BIO-YOUTH TOOL KIT

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PREFACE

Dear Reader,

This Toolkit is prepared according to Project named as "Enhancement the capacity of Youth on Biobased Economy". It aims to assist education and training of youth. This toolkit composed of 6 different experimental applications as well as some background information which helps the reader to understand the subjects of Biobased economy better.

One of the outputs of the before mentioned Project is the e-teaching course prepared by Assist. Prof. Berat Haznedaroğlu from Bosporus University, one of the partners of Project. This course covers some basic subjects of circular bioeconomy. Before applying this tool kit, it would be better to follow the course which will help all the participants especially the implementers of experiments for understanding the basics and importance of bioeconomy.

It is important to say some information about safety of experiments. The safety instructions reminded in each experimental design is just some basic safety precautions. It is impossible for me to analyze all possible situations, places of applications, age range of participants, the properties of all materials etc. Please be alert those officials and implementors etc. will be responsible for safety. They must analyze each situation and take all kinds of safety precautions. The safety precautions reminded here are just suggestions and covers some aspects of safety not all.

In addition, there may be some aspects of this tool kit needs to be developed, misconceptions etc. This tool kit is not a must, it is only a starting point which may need further development.

I hope this tool kit will help all the readers to enhance the capacity of youth about biobased economy.

BIODIESEL PRODUCTION FROM WASTE EDIBLE OIL

AIM:

To show possibility of production of diesel fuel from biomass sources other than petroleum

REACTIONS TAKING PLACE:

Transesterification

SIMILAR APPLICATIONS:

https://www.youtube.com/watch?v=n4Ks2R_RX38

MATERIALS:

1. 450 gr. Waste edible oil
2. 90 gr. Methyl alcohol (20%-22%)
3. 2,25 gr. Sodium hydroxide (catalyzer) (0,5 %)

EQUIPMENT:

1. Laboratory scale (kitchen scale-weighing instrument)
2. Filter paper or filtering equipment
3. Magnetic heater (or gas heater-kitchen heater)
4. Turning magnet
5. Heat resistant glass equipment
6. Thermometer

EXPERIMENT:

1. Waste edible oil is filtered to get rid of tiny particles
2. All the materials are weighed and poured into glass equipment.
3. Filtered waste oil is started to be heated till 100^{0}C over magnetic heater with the help of turning magnet (magnetic fish, magnetic stirrer) to evaporate water in oil. Then wait till the temperature becomes 60-70^{0}C
4. Sodium hydroxide is dissolved in methanol in a closed glass container. To make dissolution faster granulated forms of sodium hydroxide is used.
5. Dissolution is added in heated filtered oil by means of funnel and container cap is closed. The mixture is mixed gently for a while and transferred in reverse funnel glass container.
6. The mixture is hanged while cap closed.
7. Glycerol is waited to be settled and then transferred by opening lower valve of funnel container.

BE CAREFUL ABOUT:

- Because many tiny unwanted particles are expected to be present in waste edible oil Filtering step may last long. Not to spend such a long time by filtering, filtering is accomplished before experiment starts
- The amounts of materials are calculated by taking into account the molecular weights of ingredients of reactions.
- The amount of catalyzer is decided by using results of many trials so should not be less than %0,5 which is equal to 2,25 gr.
- Theoretically ethyl alcohol can be used. But in practice to dissolve catalyzer in ethyl alcohol is very difficult than in methanol so methanol should be preferred instead of ethanol.

- Since alcohol is volatile in room temperature, the container should be closed
- The settling of glycerol will take some time more than 6-7 hours so the experiment should be designed by taking into account this long settling time.
- In an experimental design aiming to get high quality biodiesel, the water and dissolved glycerol should be removed by washing the mixture a few times more and giving extra time for settling the remaining glycerol. Since these extra steps makes would make the experiment take longer and quality of biodiesel is not important for our aim, washing steps of biodiesel are not included.

SAFETY:

It includes only just a few advises. All the safety precautions must be analyzed and held by authorities and implementers where the experimental designs are conducted.

- Always there should be someone responsible for safety of experiment. If not possible the one who is performing the experiment should be responsible for safety as well.
- All laboratory safety equipment like starts, gloves, apron, protective eyeglass, googles etc. should be put on before experiment
- The labels of all materials and equipment should be read carefully, especially safety precautions, directions for use and calibration before experiment starts (For example methanol and lye are dangerous chemicals, they can burn the skin or eyes etc.) Be very careful about obeying all precautions and directions for use
- Any materials including the resulting materials or equipment should not be let outside the lab
- Any materials including the resulting materials or equipment should not be let in use for everyday life. Because the resultant biodiesel in this experiment does not meet

qualification standards for use in engine, do not try to use resultant biodiesel in car engines

- ❖ No material should be inhaled, eaten or touched by bare hand

BACKGROUND INFORMATION:

Diesel engine is invented by Rudolf Diesel in the beginning of 1960's. Those engines can produce a high torch so they are very powerful and suitable especially for heavy works including excavators, planes etc. Today those engines are working on fuel from petroleum but when they were invented, they were working on peanut oil. Interestingly they were advertised by saying "farmers, you can produce your own diesel". By the invention of petroleum-based fuels, organic based oil lost their preference in favor to fuels. As time passed petroleum-based fuels become cheaper, easily and continuously accessible. However, climate change come onstage and started to affect our everyday lives seriously.

Nowadays instead of petroleum-based fueled engines, people suggest electricity or hydrogen powered engines. But those technologies are new and long-term results and effects on nature cannot predicted yet. There are some question marks about new technologies: What about the sustainability of raw materials used in the production chain of electricity or hydrogen-based engines especially in cars? Is it logical to depend only on electricity or hydrogen-based cars, engines, motors? Is it possible that the patent owners of those new technologies do the same what the patent owners of petroleum and petroleum-based engines have done before? Is it logical or sustainable to waste all the engines working on diesel and buy new electricity-based ones?

In this complex situation to get rid of those possible future energy monopolies and to cope with the climate change together, diesel fuel made from biomass other than petroleum becomes important. However, due to climate change and population increase, production

of biomass for energy purposes should not compete with production food. instead of biomass from eatable food materials, by-products or waste products becomes important. Waste edible oil is the one most important of them.

Many countries have already been producing biodiesel rom waste edible oil in huge facilities including European Union and Türkiye, U.S.A. etc. It has already been used by itself (B100(100% biodiesel) by mixing up with petroleum-based fuels (B20 (20% mix) Biodiesel is a good alternative for petroleum because:

- ✓ It oils the pieces of engines and makes them work better and longer
- ✓ It works in many difficult climate conditions better because it has lower freezing temperature
- ✓ It is safer because it has higher combustion temperature
- ✓ Since it has no sulphury compounds, it does not lead to acid rains
- ✓ When burned it does not produce carcinogenic compounds and carbon monoxide
- ✓ Since it is a waste product, has no cost other than collecting and transferring cost

However, there is a very important point about use of waste edible for biodiesel. What about its continuity? What happens when the times of crisis of finding oil for consumption and then for waste oil?

As time passes when most of the engines starts to use eco-friendly energy sources, what will happen to waste edible oil? In this experiment it is shown that glycerol is produced as by product in addition to biodiesel. Historically by saponification reaction people have already been familiar with the production of soap from oil. But also, by the help of bio technology which is a part of circular bio economy, it may be possible to produce more valuable products from those waste edible oil instead of production of biodiesel. For example, there are studies on usage of waste oil to produce slow-release fertilizer etc. This experiment though being a very classic technology, can be

open minding and guide the youth to ingredients of circular bioeconomy by referring to bio technology.

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MICROALGEA CULTIVATION FOR BIODIESEL

AIM:

To show that the microalgae could be biomass alternative to petroleum-based chemicals.

REACTIONS TAKING PLACE:

Photosynthesis, Oil Extraction

SIMILAR APPLICATIONS:

https://www.wikihow.com/Grow-Algae

MATERIALS:

1. Four types microalgae culture (four different microalgae species)
2. Pure water
3. Liquid fertilizer (fertilizer for gardening)

EQUIPMENT:

1. Laboratory scale
2. 2 types of plastic bottles (or glass aquarium)
3. Thin aerator tubes to install on the cap of bottles
4. Graduated cylinder
5. Funnel
6. Separation funnel shaped glass container with valve
7. Algae color identification chart
8. Blender (laboratory or kitchen grade)

9. Filter
10. Long spoon (to mix aquarium ingredients)
11. Aquarium motor for aeration

EXPERIMENT

1. Plastic bottles (or glass aquarium) labeled by the name of each microalgae species
2. Amount of pure water and liquid fertilizer is measured by graduated cylinder.
3. To each bottle (or aquarium) same amount of water is added.
4. To each bottle (or aquarium) same amount of fertilizer is added.
5. 1ml of determined species of microalgae is measured and added to same named bottle (or aquarium).
6. Each bottle (or aquarium) is mixed gently for a while.
7. Bottle caps with aeration tubing is closed to each bottle (or aeration motor is installed to each aquarium)
8. Those bottles (or aquariums) become mini photobioreactors. They are placed under different places in such a way that each should be exposed to different amount and kind of light (sun light, florescent light)
9. After one-two-three-week period of cultivating, each bottle (or aquarium) is placed near color identification chart and successful ones are decided.
10. To harvest as more algae as possible all of the ingredients of each bottle are mixed in a large basin
11. Algae cultivated is harvested by filtering or just squeezed by hands (gloves must be put on)
12. Harvested algae is transferred into blender and mixed continuously for 10 minutes
13. The mix is transferred into separation funnel and waited till algae is settled and split up from the oil.

14. The settled sediment is separated by opening the lower valve.
15. Bear in mind that the oil obtained can be further converted to biodiesel in the same way as mentioned in the "Diesel production from waste edible oil" experiment

BE CAREFUL ABOUT:

- The transparency and wholeness of bottles (or aquariums) should be same
- The variables of the experiment are decided as light (kind and intensity), temperature, shape of bottle (thin long-thick short), amount of stirring and algae types. Of course, more experiments can be designed to make fertilizer amount and type, water amount etc. as variables as well
- Bear in mind that depending on the species of microalgae, CO_2, light, stirring; there may not be enough microalgae for cultivation
- During harvesting filter can be used. But some of microalgae can be lost because some of them can stick to pores of the filter.
- Aeration motors can be a variable, one aquarium should be aerated by aquarium aeration motors while the other should not
- If aeration motors used, electric consumption should be taken into account, which will increase the expense of production.

SAFETY:

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- Always there should be someone responsible for safety of experiment. If not possible the one who is performing the experiment should be responsible for safety as well.
- All laboratory safety equipment like gloves, apron, protective eyeglass, googles etc. should be put on before experiment starts.
- The labels of all materials and equipment, safety precautions, directions for use, calibration procedures should be read and obeyed carefully. (For example, algae and fertilizers can be allergic to the skin or eyes or may lead to skin burn; blenders are electrical equipment and very dangerous so utmost care must be taken)
- Any materials including the resulting materials or equipment should not be let outside the lab.
- Any materials including the resulting materials or equipment should not be let in use for everyday life
- No material should be inhaled, eaten or touched by bare hand (For example when cultivating, harvesting and transferring the algae, wholeness of gloves and googles are of special importance. In any part any material should not be inhaled)

BACKGROUND INFORMATION:

Algae are living organisms around us more than we think. They started producing oxygen by photosynthesis before higher plants with green leaves. They made a great contribution on making the earth's atmosphere suitable for us. Macro forms can be seen easily in forests, at sea etc. Microalgae can easily be perceived, too. To observe them looking at the changing color of the oceans, lakes, water ponds from winter to summer is enough. In the ocean they are named as phytoplankton which are making photosynthesis and food for many creatures.

Algae are unicellular organisms making photosynthesis, having cellular materials like cell membrane, cell wall etc. They produce sugar, carbohydrates and oil molecules as cellular energy stores. By means of those products, microalgae become good biomass for many potential uses including biodiesel production which is a bio alternative petroleum-based fuel.

In addition, microalgae have many kinds. They can live diverse conditions from salt water to waste water from intense light to shadow. They do not require soil to grow provided that some nutrients (N, K, etc.) are given. They are not preferred as food so their production do not compete with food production. Taking into account many such superior characteristics, many authorities supply researches on algae and buy the algae-based diesel. There are many algae-based fuel producers around the world[3]

The problem about algae is more or less the same as seen in other biomass sources: the amount of energy required to get energy from algae should be a much less than the energy obtained. To be able to compete with the petroleum-based fuels, more research is required to obtain best species giving most oil in least time together with least energy input.

Some algae species like spirulina have many usages other than biodiesel production. Those species have currently been produced and used for the production of many very valuable materials like vitamins, minerals, raw materials of food supplements, pigments like chlorophyll etc.

To sum up, observation of production of algae by means of such small-scale experimental design would be open minding for youth especially about circular bio-based economy and its components like biotechnology.

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ETHANOL PRODUCTION FROM SUGARY SOURCES

AIM:

To show that it is possible to obtain energy from biomass like sugary sources

REACTIONS TAKING PLACE:

Fermentation (indication is gas formation)

SIMILAR APPLICATIONS:

https://www.youtube.com/watch?v=G2Aj187T4Q8

MATERIALS:

1. Boiled corn, potato and table sugar
2. Water

EQUIPMENTS:

1. Sealable plastic bags (zipper bags)
2. Sticker for labelling
3. Pencil
4. Ethanol sensor
5. Injector
6. Laboratory scale
7. Graduated cylinder

EXPERIMENT:

1. 10 gr of each biomass sample is weighed by laboratory scale
2. Zipper bags are labelled (name of the samples are written)
3. Each zipper bag is filled with 10 gr of written sample
4. 50 ml. water is measured by graduated cylinder and added to each zipper bag
5. 1 gr Baker's yeast is added to each bag and bags are shaken slowly after sealed
6. Bags are placed at room temperature
7. After 2 hour, 4 hours of waiting and end of the date, gas production of each bag is measured by ruler
8. Ethanol production is measured by taking gas in an injector and injecting the gas formed in to ethanol probe immediately

BE CAREFUL ABOUT:

- The zipper bags should have no leakage otherwise gas would be lost and cannot be observed
- Ethanol sensor or alcoholmeter should be used according to user's manual and be calibrated
- The production of gas is indicative of production of ethanol.
- Since ethanol can be lost quickly, the transfer of injector to alcoholmeter is very important step

SAFETY:

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- Always there should be someone responsible for safety of experiment. If not possible the one who is performing the experiment should be responsible for safety as well.

- All laboratory safety equipment like gloves, apron, protective eyeglass, googles etc. should be put on before experiment starts.
- The labels of all materials and equipment especially safety precautions, directions for use should be read and obeyed carefully (For example wearing of gloves is important because in case of contact with skin, Saccromyces cerevisiae can be allergic)
- Any materials including the resulting materials or equipment should not be let outside the lab
- Any materials including the resulting materials or equipment should not be let for everyday use.
- No material should be inhaled, eaten or touched by bare hand.

BACKGROUND INFORMATION:

Ethanol is kind of alcohol and a source of energy. It has many uses from medicine to technology. It has been currently used as disinfectant, antifungal, bacteriocidic, antimicrobial, medicinal solvent in medicine. It has also large scale of uses in many industries. It is used in chemical, food, beverage, paint, textile, flavorings, cosmetics, dye industries. Additionally, like petroleum-based fuels, it dismisses energy when burned. Even though its energy capacity is 30-35 % lower than petroleum-based alternatives, its octane value is very high, even higher than petroleum-based fuels. This high-octane value makes its suitable for both additive to petroleum-based counterparts or an energy source by itself.

Usage of ethanol as fuel for vehicles is widespread all around the world especially in Brazil and USA. Many counties produce ethanol either to add petroleum-based fuels to produce E 10 (10% ethanol, 90% petroleum) or E 85 (%85 ethanol, 15% petroleum) or directly use as fuel for vehicles called flex vehicles as present in Brazil.

Ethanol can be obtained from many kinds of biomass sources. The main principle remains the same: the amount of energy required should be much less than the energy obtained. There have been sources like corn, potato, sugar cane etc. currently used to produce ethanol.

However, climate change, water scarcity and increasing human population makes the authorities unwilling to use the sources of food, feed and medicine for energy purposes. In addition, it is known that in ethanol production process some bacteria may present in the environment which may use sugar instead of Baker's yeast. To get rid of bacteria, antibiotics are used. Of course, long term results of that use of bacteria are unknown. We don't know whether it may result in antibiotic resistant bacteria species. For this reason, scientists are trying to find new eco-friendly ways to get rid of bacteria in ethanol production and new eco-friendly sources for energy. Here biotechnology which is a part of bio economy becomes important.

By this small-scale ethanol production experiment, youth will be familiar with finding eco-friendly alternatives to petroleum-based products and importance of all aspects of circular bio economy including biotechnology.

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ETHANOL FROM CELLULOSIC BIOMASS

AIM:

To show the possibility of production of diesel from cellulosic biomass which is abundant on earth

REACTIONS TAKING PLACE:

Enzymatic Hydrolysis and Fermentation

SIMILAR APPLICATIONS:

https://www.youtube.com/watch?v=249JMD150so

https://www.youtube.com/watch?v=NjQlEYgoYJE

https://www.youtube.com/watch?v=8iNAWPy7xS8&t=11s

MATERIALS:

1. Biomass samples gathered directly from nature (leaves, dry tree branches-sticks, etc.)
2. Biomass samples from industrial waste (cardboard, waste cotton pieces, waste cotton fibers etc.)
3. Cellulase enzyme
4. Baker's Yeast (Saccromyces cerevisiae)

EQUIPMENTS:

1. Grinder
2. Heat resistant test tubes with caps
3. Magnetic heater
4. Basin for hot water
5. Classroom grade ethanol sensor and interfaces

6. Standard blood glucose meter and its sticks
7. Tube holders
8. Graduated cylinder
9. Pipettes, eyedropper similar

EXPERIMENT

1. Ground the samples into very small pieces in order to put in test tubes (for increasing surface area to make the enzymes work better)
1. Label each tube by the name of the sample by using pencil
2. Weigh 100 gr of each biomass samples
3. Add each sample into test tubes and label them.
4. Measure 25 ml water by using graduated cylinder and add each test tube
5. Cap the test tubes and shake them till mixed properly
6. To break the cell wall and get the cellulose better of collected samples, test tubes are boiled either dipping into boiling water in basin or in a container filled with boiling water on magnetic heater
7. Add cellulase enzyme to each sample to convert cellulose into fermentable glucose
8. Close the caps and shake each tube properly after adding cellulase enzyme
9. Put all samples in 80 ^{0}C warm water bath for a night so the enzymes can actively work
10. Allow the samples to settle for a while then take 1 ml from each sample, put the droplet on a piece of clean waxed paper and measure the glucose levels by using blood glucose meters
11. In the next day weigh 1 gr of Baker's yeast (Saccromyces cerevisiae) by lab scale and add to each sample
12. After adding yeast close the caps of each tube and shake them properly

13. After shaking properly loose the caps of each sample because during fermentation gas is produced and makes pressure
14. Put the samples in the warm water bath (80 ^{0}C) again for a night to let yeast ferment sugar to produce ethanol
15. Open the caps of each sample and wait for 30 seconds
16. Stick a new permeable membrane in the sensor part of ethanol probe and measure ethanol level of each test tube from 2 cm over the liquid level of each sample

BE CAREFUL ABOUT:

- Using blood glucose meters is a very important task (YouTube video is also available for this purpose). User Manuel should be read carefully.
- Every measurement should be done using new stick.
- If the result written high, the samples have sugar content higher than 500 mg/dl, The samples should be diluted by adding the same amount water (1 ml water) and result should be multiplied by 2.
- If result is written lo, it means it is lower than 20 mg/dl.
- There are calibration solvent present for measurement. To calibrate it should be used.
- Test strips and upper fastened part must be the same batch. All measurement should be done by using same batch.
- Before testing droplets, droplet icon should be seen on screen of blood glucose meter.
- The droplets must be the same size,
- Using ethanol sensor with interfaces is an important task (YouTube video is also available for this purpose).
- The sensor should be calibrated according to User's Manuel (manufacturer's instructions).
- The measurements should be done at room temperature.

- All the samples should rest for 30 seconds together before measurements.
- Probe should be hold 2 cm over the liquid level. It is very important because this height affects the readings.
- For each reading wait for 1-2 minutes to stabilize the readings.
- Take readings of highest point. If required, take 2 reading and average the results

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Ethanol can be obtained from many kinds of biomass sources. The main principle remains the same: the amount of energy required should be much less than the energy obtained. There have been sources like corn, potato, sugar cane etc. currently used to produce ethanol. However, climate change, water scarcity and increasing human population makes the authorities unwilling to use the sources usable as food, feed and drug for ethanol production. Here comes cellulose onstage because it is a wide spread, rich biomass and nonfood and non-medicine source. It is not easily job to convert cellulose, lignin and hemicellulose to ethanol. Because of that scientist are trying to find ways to obtain sugar from cellulose as cheap, easy and fast as possible.

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BIOPLASTIC FROM BIOMASS

AIM:

To show that it is possible to produce nature friendly plastic from biomass

REACTIONS TAKING PLACE:

Polymerization

SIMILAR APPLICATIONS:

https://bilimgenc.tubitak.gov.tr/makale/doga-dostu-biyoplastik-yapalim

MATERIALS:

1. Corn starch
2. Pure Water
3. Glycerin
4. Vinegar

EQUIPMENT:

1. Food grade pigment
2. Laboratory scale
3. Graduated cylinder
4. Aluminum Folio
5. Magnetic or gas heater
6. Heat resistant glass container
7. Tea/coffee spoon

EXPERIMENT:

1. 60 ml of pure water is measured by means of graduated cylinder
2. 10 gr of corn starch is weighed on laboratory scale (lab grade weighing instrument) and added to water
3. 5 ml (1 tea spoon) of vinegar and 5 ml (1 tea spoon) of glycerin are measured in sequence by graduated cylinder and poured in to the mixture
4. Food grade pigment can be added to the mix to give color if desired
5. The mixture is put on magnetic heater. The mix is then heated and mixed continuously by tea spoon till gelatinized and foamed.
6. The gelatinized mix is poured on aluminum folio and thinned by means of spoon.
7. The folio can be put in paper cup or plate to give cup or plate shape.
8. Then mix is let to dry for 1-2 days.
9. Bio-degrading capacity of mixture can be measured.

BE CAREFUL ABOUT:

- The amount of glycerin should be carefully measured because the glycerin makes the product softer. In order to get the mixture has the desired softness 5 ml is enough.
- The aluminum folio should be smooth otherwise the plastic produced would crack at the wrinkles.

SAFETY:

It includes only just a few advises. All the safety precautions must be analyzed and held by authorities and implementers where the experimental designs are conducted

- Always there should be someone responsible for safety of experiment. If not possible the one who is performing the experiment should be responsible for safety as well.
- All laboratory safety equipment like gloves, apron, protective eyeglass, googles etc. should be put on before experiment starts,
- The labels of all materials and equipment should be read carefully especially safety precautions, directions for use and calibration
- Any materials including the resulting materials or equipment should not be let outside the lab
- Any materials including the resulting materials or equipment should not be let in use for everyday life
- If gas heater is used, be more careful to get rid of burns
- No material should be inhaled, eaten or touched by bare hand

BACKGROUND INFORMATION:

Plastic is an ancient Greek word meaning that having many pieces. Today it is used for petroleum-based polymer materials which are made up of very small particles called monomers Those monomers are polymerized by means of temperature and pressure. Depending on the uses; additives, pigments, stabilizers, UV protectors etc. can be added to increase quality and to develop desired characteristics. Those petroleum-based plastic has a broad range of uses from everyday life products like fork, spoon to high tech vehicles like rockets to planes because they have high-quality characteristics like lightness and durability.

What happens when their life ends? They cannot degrade naturally. Unfortunately, they are split into small pieces and those pieces called microplastics are very dangerous to both human health and nature. They spread everywhere from top of the mountains to

middle of the oceans. In the oceans they formed plastics islands having many squares kilometers surface area.

Elimination of plastics is not easy. Construction of powder plants burning garbage at very high temperatures (800^0C-1000^0C) is required.

Scientists have been declaring the severity of situation for many years. After many years of pollution, even after polluting the blood of newborns with microplastics, serious amount of budget is now devoted to studies for finding alternatives for plastics. For this purposes bioplastic were invented by Japan scientists from potato starch. They declared that this new plastic is nature friendly because it is degradable naturally. However, it is sadly understood that it looks like petroleum-based counterparts because it cannot degrade so easily. That means using biomass for making plastic does not guarantee the naturel degradability. So, a new term come on stage: Biodegradability

In the past bioplastic and biodegrading capacity were used interchangeably. Bu now it is known that each has totally different meanings. Bioplastics does not have to be biodegradable. Also, there are a few kinds non bio plastic but biodegradable products. Taking into account the importance of drinkable water, food, feed and medicine requirements of much more crowded world and climate change, one can easily say that the materials used for the production of bioplastics should not compete with sources of food, feed and medicine. Nowadays scientists are using biomass like cellulose, lignin, cactus, non-eatable mushroom, microalgae etc. to produce totally degradable even compostable bioplastics. However, there should be much more research to make bioplastics from those totally nature friendly bio sources es cheap and qualified as petroleum-based predecessors.

By this experiment, youth will be familiar with some basic concepts of bioeconomy like life cycle analysis.

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BIOMASS USAGE FOR SOIL: COMPOSTING

AIM:

To show that it is possible to enhance the structure of soil and decrease the requirement of fertilizer by using biomass

REACTIONS TAKING PLACE:

Fermentation

SIMILAR APPLICATIONS:

https://www.tarimorman.gov.tr/ABDGM/Belgeler/Uluslararas%C4%B1%20Kurulu%C5%9Flar/G%C4%B1dan%C4%B1%20Koru%20Kompost.pdf

MATERIALS:

1. Food waste
2. Gardening waste
3. Paper, cardboard etc. (without plastic parts or layers)
4. Water without chloride

EQUIPMENTS:

1. Compost thermometer (only for hot compost)
2. Composting machine (only for hot compost), compost drum-tumbler, compost bin

EXPERIMENT:

To make the compost nitrogen and carbon are required. The materials which are nitrogen-rich are classified as green, the materials which are carbon-rich are classified as brown. The greens are mostly green but sometimes they may have some pigments other than chlorophyll. So, their color changes depending on the color of pigments. Some examples of greens are green leaves, remaining after cutting of green grass, vegetable scraps etc.

The brown materials, rich in carbon have colors from dark yellow to brown. Most of them are rich in cellulose. Some examples of browns are chopped wood, wood shavings, sawdust, egg-cartons, egg shells, papers, cardboard, paper bags without plastic layers, tea bag, coffee remaining etc.

The remaining of greasy meal, bone, meat, milk, milk products, onion -garlic scraps, citrus fruit scraps, cat litter, manure etc. should not be added to the formula especially for cold compost. Because those materials may have bacteria, viruses causing diseases. The hot compost made by machines may have different larger scale formulas. But here for safety and easiness is more important cold compost should be conducted. Hot compost is given for participants have idea about the fundamentals of composting

For cold compost

1. Green materials and brown materials are put by layers of at most 2 cm.
2. Cap is closed
3. Wait for 6 months to 1 year.

For hot compost:

1. Compost ingredients are mixed
2. Thermometer is dipped in the compost
3. Temperature and smell of compost is controlled sometimes
4. Compost is mixed sometimes

BE CAREFUL ABOUT:

Since easiness and the safety of experiments is crucial, it is better to apply cold compost. Hot compost is mentioned to make the participants have an idea about subject

Cold compost:

- Cold compost should be closed for at least 6 months otherwise composting does not occur
- Ingredients should be strictly controlled otherwise bacteria, viruses, insects can form and it would be dangerous to health and environment
- If the ingredients are cut into small pieces the time requirement for whole process is lessened because it will enzymes work better

Hot Compost:

- Gas is formed during composting because of fermentation.
- Not to exceed temperature limit and formula limitations
- In case of temperature increase brown materials should be added.
- In case of bad smell brown materials should be added.
- In case of temperature decrease green materials can be added
- Nothing happens, the humidity should be controlled.
- mixing of compost is important.

SAFETY:

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- Always there should be someone responsible for safety of experiment. If not possible the one who is performing the experiment should be responsible for safety as well.
- All laboratory safety equipment like gloves, apron, protective eyeglass, googles etc. should be put on before experiment starts.
- The labels of all materials and equipment should be read carefully, especially safety precautions, directions for use and calibration
- Any materials including the resulting materials or equipment should not be let outside the lab
- Any materials including the resulting materials or equipment should not be let in use for everyday life
- No material should be inhaled, eaten or touched by bare hand

BACKGROUND INFORMATION

There is no garbage in eco system. The garbage of one would be food of the other directly or indirectly. The indirect way consists of breaking big materials into much smaller one's that the creatures can use them easily to make their food.

However, this perfect system has been wounded by human beings by using of materials that has not been produced naturally like plastics. Now we have many kilometers squares garbage islands and garbage mountains of many kilometers tall. Additionally, completely new systems required to get rid of that garbage.

When human beings come face to face with the results of the climate change, bio-based economy has attacked the deserved attention at last. Composting being a part of sustainability giving the materials back to the soil in a usable and safe way attacked the attention as well. In composting some kinds of organic waste is fermented and becomes "compost" which can be used to enhance the soil structure and to decrease the requirement of chemical fertilizer.

The compost is not fertilizer itself but a good structure for soil healing. For example, it increases the water holding capacity of soil, it helps the plants during growing by making the hard soil types like clay -rich soil softer. It may have some compounds like nitrogen, phosphorus etc. in a limited amount depending on the type of waste used. It gives those compounds to soil in a long time unlike fertilizer which gives the compounds the plant required directly to the soil.

Nowadays composting is currently used in many countries: Some authorities encourage people by preparing guidelines for production of compost because composting is not a very difficult task but not so easy as well because especially in cold compost without help of any machine or equipment, to achieve the resultant compost may not be possible. The resultant quality and structure of compost mostly depends on the raw materials used for production. The best formula for fastest fermentation is C/N ratio 30:1 (1 unit nitrogen source and 30 unit of carbon source)

Is compost completely safe? It seems to be very safe and eco-friendly. However, depending on the purity of raw materials compost may be dangerous instead of beneficial to the soil. What happens if the raw materials have inorganic wastes like metal, lead, battery in? What happens if the raw material has excess amount of salt in it Here waste separation in the source becomes very crucial. By means of this small-scale experimental application the youth could experience it, learn the importance and do it habitually.

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