MEDS Chinese Medicine (2021)
ISSN 2616-1753 Volume 3 Issue 2

DOI: 10.23977/medcm.2021.030234
Clausius Scientific Press, Canada

What affects the decomposition rate of fungi?

Shuhan Cheng

Faculty of Electronic Information and Eletrical Engineering, Dalian University of Technology, Dalian, Liaoning, 116024

Keywords: fungi, decomposition model, temperature, humidity

Abstract: Carbon cycle plays an important role in biogeochemical cycle, in which fungi play an extremely important role. Analyzing the changes of fungi in the process of decomposing lignin and cellulose in soil can help us understand the material cycle and energy flow, and also provide reference for the biological decomposition of waste straw and waste wood. First, we studied the rate at which fungi decompose cellulose and lignin. Based on the knowledge of power function and exponential function, combined with linear programming, we established the general model of fungal decomposition rate. The general model considers the effects of fungi growth rate, lignin content in the soil under initial conditions, temperature, humidity and other factors. By extracting the data from the relevant statistical graph, we get the corresponding function expression. Secondly, according to the statistical graph given in the competition, we extracted the data in the graph, and obtained the model of fungus decomposition rate and its growth rate. We also use the method of controlling variables to obtain the function analytical expressions of fungi growth rate and decomposition rate under different temperature conditions, and analyze the total model established under different weather conditions. Thirdly, according to the data given in the competition, we established the exponential function model of fungi moisture tolerance and decomposition rate by using the fitting method, and analyzed the error in establishing the model. Then, according to the current academic research results, we selected three specific strains and used the linear fitting method to get the function relationship of decomposition rate overtime. By comparing the corresponding linear function coefficients, we analyzed the interaction between different strains.

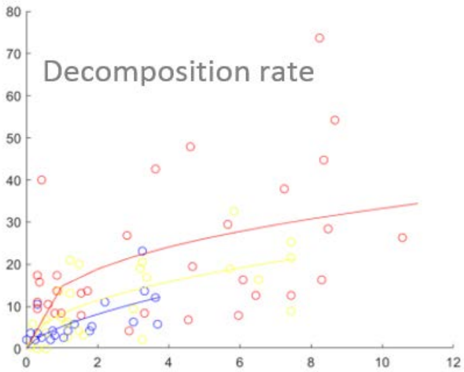
1. Introduction

Whether it is the deforestation, the discarding of waste wood products or the withering of branches and leaves, there will always be a lot of sawdust and lignin which are relatively difficult to degrade in the soil. Lignin in soil is the transfer station of material and energy from plant to soil, which plays an important role in rainforest, forest and other systems. Microbial decomposition can accelerate the return of nutrients and maintain soil fertility. The decomposition of plant matter and lignocellulose is an important part of material cycle and energy flow, which is of great significance to maintain soil fertility and nutrient balance. However, the establishment of the model of fungal decomposition of organic matter is facing a great challenge, that is, the decomposition of substances is affected by multiple factors. These factors include soil lignin concentration, environmental temperature, humidity, light intensity and microorganisms themselves. The purpose of this study is to provide a theoretical basis for nutrient protection in the process of land carbon balance. In addition, in recent years, more and more attention has been paid to the application of biological treatment technology in the field of straw and other lignocellulosic wastes. Our work is also helpful for researchers to find efficient and stable methods to decompose lignocellulose.

2. Analysis of influencing factors

2.1 The Relationship between Growth Rate and Decomposition Rate

We process the image in the problem and get the coordinates of the points, and then we fit the points into curves to get the same curve in the problem. Because the coordinates of the points have error, we correct them. For the points on the axis, their deviation is so small that it satisfies the demand of using MATLAB to perform the function fitting. The errors in this step are small and can be neglected. We use power function to fit, and output the curves. The results are as follows.



Picture 1: The relationship between growth rate and decomposition rate

First, we analyze the errors of the curves. The errors exist in the following aspects: the error when we get the coordinates of points, the error when we correct the coordinates, the error when the function fitting is performed. The first two errors are so small that we can neglect them, so we turn to the third error.

Table 1: Error evaluation of different curves

Error evaluation	red	yellow	blue
SSE	6870.5	1146.5	322.3275
R-square	0.1957	0.4364	0.3925
Adj R-sq	0.1697	0.4147	0.3587
RMSE	14.8872	6.6403	4.2317

From the data, we can see that the value of SSE is relatively big and R-square is not close to 1. The reason of the error is mainly that the points are scattered all over the picture. Therefore, the regression equation can only give a result qualitatively.

In the following pictures, the blue refers to the curve at the temperature of 10℃, the orange one refers to the curve at the temperature of 16℃, and the red one refers to the curve at the temperature of 22℃. [1]

Then we perform the function fitting on the coefficients to get the influence of temperature on the rate of decomposition:

Table 2: The error analysis of a and b

Error evaluation	a	b
SSE	2.0207	5.53e-04
R-square	0.9578	0.9871
Adj R-sq	0.9155	0.9741
RMSE	1.4215	0.0235

Because the points are few, and follow the linear distribution, SSE and RSME are both small and R-square and Adj R-sq both approach 1. The outcome of this function fitting is satisfying. We get the functions as follows:

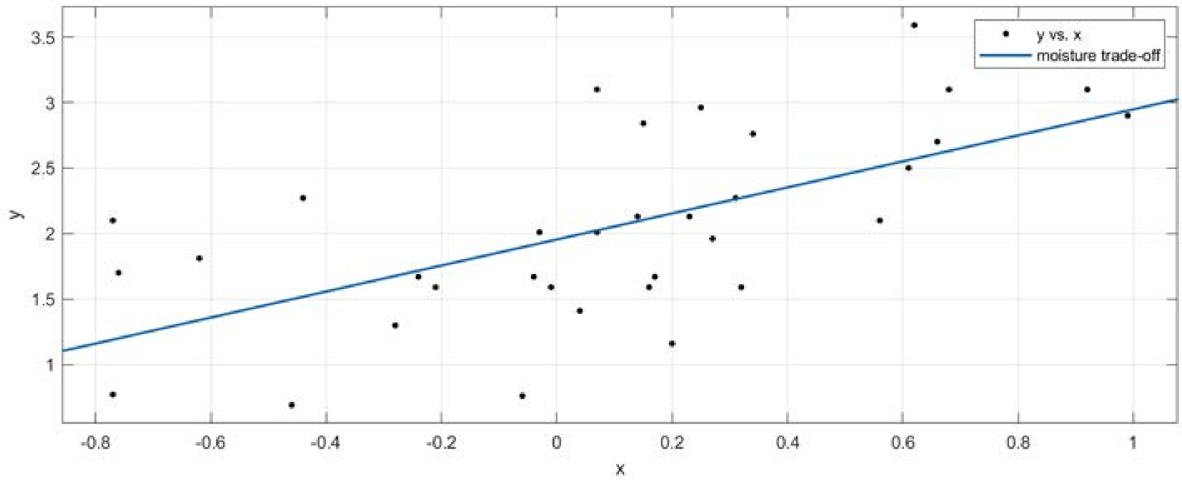
$$a = 0.8T - 3.33 \tag{1}$$

$$b = -0.02422T + 0.875 \tag{2}$$

$$k = (0.8T - 3.333)x^{(-0.024T + 0.875)} \tag{3}$$

2.2 The Relationship between Moisture Tolerance and Decomposition Rate

We perform function fitting on data showing the relationship between moisture tolerance and the rate of decomposition. We choose the linear function because of the hint in the picture shown in the problem. X axis is moisture trade-off, and y axis is decomposition rate.



Picture 2: the relationship between moisture trade-off and decomposition rate

Table 3: Error evaluation of log (decomposition rate)

Error evaluation	log (decomposition rate) = f(x)
SSE	10.6796
R-square	0.3892
Adj R-sq	0.3701
RMSE	0.5777

The result of the relationship between moisture tolerance and decomposition rate is $y = e^{n+1.954}$.

3. Conclusions

By analyzing the data of decomposition and using MATLAB to get the fitting function, we get the following conclusions:

(1) general model:

$$y = y_0 - a_0 e^{\frac{kt}{100}} \tag{4}$$

$$k = a_0 (0.8(25 - |T - 25|) - 3.333) x^{-0.024(25 - |T-25|) + 0.875} e^{n+1.954} \tag{5}$$

(2) The relationship between growth rate and the rate of decomposition:

$$k = (0.8T - 3.333) x^{(-0.024T + 0.875)} \tag{6}$$

(3) The relationship between moisture tolerance and the rate of decomposition:

$$y = e^{n+1.954} \tag{7}$$

(4) The influence of the increase of number of fungi on the rate of decomposition: the rate of decomposition increases at the beginning, when the number of fungi becomes too large, the increase will slow down and will even come to a stop. There is a promoting relationship between different strains, of course, there is also inter-species competition. The final result of the interaction between strains is the quantitative relationship of the population, which shows the increase or decrease of the number of strains in a region.

(5) The influence of multiple environmental factors: the rate of decomposition also changes every season, and is also affected by altitude.

References

[1] Nicky Lustenhouwer, Daniel S. Maynard, Mark A. Bradford, Daniel L. Lindner, Brad Oberle, Amy E. Zanne, Thomas W. Crowther. A trait-based understanding of wood decomposition by fungi [J]. Proceedings of the National Academy of Sciences, 2020(prepublish).

[2] He Shuiqing, Ai Shiqi, Wang Jianhao, etc. Analysis of decomposition characteristics and bacterial composition diversity of lignocellulosic decomposition complex strains [J], Jiangsu Agricultural Sciences, 2017, 45 (016): 241-246.

[3] Zhang Zhen. Seasonal dynamics of soil fungi and enzymatic activity inspruce (Picea crassifolia) forests of Qilian Mountains [D], 2019

[4] Fu Zuoqin. Response Characteristics of Litter Decomposition with Different Masses to Altitude Gradient [D]. Fujian Normal University.2019

[5] https://biologydictionary.net/fungi/.2021

[6] Yang Chen. Effects of several fungal communities on litter decomposition and nutrient cycling [D]. 2016

[7] Yu Shuling. Research progress on decomposition of soil fungi in ecosystem [J]. Journal of Xingtai University, 2006(04): 126-128.