo: same poo as day 2
Plastic: no plastic was put in here
Cabbage: non eaten, but has become darker and looks less fresh
Oatmeal: not much eaten
Activity: seems happy and active
Weight: 19 grams
Size: about 2-3 cm
G2:

Poo: grey, small, kinda dark
Cabbage: became very dark and looks like it will go bad soon (not much eaten)
Oatmeal: Still a lot
Activity: slow not very energetic
Weight:
Size:

DAY 4:

G1:
Poo: Same poo as before
Plastic: No plastic in here
Cabbage: More wilted, moisturized from the air
Oatmeal: Many food left
Activity: Very active, happily chewing on food
Weight: 20g
Size: Around 3–3.3cm

Poo: More poo than last time roughly around x4.5 (Bumpy poo)
Plastic: No plastic
Lettuce: Only stem of cabbage left (same color as before banana)
Oatmeal: More or less same as before but still 0.5 less
Activity: Less movement than at 1 but still very active. Slower movement
Weight: 20g
Size: Approximately 3.1–3.3cm

G2

2-1
Poo: Around same as last time roughly 1.5x more. Approx 1.5x more
Plastic: No change, slightly less. Maybe around 0.5
Cabbage: Less than same as G1, almost none
Oatmeal: Same amount as before, slightly less
Activity: Not as active as G1 just cruising, is calm, all look very tired
Weight: 22g
Size: Around 2.5cm average smaller than G1, roughly 3cm–0.2cm

2-2
Poo: Bottom is mostly covered (good amount) smaller than 2-1
Plastic: Same except one piece was curved around on the corner, as better
Cabbage: More cabbage left than group 1
Activity: Little to no movement but is out on group one. Slightly more active
Oatmeal: Slightly more left than 2-1

Weight: 20g
Size: All flatter than last of 2-1. 2.5cm–0.3cm

2-3
Poo: Less poo than G1 and the previous G2
Plastic: Many poo with bumps curving without but still some approx 0.5
Lettuce: Significantly less cabbage than all previous group same color
Oatmeal: Little oatmeal left structure or clumped
Activity: Little to none. Almost NO ACTIVITY at all except for the tiny grabbing movement
Weight: 20g
Size: All varying. Big range of size 2cm–0.2cm ~ 3.2–0.4cm

G3

3-1
Poo: Grey/Brown poo almost no poo all white/very powder
Plastic: Many bumps and tears and some wrapped items
Cabbage: 2 pieces wilted, greener than most (darker green)
Oatmeal: Decent amount same as G1 + G2
Probiotic Powder: No visual probiotic powder left the powder/none visible
Activity: Not as active as G1 but more active than G2
Weight: 21g

3-2
*Poo is coming out watery/light brown
Size: All fat, no little ones. Average: 3.0–0.2cm
Poo: Fat greasy colored poo maybe mixed with oatmeal powder
Plastic: Many bumps but otherwise same
Cabbage: 2 pieces, sharp and very brown
Oatmeal: Same as 3-1
Powder: none to see, visible powder to eye, powder may be but thicker and more colored than oatmeal powder
Activity: slightly less active compared to 3-1
Weight: 21g
Size: slightly smaller than 3-1. Average: 3cm–0.1cm (Approx)

3-3
*Poo is coming out watery and grey, less movement
SAME as 3-1
*Lettuce is much less

G4

4-1
Poo: Brown/Black poo around mass is 2–2. Looks sticky
Plastic: Same amount
Cabbage: One big piece, one tiny piece
Oatmeal: Covered in poo
Vitamin C: None to see, has no white powder anywhere
Activity: Not hiding as much in oatmeal, not much movement
Weight: 21g
Size: Much bigger than G2

4-2
*Poo is sticking together, black stick
Difference:
Poo: Black and normal (same as G1)
Lettuce: very green and wilted

4-3
Difference:
Poo: Very sticky sticking together and to everything but has black poo as well
Vitamin C: Still some leftover cabbage

G5

5-1
Poo: White and bumpy, some black spots
Plastic: No change, bumps and tears but still same
Lettuce: Same, many wrinkled edges
Vitamin C / Probiotics: Stuck to oatmeal, same on lettuce
Oatmeal: Same amount
Activity: Same / same movement but doesn't move a lot

5-2 SAME but,
darker dish (eg darker oatmeal, poo, lettuce)

5-3 SAME, one with exploded guts/ molt.

G6

6-1
Poo: Really foamy, / early grey.
plastic: same old.
cabbage: very wilted.
oatmeal: dark, right amount.
Powders: None to see except for foamy poo.

Activity: slow, covered in white powder thing.
Weight: 21g.
Size: same as G1

6-1b
All the same except!!!

6-2
Less foam poo.

G7

7-1
Poo: less poo, very little poo, black and little, dry.
plastic: Trying to go through but do not have any change
cabbage: None
Activity: Not much
Weight: 18g
Size: very skinny but long 3cm, 0.1–0.2cm

7-2 Same but:

- Still has cabbage though moldy and shriveled -16g
- Poo is brown and more mushy
- Just all have more moisture

7-3 Same as 7-1 -15g

DAY 5: No significant change

DAY 6: No significant change

DAY 7:

G1 (Eva 1-1 & Eva 1-2)

Eva 1-1

- **Poo:** lots of poo oatmeal:poo 1:1, dark grey **A LOT** very dry like sand
- **Oatmeal:** very little left and very little compared to everything else
- **Dead ones:** 2 dead ones, have a black head, look like corpses, very stiff. **BLACK HEADS**
- **Note:** When heads turn black, All the colour goes to head, everything else is pale.
- **Mealworms:**

    - **Movement:** Moving lots ⋆⋆⋆⋆⋆
    - **Length/width/velocity:** Largest Average: 3.1cm, 3mm
    - **Colour:** Tail is dark head is dark
    - **Weight:** 16g

Eva 1-2

- **Behavior:** Hurried. Trying to escape
- **Cabbage/lettuce:** very Brown looks like poo
- **Poo:** oats:poo 4:6, dark grey and slightly lighter also very dry like sand
- **Oatmeal:** Shriveled, very white
- **Dead ones:** 2 dead ones, same for one but one is chewed out half its body is gone dark/light (head is gone), White crumbs, Slightly hollow and crunchy.
- **Measurement:** 3cm 3mm
- **Summary:** 16g, 23 alive 2 dead, look desperate

G2 (Erin, G2-2)

- **Mealworms:**
    - **Average width/length:** 2.5cm/0.3cm
    - **Movement:** ⋆⋆⋆⋆ pretty fast and happy in place
    - **Colour:** Darker tail + head
- **Weight/Count:** 20g total, 25 mealworms (alive)
- **Plastic:** 1.5 cm2, but one has a little chew affect in corner
- **Poo:** Dark grey A LOT, constipation problems
    - Maybe more makes 'em poo MORE
- **Lettuce:** A lot left.
- **Oatmeal:** A fair amount left spread across top.
- **Dead ones:** None are dead.
- **Behavior:** All in small groups of 2-3. Trying to hide them.

G3 - Vitamin C (Eva 3-1)

- **Mealworms:**
    - **Average length/width:** 3.1cm / 0.3cm
    - **Movement:** ⋆⋆⋆⋆
- **Plastic:** smooth, no attempts
- **Colour:** Blended and light
- **Lettuce:** No lettuce.
- **Poo:** Light grey, very mixed in, standard sand
- **Behavior:** Standing up a lot and twisting, trying to get out

- **Weight:** 18g.
- **Dead ones:** 1 dead one, Almost completely black
- **Note:** Poo is mostly white, Vitamin C congestion is what caused them
- **Appearance:** Really light poo
- **Social:** They enjoy going separate ways, trying to escape
- **Status:** 23 mealworms (ALIVE) 1 dead, the other one we're assuming got eaten after death.

G4

- **Setting:** Generally very dark setting.
- **Poo:** Very sticky, sticking to each other, thick as well, in clumps of 1 cm2
- **Oatmeal:** Yellow and dark
- **Movement:** ⋆⋆ not moving as much
- **Stats:** 2.7cm 2mm, 19g.
- **Dead ones:** 3 are dead and all black
- **Sheds:** Many sheds
- **Food:** Lettuce covered in poo. Many black dots on oatmeal and lettuce.
- **Special!!** One completely pale mealworm

G6

- **Mealworms:** all very dark
- **Stats:** 3cm 3mm, 21g.
- **Poo:** foamy, Sandy, light coloured, **VERY LIGHT BROWN**
- **Lettuce:** Poo green
- **Note:** There are certain small ones. Poo is foamy.

G5

- **Movement:** ⋆⋆⋆
- **Behavior:** Not really excited to get out, none of them
- **Colour:** more blended in and darker
- **Status:** FEEL unhappy
- **Poo:** Brown poo

G7

- Poo completely black and kinda dry, in somewhat clumps, not mush, they ate their poo
- Weight
  2.4cm-2mm → 25 of them, 15g
- Colour
  There's a pale/white one, still alive
  dark in the head lighter in the
  body, 3 pale ones, lotta pale
- Plastic: Nothing changed, some bitemarks

DISCUSSION:

1. Why did the mealworms turn white?
    a. Probiotics have the ability to make skin tone brighter, and since much of it was consumed, the mealworm's skin turned bright into white
2. Why did the mealworms in G4 have foamy poo?
    a. Probiotics have an effect on kidneys but because the mealworms kidneys are so small, it may have been overload for them
3. Why were there (more) dead mealworms in the groups with something added into them
    a. They thrive best in their natural environment
4. Why was vitamin C better than probiotics?
    a. Vitamin C is still more of a 'vitamin' whereas probiotics are a 'medication'.
    b. Probiotics have a stronger impact than Vitamin C

ERRORS:

- Plastic was too tall and thin and cut in the wrong shape for them
- The amount of Vitamin C/Probiotics given was not the correct amount
- The time span was too short
- The environment may not have been fit for them

IN THE FUTURE:

Using living organisms to eliminate waste and restore the environment must be approached with great caution. As observed in our experiment, living organisms are highly sensitive to delicate environmental variables such as temperature, humidity, and food availability, making their behavior volatile under changing conditions. In addition, waste exists in countless types and

shapes. Unless very specific conditions are met simultaneously, it may be unrealistic for organisms to consistently consume waste in real landfill environments. Investing heavily in such systems based solely on theoretical assumptions—without fully understanding these limitations—could result in irreversible financial loss and even increased environmental pollution.

Furthermore, if organisms such as mealworms are considered for use in landfills, it is crucial to prioritize recreating their original natural living conditions rather than artificially modifying the environment for human convenience. Excessive human intervention may prevent the organisms from functioning effectively. If waste must be physically altered to a specific form—for example, shredding plastic into small particles so that organisms can consume it—the cost of manufacturing, operating, and maintaining shredding machinery may far exceed the environmental and economic benefits gained from using the organisms themselves. Therefore, a thorough cost–benefit analysis is essential before applying this approach on a large scale.