

**32**  
pages



**EXERCISE BOOKS**  
**CAHIER D'EXERCISES**

**21.6 x 27.5cm / 8.5" x 10.82"**  
**Ruled / Ligné**

**Name / Nom:** Benjamin Mathew

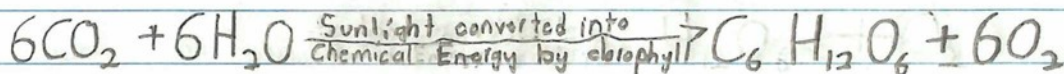
**Subject / Sujet:** Science Fair Log Book 25-

Wednesday, October 15<sup>th</sup>

My goal for science fair this year is to take CO<sup>2</sup> and use it in a helpful way. From what I've learned CO<sup>2</sup> is used to: Make cement, In fire extinguishers, Inflate stomach for surgery, Boost greenhouse yield, Carbonate drinks, Make jet fuel, and Make some plastics. Of these topics what seems most useful + helpful + interesting is agriculture. On the NASA Carbon Dioxide-Earth Indicator, At Mauna Loa the CO<sup>2</sup> levels are highest in May which is just before prime agriculture season, when plants photosynthesize.

Photosynthesis is when a plant takes Carbon dioxide, Water, and sunlight and makes Oxygen and energy in the form of Glucose (a sugar). The plant uses photosynthesis to grow and to help develop fruit.

Photosynthesis Chemical Equation



Thursday, October 16

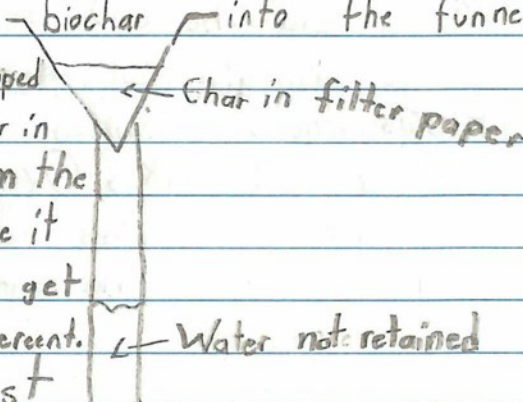
In this project I not only want to use CO<sup>2</sup> but I want to get it from emissions. One thing that is being done is making Biochar. Biochar is a non-natural product of Biomass. Biomass is organic material that can come from nearly anything. Wood, Algae, Crop waste, Manure and others. The process of turning Biomass into Biochar is called pyrolysis, in pyrolysis Biomass is put into a container generally a kiln and heated without oxygen. If oxygen is within oxygen can bond to the carbon and create CO<sup>2</sup> instead of Biochar. Inside the kiln the biomass becomes Biochar, Bio-Oil, and Syngas. Biochar is very high in carbon and can be used just like additional carbon in greenhouses.

Friday, October 17<sup>th</sup>

One idea for a project is this, Using a pyrolysis kiln make different biochars and test their water and nutrient retention as well as its effect on plants

Monday, October 20<sup>th</sup>

A way to test the water retention of the biochar would be to put it into a funnel that has a filter paper inside it and put the funnel in a graduated cylinder. Then put the biochar into the funnel and pour water over it. Once the water has stopped dripping measure the amount of water in the cylinder and subtract it from the amount of water poured in and divide it by the weigh of the biochar to get the water holding capacity in percent. This is called percolation. To test the nutrient retention of soil there are many home test kits that measure: pH, nitrogen, phosphorus and potash.



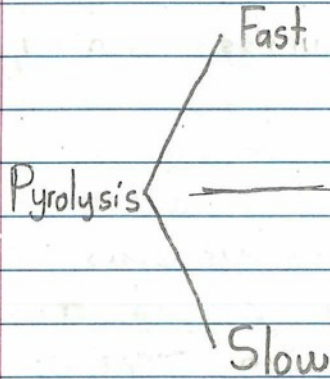
Wednesday, October 22<sup>nd</sup>

On the government of Canada website there is a page that talks about biochar, Vicky Lévesque works with Agriculture and Agri-Food Canada (AAFC), she is testing biochar on tomatoes and peppers in Nova Scotia. Her research found that biochar can reduce nutrient loss, increase size and volume of fruits, increase beneficial bacteria, reduce fertilizer use. In her study she made biochar from sawdust, wood waste from fires and grasses. Factors that can change biochar properties are: temperature, materials used, time heated, moisture content of biomass. The methods of producing biomass are: Pyrolysis, Hydrothermal carbonization, Gasification, Torrefaction and Flash carbonization. I contacted Dr. Vicky Lévesque asking for biochar and for advice/comments.

Biomass Creation Method

Definition

Residence time:  $\leq 2$  s  
 Temperature:  $500-1000^{\circ}\text{C}$



Residence time: Hour-Day  
 Temperature:  $300-700^{\circ}\text{C}$

Hydrothermal Carbonization

Hydrothermal Carbonization happens when biomass is in a reactor at  $180-250^{\circ}\text{C}$  and under pressure, after 20-240 minutes it will yield hydrochar

Gasification

Gasification occurs when biomass comes into contact with high heat while oxygen is present

Flash Carbonization

Torrefaction

Torrefaction is done the same way as pyrolysis but, in lower temperatures

Monday, October 27

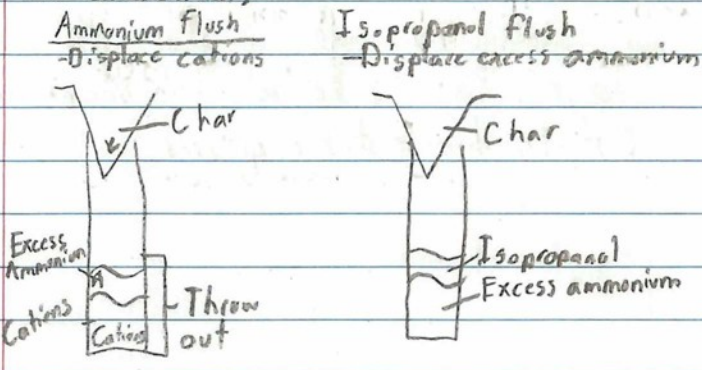
If I have access to a lab and pyrolysis kiln I would like to try to make different biochars by using different biomass components like plants with higher energy. Then I would test the biomasses. Water and Nutrient retention, Carbon content and if possible its effect on various crops. The way I would test nutrient retention would be to measure its cation exchange capacity. A cation is an Ion that is positively charged so has more protons than electrons. Most soils are negatively charged so positive cations stick to the soil, however only so many nutrients can stick to the soil this is the soils cation exchange capacity.

Sunday, November 16

Calcium, potassium, magnesium and ammonium are all positively charged compounds that are used in the cation exchange.

Monday December 29

I don't think that realistically I will be able to make my own Biochar with a pyrolysis kiln so I might instead use store bought ones, run the same tests and look at that to find the best biochar. The way to test nutrient retention would be by washing it with ammonium acetate to take the place of the cations then with Isopropanol to rinse out excess ammonium not taking a cation spot and then with Potassium chloride to displace the ammonium and then measure the ammonium.



Potassium chloride flush

I contacted Dr. Vicky Lévesque asking her for advice about my project and Biochar.

Tuesday, December 30

Today I sent an email to Robert Edwards at the U of C who researches the bonding of biomolecules to biochar. To get the nutrient retention samples analyzed I would send them to the Ucalgary Atom mass lab. Contact at [mwieser@ucalgary.ca](mailto:mwieser@ucalgary.ca)

Sunday, January 11<sup>th</sup>

Today I sent an email to Professor David Layzell who has now retired but is still on the U of C website.

Monday, January 12<sup>th</sup>

Today Professor Layzell told me to contact Rob Lavoie and Don Harfield from Charterra and I did so through their website.

Tuesday, January 13<sup>th</sup>

I got a reply from Rob Lavoie today who offered to meet on Thursday this week.

Wednesday, January 14<sup>th</sup>

I am going to meet Rob Lavoie on Saturday at 1:30 PM as I cannot meet with him on Thursday.

Saturday, January 17<sup>th</sup>

Today I learnt that 0.881849 ounces is equal to 25 grams. My container for the biochar weighs 0.7 oz. My method will need to change as I tested it with soil today for water retention and I needed more supplies. Mr. Lavoie's phone number is 403-830-0188. Mr. Lavoie suggested that I use an electrical conductivity probe for my nutrient retention test and suggested an alternate water retention test.

Saturday, January 24<sup>th</sup>

Today, I began the water retention test on the CCFL fine medium and coarse biochars I performed the test as below.

### Water Retention Test- Method

#### Materials per test

Glass jar + Funnel + Filter paper + Cylinder

60 mL of water } 1:3 biochar to water ratio as

20 mL of biochar } Mr. Lavoie suggested.

Glass measuring cup

#### Method

1. Pour the 60 mL of water into the jar
2. Put the volume of biochar in the jar and start a timer for X minutes.
3. After X amount of time pour the contents of the jar into the funnel lined with filter paper in the cylinder
4. Wait for water to drain
5. Measure the amount of water in the cylinder
6. Subtract the amount of water in the cylinder from the amount poured in and you are left with the amount retained by the biochar.

The observations I have from my test are that all biochars made an audible bubbling sound when placed in water, the water of the coarse and medium biochars was mainly clear, but that of the fine biochar was black. On the next page is my results from today.

Sunday, January 25<sup>th</sup>

This morning when I looked at the jars, I noticed all three had noticeable condensation on them. The variables for my experiment

Controlled: Amount of biochar + water, size of jar,

Manipulated: Granularity of biochar

Responding: Amount of water retained by biochar

# Volume

## Results - Water Retention

	CCFL Coarse	CCFL Medium	CCFL Fine >1mm	TEST 1
Volume of water	60 mL	60 mL	60 mL	
Volume of biochar	20 mL	20 mL	20 mL	When X is
Volume of water not retained	53 mL	48 mL	40 mL	1 Hour
Volume of water retained by biochar	7 mL	20 mL	2 mL	

Monday, January 26<sup>th</sup>,

At school they do not have an electrical conductivity probe but they have a multimeter which may work. Multimeters traditionally measure circuits but can work on soil. The multimeter tests voltage, current, and resistance, voltage is measured in volts, current in amps and resistance in ( $\Omega$ ) ohms. For my test I measure the resistance. First mix 10 mL of soil with 50 mL of deionized water and agitate for two minutes before letting it settle for 5 minutes. Then with the multimeter set to reading ohms insert the tips into the solution spaced by 1 cm. Repeat the prior step 3 times and take the average to ensure accuracy. A higher reading in  $\Omega$  means less conductivity while a lower reading means higher conductivity.

Tuesday, January 27<sup>th</sup>,

Today, I got my soil water retention tests done, all the biochars and soil have now done a volume based water retention test. I got the multimeter from school as I now know it will be helpful and began to charge the biochar with the fertilizer.

Tuesday, February 3<sup>d</sup>,

Today I set up the nutrient retention test using 80 mL of biochar and 80 mL of fertilizer prepared with deionized water to test the multimeter

Friday, February 13<sup>th</sup>

Today, I began testing the nutrient retention of the CCFL medium, CCFL coarse and CCFL medium biochars.

# Water Retention <sup>Volume</sup> when $X=24$ hours

	CCFJ Medium	CCFL Coarse	CCFL Fine	CCFL Medium	Soil
Volume of Water	60 mL	60 mL	60 mL	60 mL	60 mL
Volume of Biochar	20 mL	20 mL	20 mL	20 mL	20 mL
Volume of Water not Retained	43 mL	53 mL	40 mL	48 mL	48 mL
Volume of Water Retained	17 mL	7 mL	20 mL	12 mL	12 mL

Saturday February 14<sup>th</sup>

Today, I set up the nutrient retention tests for the CCFL fine biochar and soil as well as read the tests from yesterday.

Sunday February 15<sup>th</sup>

Today when I tried to read the nutrient retention of the soil I was unable to get a reading. Here are the rest of my results.

## Nutrient Retention

	CCFJ Medium	CCFL Coarse	CCFL Medium	CCFL Fine	Soil
Volume of Biochar	80 mL	80 mL	80 mL	80 mL	80 mL
Volume of Fertilizer	80 mL	80 mL	80 mL	80 mL	80 mL
Reading from probes in $\Omega$	1880, 2000 $\Omega$	968, 2000 $\Omega$	4.6 20 K $\Omega$	703, 200 K	
Converted reading in $\Omega$	1760000	1936000	92000	190600000	
Conductance	0.000000568	0.0000005165	0.00001086956	0.00000006711 237553312809	
Temperature	62°	64°		63°	68°
Ph	4.7	7		5.3	7
Fertility	5	1		4	1

Tuesday, February 17<sup>th</sup>

I shared with Mr. Lavoie my results and he encouraged me to perform the water retention tests by weight to even out the potential inequalities when measuring the biochar by volume.

## Water Retention by weight, $x=1$ hour

	CCFL Coarse	CCFL Medium	CCFL Fine	CCFL Medium	Soil
Volume of Water	50 mL	50 mL	50 mL	50 mL	50 mL
Weight of Biochar	5g	5g	5g	5g	5g
Volume of Water in flask	47 mL	31 mL	29 mL	31 mL	40 mL
Volume of Water Retained by Biochar	3 mL	19 mL	21 mL	19 mL	10 mL

## Water Retention by weight, $x=24$ hours

	CCFL Coarse	CCFL Medium	CCFL Fine	CCFL Medium	Soil
Volume of Water	50 mL	50 mL	50 mL	50 mL	50 mL
Weight of Biochar	5g	5g	5g	5g	5g
Volume of Water in flask	40 mL	25 mL	21 mL	29 mL	40 mL
Volume of Water retained by Biochar	10 mL	25 mL	29 mL	21 mL	10 mL

Wednesday, February 18<sup>th</sup>

Today, I decided that I have enough time to perform another experiment and since I'm testing how well biochar helps grow plants, I'm going to try growing a quick plant. Last year in science class we grew oat grass as a quick plant and I will grow it again.

Friday, February 20<sup>th</sup>

Today I planted the seeds for my plant growth test, their height is on the next page.

# Plant Growth Test

(cm)	Height after	CCFL Medium			CCF3 Medium			CCFL Fine			Soil		
		1	2	3	1	2	3	1	2	3	1	2	3
	1 day	0	0	0	0	0	0	0	0	0	0	0	0
	2 days	0	0	0	0	0	0	0	0	0	0	0	0
	3 days	0	0	0	0	0	0	0	0	0	0	0	0
	4 days	0	0	0	0	0	0	0	0	6	6	6	0
	5 days	0	0	0	0	0	0	0	0	0	0	0	0
	6 days	14.3	17.0	10.3	11.7	14.3	26	29	0.7	29	16.7	0.3	0
	7 days	25.3	30	21.7	20.7	28	49.3	49	5	49.7	35.7	8.3	0
	8 days	36.3	44.7	36.7	37.7	44.3	77	76.3	10	68	60.7	15	0
	9 days	50.7	58.7	47	51.3	61	109	103.3	11.3	94.3	83.3	29.3	0
	10 days	51.7	61.3	54.7	55.7	81.7	119	115	16.7	104.7	90.7	29	0