Functional tests - LeftLovers Loopbin

Compost testing

This experiment is researching the duration of the composting process and the factors that influence it. Three different containers were used: a completely closed bin, a bin without a lid and a bin with holes in the side. This setup allows for observation of the impact of oxygen flow on the composting process. The three bins were all kept inside a big box, so that the environment could also be measured. The process started on April 30th, as seen in figure 1. it started with a big batch of food scraps, brown waste and some already finished compost. This was mixed thoroughly and divided into the three bins, this way all the bins have the same contents. After six weeks, decomposition was visible in all three containers: the material resembles compost, as seen in figure 2. Which means that it could be used as fertilizer for growing plants.

Figure 2 May 29th, bin with holes in the side

Figure 1 June 11th, bin with holes in the side

Temperature

Temperature serves as an important indicator of microbial activity during composting. Higher temperatures are expected in containers where the composting process is most active, as increased microbial activity generates heat and causes the compost to warm up.

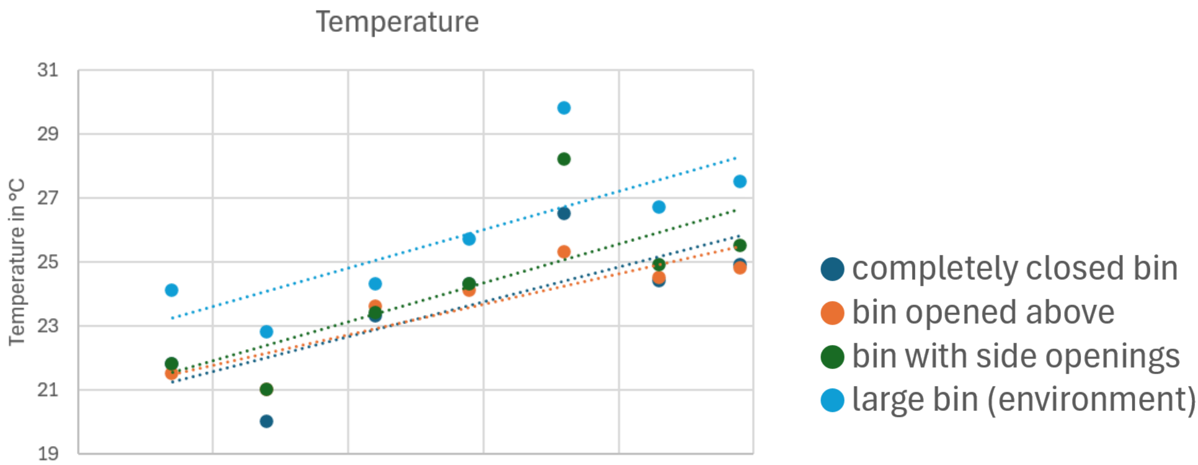

Figure 3: Results temperature

Figure 3 shows the recorded temperature results. The light blue line represents the temperature inside of the big box where the bins are stored, providing context for the measurements. The highest temperature was observed in the container with side openings. This suggests the highest level of microbial activity occurred in this container. A partially ventilated environment may therefore be optimal for microbial growth because it provides sufficient oxygen for aerobic organisms while preventing rapid drying.

Normally, you would expect the temperature of compost to be higher (around 50 – 60 °C), but in this experiment it remained significantly lower (around 25 °C). This is probably because it is on a much smaller scale. Because in a small container, the heat that is released cannot be retained well.

Moisture

Moisture is also an important parameter in the composting process. This factor influence which organisms are active and the efficiency of organic matter breakdown. For the first three weeks, two different types of meters were used to measure the moisture. These meters did not give a concrete percentage but the user had to read it off of an indicator. However they did work the same way, by putting the tool into the compost. Both meters showed results around 15 %, as seen in figure 4 and 5. The environment was measured by a different tool, made for measuring the humidity. These results provide context for the measurements.

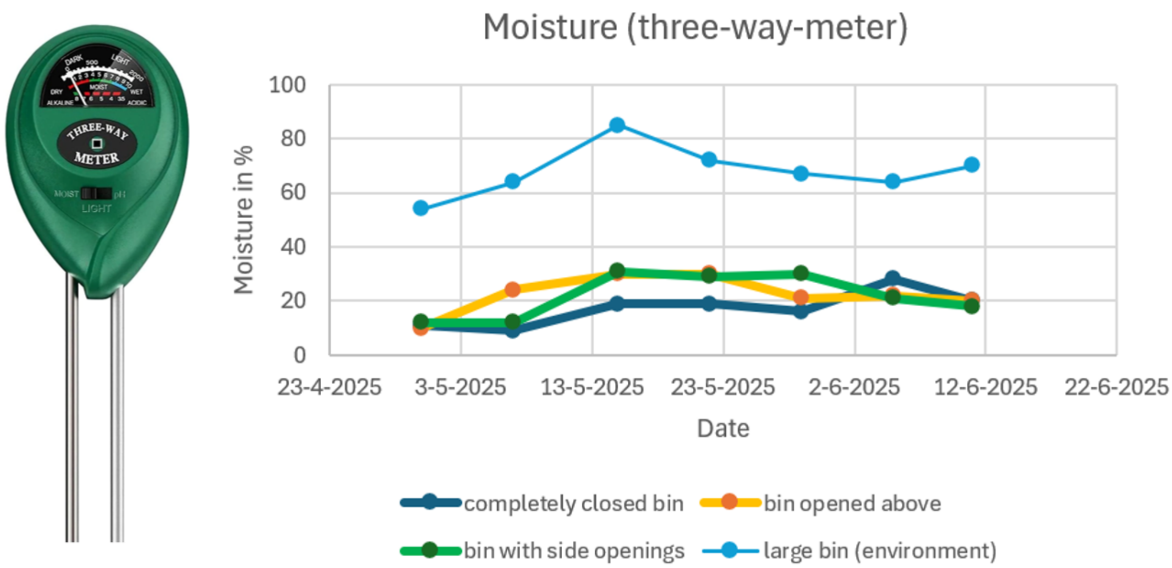

Figure 4 Results moisture three-way-meter

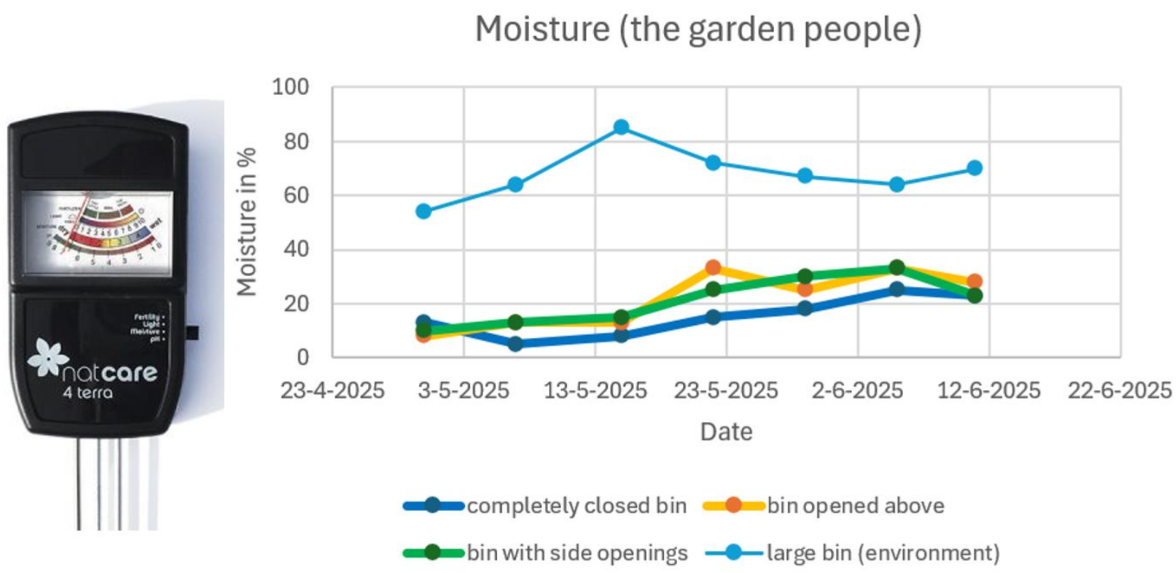

Figure 5 Results moisture the garden people

This was much lower than expected (55 – 65 %). However, the compost looked moister, suggesting that the measurement tools were not accurate. So, in the fourth week a new meter was used, which can be seen in figure 6.

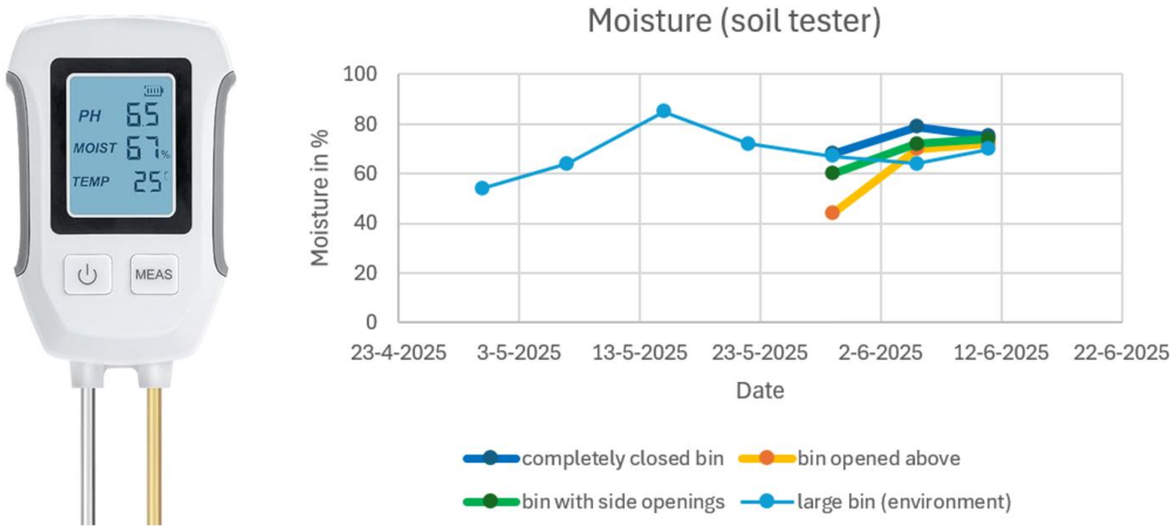

Figure 6 Results moisture soil tester

This tool was giving readings closer to the expected values. Since there was not much time left, only three measurements were taken with this device. This is not enough to determine the exact moisture levels of the compost.

However, it can be concluded that there is no clear difference between the different compost bins, suggesting that the amount of airflow does not have a major effect on moisture levels.

Odor

The smell of the compost was also evaluated throughout the composting process. All three containers gave off a typical "earthy" smell, which was not considered unpleasant. The odor remained largely contained within the boxes and was barely noticeable in the environment.

Testing electronic components

Setting up the prototype's electronics is simple. The components to be connected are a sensor, a board, and the server. To test this functionality, it is necessary to ensure that the sensor can transmit a measurement to the board, which will then be transmitted to the server. Next, it may be useful to test the overall operation, sending a request from the server to request a measurement, then the response from the board. Once connected, the sensor is tested first. To do this, it must be calibrated, then tested with a simple code.

```
#define capteur 33

void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
}

void loop() {
  // put your main code here, to run repeatedly:
int valeur = analogRead(capteur);
int humidite = map(valeur, 3669,768,0,100);
Serial.println(valeur);
Serial.println(humidite);
delay (5000);
}
```

This code simply reads the value returned by the sensor and converts it into a percentage, which is easier for the application to use. The limits of the “map” function are defined by calibration. This made it possible to test the sensor in very humid and dry environments to verify its proper functioning and wiring. Once the data has been acquired, it must be communicated to the server. To do this, the card is connected via Wi-Fi, which allows it to access the server. To check this step alone, the sensor values will all be simulated (random). The aim here is to check that the data is transmitted in JSON format on the requested port. It is then displayed on a web page using simple HTML code to provide visual feedback on the transmitted data. To go a step further, it was also interesting to test the overall functioning of the system. To do this, we need to ensure that the server sends a request to the board. Upon receiving this request, the board analyzes it and acts accordingly. To monitor the different stages of this process, “Serial.Print()” commands have been added. This makes it possible to read in the “Serial Monitor” which elements are received by the card and how it interprets them. Below is a table summarizing the different steps tested.

Board Function	**Status**
Receive sensor information	PASS
Send information in JSON	PASS
Retrieve the state of the “state” variable	PASS
Operation in “measurement” mode	PASS
Operation in “pause” mode	PASS
Operation in “fan” mode	PASS

Server Function	**Status**
Receive a measurement	PASS
Display in HTML	PASS
Timing	PASS
Measurement button	PASS

The last two functions are those that allow you to start a measurement cycle. A timer is present on the server to request a measurement one minute after receiving the previous one. It is possible to test this by checking that the HTML page displays new values one minute after the previous ones, or by checking the time between two requests in the "Serial Monitor." Finally, there is also a button on the HTML page that allows you to request a measurement without waiting for the timer. This allows us to anticipate how this feature will work in the application. It can be tested in the same way as the previous function.

Request	Use Case	Method	Result	Size (B)	Latency (ms)
10	Get Data	GET	10	265	100
100	Get Data	GET	100	266	100
1000	Get Data	GET	1000	266	102

Load Results

Operation	Method	Result	Size (B)	Latency (ms)
Get data	GET	PASS	264	309
State variable	GET	PASS	187	341
HTML display	POST	PASS	409	328
Trigger	GET	PASS	168	317
Sign Up	POST	PASS	409	345
Log In	POST	PASS	409	318

API: Functional and performance results

Testing mechanical parts

To make sure that the mechanical parts work, they were tested during the assembly of the prototype. The parts that were tested are shown in the image underneath:

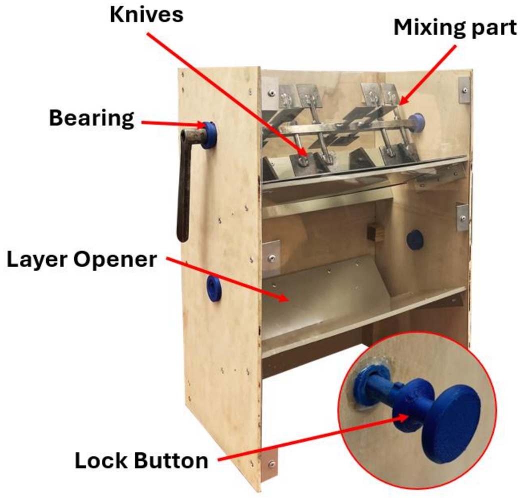

Figure 4: prototype with the tested mechanical parts

The parts were tested by using it and analyze if it fulfills the function it was designed for.

Bearing: The 3D printed bearing makes sure that the mixing part can move while being hold in place in the wall of the compost bin.

Knives: The knives need to cut the leftovers that are added to the bin into smaller pieces. Smaller pieces of food waste will break down into compost faster. To test this function, paper (by hand) and cardboard (in mixer) were cut by using the knives. After testing, the paper got cut easily, the cardboard didn't cut very well. To solve this, the knives should be more sharp and the mixing part should be improved.

Mixing part: The mixing part needs to make sure that the freshly added food waste gets mixed with the compost and older food waste that are already in the bin. This to speed up the composting process. During a first test trial, pieces of cardboard were added into the first room of the compost bin and mixed by using the mixing part. The pieces got mixed up in the chamber which shows that the mixing part works in a proper way. During a second testing trial, the same was tried but this time using water beads. This showed that the form of the layer sheet is not ideal. The mixing only works when there is enough material in the chamber. To improve this, the shape of the layer sheets should be reconsidered.

Layer Opener: The layer opener has to drop down so the compost in the bin can fall through to the room below. While testing this, the layer opened without weight added on top. It works in a proper way.

Lock button: The lock button has to keep the layer locked most of the time and to hold the weight of the compost that is added to the room. While testing, the lock worked but the cylinder part collapsed when pushing softly on the layer. The design needs to be improved by adding a metal screw in or 3D print in in a different way. For the locking of the system it passes the test.

In the following table a summary is given of the tests:

Part - function	**Pass/Fail**
Bearing - turn	**PASS**
Knives - cut	**FAIL**
Mixing part – mix cardboard	**PASS**
Mixing part – mix water beads	**FAIL**
Layer opener - open	**PASS**
Lock button - lock	**PASS**