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Investigation of the Effects of Kombucha Mushroom on Mycelium Growth of Agaricus bisporus Using Artificial Neural Networks

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Keywords: Kombucha, *Agaricus bisporus*, Mycelle development, Artifical Intellegience, Artificial Neural Networks, Machine Learning.

Abstract
The effects of Kombu mushroom extract on Agaricus bisporus mycelia development were the subject of this study. To prepare kombu mushroom extract; 60 g of sugar and black tea were added to 1 liter of water and fermentation of Kombu mushroom was achieved in this environment. The obtained extract was added to the potato dextrose agar medium at 0, 50, 75, 100cc. Mycelial agar discs of Agaricus bisporus with prepared agar were inoculated, developed at 23°C for 10 days, and mycelial development was examined. At the end of the incubation period, it was observed that mycelial development in the groups to which Kombucha mushroom extract was added was much better than the control group.

1. Introduction

Manchurian mushroom, also known as Kombucha or Kombu Tea, is popular in Far Eastern Countries and has been used for many years. Although it has not yet received enough attention in Western countries, it has been the subject of some research in recent years and its popularity is gradually increasing. It is used in the food industry, cosmetics and alternative medicine around the world. Although it is not well known in some countries, Kombucha mushroom has been examined in many studies [1], [2]. Studies show that the Kombu mushroom forms a symbiotic association with bacteria and yeast, which is quite intriguing. [3], [4]. Investigate antimicrobial activities against many organisms such as Staphylococcus aureus, Shigella sonnei, Escherichia coli, Aeromonas hydrophila, Yersinia enterolitica, Pseudomonas aeruginosa, Enterobacter cloacae, Staphylococcus epidermis, Campylobacter jejuni, Salmonella enteritidis, Salmonella typhimurium, Bacillus cereus, Helicobacter pylori and Listeria monocytogenes [5]. Unfortunately, studies on kombu mushroom are almost non-existent in our country. Apart from 1-2 studies on antimicrobial effects, not much research has been done on this subject in our country. In a master's thesis conducted at Marmara University, the fibrinolytic system and antibacterial effects of Kombu mushroom extract were examined, and in another study conducted at Gazi University, its effect against gram positive and gram negative bacteria was investigated [6], [7].

In a master's study conducted at Kırıkkale University, the cultural properties and antibacterial effects of Kombucha mushroom were investigated. Measurement of sugar reduction has been examined [8]. Agaricus bisporus production in Turkey has shown rapid development, especially in recent years. While the production amount of Agaricus bisporus was 80 tons in 1973 [9]., this value increased to 18,000 tons in the 2000s and 65,000 tons in 2018 [10]. As of 2020, it is around 75000 tons. Agaricus bisporus cultivation, which has become widespread especially in the Mediterranean, Marmara, Aegean and Central Anatolia regions, has started to be practiced in almost all our regions in recent years. The development of

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the sector continues rapidly with the increase in support given to Agaricus bisporus cultivation in recent years. 75% of our mushroom production in our country consists of Agaricus genus mushrooms [9]. Agaricus bisporus cultivation is quite different from other agricultural cultivation branches due to its structure. Cultivation is done with a bag system on bunk beds and shelves, and in recent years, block-pressed mycelial-grown ready-made composts have been used. Today, in many countries that grow Agaricus bisporus, production is carried out using variations of the bag/block system [11]. Commercial mushroom cultivation in Turkey started in the 1980s. [12]. Since it is a newly developing sector, full efficiency has not yet been achieved and there is very little research done in this field. In this study, the effects of Kombucha mushroom on Agaricus bisporus productivity were determined by measuring zone ages and it was determined that Kombucha mushroom had a positive effect on Agaricus bisporus mycelial development. In the following stages, the amount of Kombucha to be added was determined using the artificial intelligence program.

The effects of Kombu mushroom extract on Agaricus bisporus mycelia development were the subject of this study. To prepare kombu mushroom extract; 60 g of sugar and black tea were added to 1 liter of water and fermentation of Kombu mushroom was achieved in this environment. The obtained extract was added to the potato dextrose agar medium at 0, 50, 75, 100cc. Mycelial agar discs of Agaricus bisporus with prepared agar were inoculated, developed at 23°C for 10 days, and mycelial development was examined. At the end of the incubation period, it was observed that mycelial development in the groups to which Kombucha mushroom extract was added was much better than the control group.

2. Material and Method

2.1. Preparation of Kombucha Mushroom

Pre-sterilized glass containers should be used to prevent contamination of Kombucha from pathogenic organisms during preparation. Kombucha is usually brewed by adding black tea products (1.5 g/L) to fresh boiling water, sweetening with 50-150 g/L (5-15%) sucrose (tea sugar) and brewing for about 10-15 minutes. Preparation of infusion. The recommended tea is used to ensure that the tea leaves are prevented from cleaning later. After the prepared tea reaches room temperature, approximately 10-15% of the existing kombucha culture is added. It is then covered with a clean cotton cloth and left at room temperature for approximately 10-14 days. If this period is exceeded, the acidity level may be at a level that may be damaged in order for fermentation to continue. After fermentation, the baby mushrooms that form on the surface are removed and kept in a glass bottle with a small amount of tea to prevent them from drying out. Ready-to-drink Kombucha is stored in a glass bottle at 4 o C. Recommended daily consumption amounts are 100-250 ml [13], [14].

Figure 1. Preperation of Kombucha Mushroom

2.2. Application of Machine Learning Algorithms

Python programming language and the related modules such as TensorFlow [15], scipy [16] are used in this section. The basic modules are numpy [17], pandas [18] and seaborn [19]. The array structures and linear algebra is run by using numpy module. We can define data frame structures with the pandas module. The seaborn module is used for the statistical calculations. All of them are open source.

Machine learning process is the job that we can teach the knowledge to machines by using the data everywhere. We used the Agaricus bisporus data in this study. We applied two different machine learning applications to the problem. The first one is the regression algorithm. The algorithm is ready to use in numpy module. We define the independent and the dependent variables, and the algorithm tries to determine a polynomial with whose coefficients, which use the least square method [20]. The polynomial approximation for interpolation in numerical analysis has two important advantages. The former is that the derivatives and the indefinite integrals can be determined easily. The latter is that the algebraic polynomials uniformly approximate the functions.

Our first application for machine learning is the polynomial regression. It is obvious that the more data, the better results are obtained. We have ten experimental data, and we could get reasonable results in this study.

After the regression analysis we can find the following relation,

$$y = f(x) \approx \sum_{i=0}^{N} a_i x_i \qquad (1)$$

where the variable, which is the independent variable and corresponds to the day data, the dependent variable, which is the zone diameter, we called them as target in the program, corresponds to the coefficients of the polynomial approximation.

We tried to study different polynomials orders to get the best results. The fourth and the 5th polynomial order are seeming as the best results. Therefore, we tabulated these results, and we added the graphics of them. We have four data set control data, 50 cc data, 75 cc data and 100 cc data. The Table 1 represents the experimental data. Table 2 represents the coefficients of the polynomials and the values of each polynomial approximations. R-squared is a statistical measure which represents the proportion of the variance for a dependent variable. The closer its value to unity, the better the results.

Table 1. The experimental data

Day1	Control	50cc	75cc	100cc
1	9.05	9.08	9.20	9.65
2	9.15	9.22	9.59	10.26
3	9.31	9.45	10.05	11.01
4	9.94	10.06	10.66	11.92
5	11.12	11.25	11.86	12.93
6	13.71	14.02	14.81	14.98
7	14.62	15.01	16.02	16.65
8	16.02	16.83	17.32	17.92
9	18.36	19.26	20.05	20.69
10	19.93	20.28	21.24	22.05

.

Table 2. The polynomial regression coefficients

4^{th} order approximation				
	Control	50cc	75cc	100cc
a_0	10.28750000	9.65250000	9.64583333	9.04833333
a_1	-1.62442113	-0.66104701	-0.55459984	0.68338384
a_2	0.53260927	0.13834936	0.19626603	-0.10828963
a_3	-0.03672980	0.02497183	0.01117036	0.03749611
a_4	0.00093677	-0.00215181	-0.00136218	-0.00204254
R^2	0.99333389	0.99396541	0.99216048	0.99698312

5^{th} order approximation				
a_0	8.44133333	8.71933333	7.86200000	9.11800000
a_1	1.41895664	0.87726410	2.38602238	0.56853939
a_2	-1.06503496	-0.66919872	-1.34743590	-0.04800117
a_3	0.32045396	0.20551457	0.35629429	0.02401748
a_4	-0.03456643	-0.02009732	-0.03566667	-0.00070280
a_5	0.00129103	0.00065256	0.00124744	-0.00004872
R^2	0.99422560	0.99416806	0.99284030	0.99698419

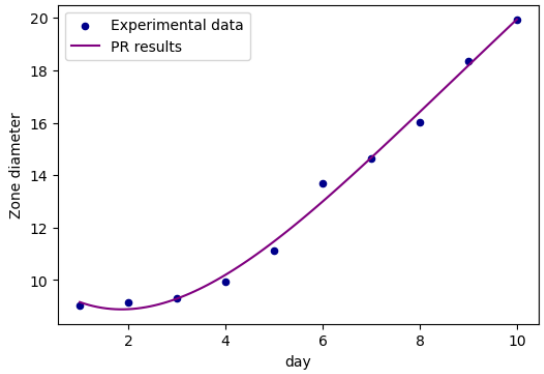


Figure 2. The 4th polynomial regression for control

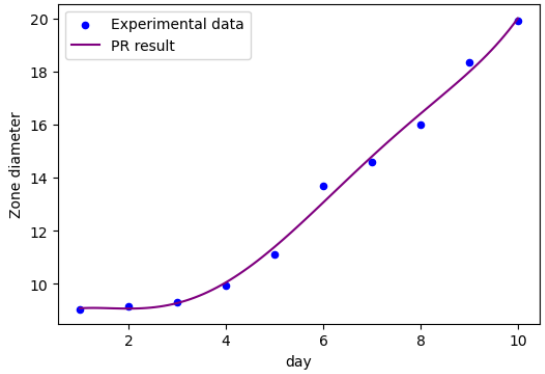


Figure 3. 5th polynomial regression for control

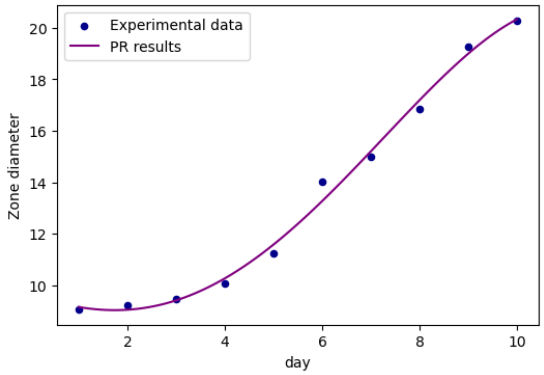


Figure 4. The 4th polynomial regression for 50cc data

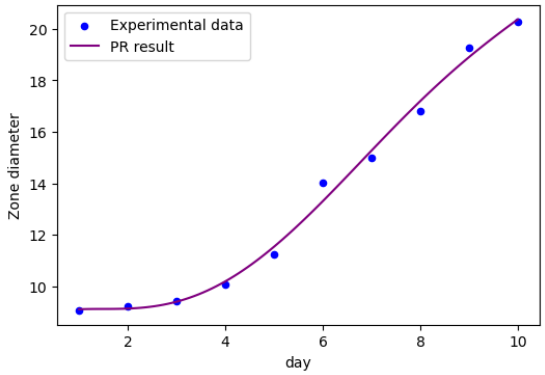


Figure 5. The 5th polynomial regression for 50cc data

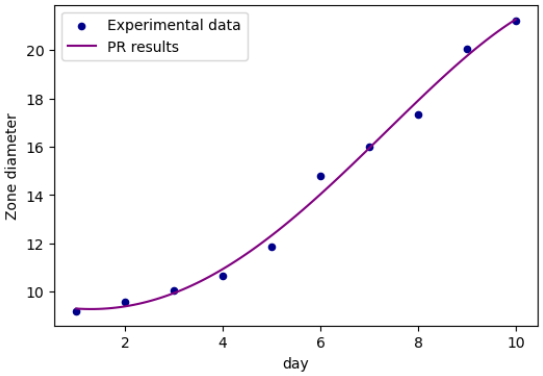


Figure 6. The 4th polynomial regression for 75cc data

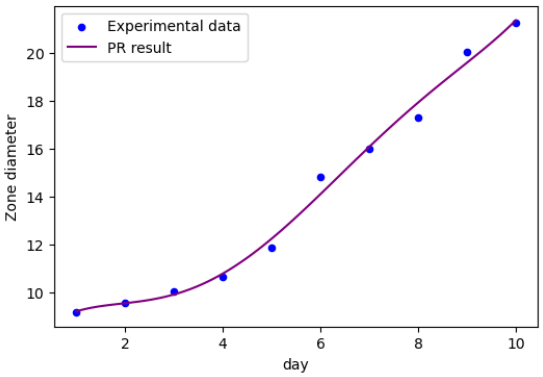


Figure 7. The 4th polynomial regression for 75cc data

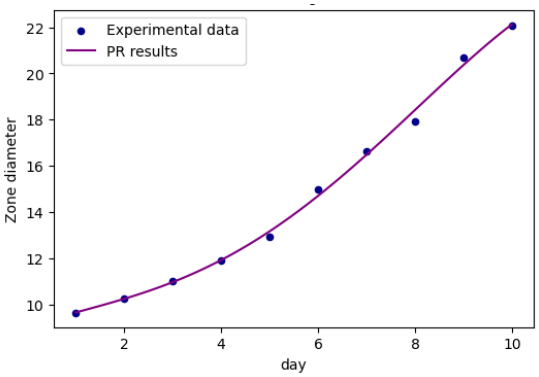


Figure 8. The 4th polynomial regression for 100cc data

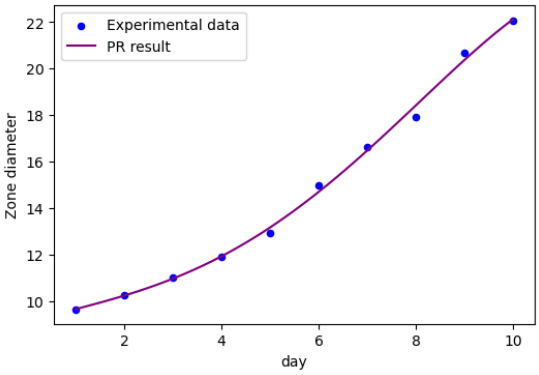


Figure 9. The 4th polynomial regression for 100cc data

The Artificial Neural Network (ANN) is another Machine Learning algorithm. It is called as ANN since the transmission of the information process to the next neuron is so similar to the biological neural network. The basic of artificial neural networks is based on logistic regression [20]. The logistic regression, which is given Figure 10, consists of an input layer, a summation layer, and an output layer.

An activation function is applied to the summation. If the activation value is bigger than a threshold value, then the output is determined. The output gives only two different results. Therefore, the logistic regression is also called as binary classification. This structure runs as a biological neuron cell.

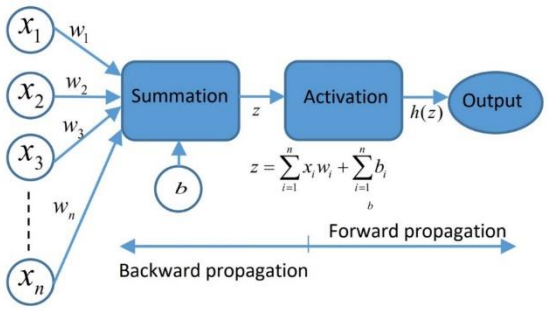


Figure 10. The structure of the logistic regression and the application of.

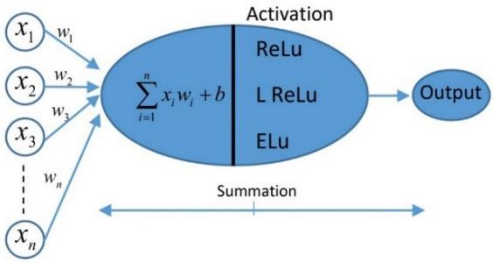


Figure 11. An artificial neuron cell in ANN

ANN is made of three layers. The first layer is called as the input layer. An artificial neural cell in Figure 11 works similarly to a biological cell. The next layer is called as hidden layers, and the number of the hidden layers is a hyperparameter. The final layer is called as the output layer. A schematic representation is given in Figure 11.

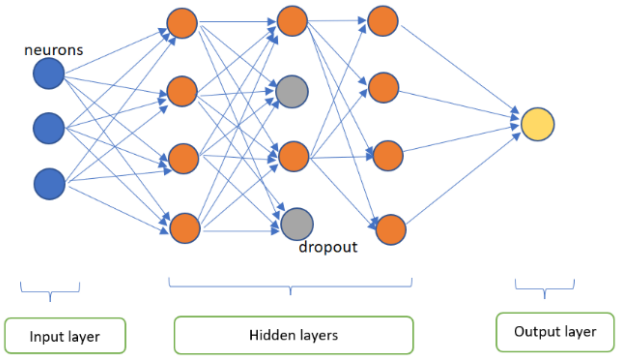


Figure 12. The structure of an Artificial Neural Network

The hyperparameter word is used for certain quantities in the ANN, which we can change these parameters. The number of neurons in the layers, the number of hidden layers are two of these hyperparameters. In the ANN calculations there are also different hyperparameters such as, the optimization function, the number of epoch, the batch size etc. The used hyperparameters in this study are given in Table 3

.

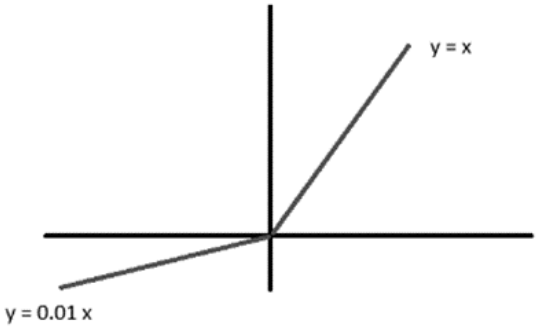
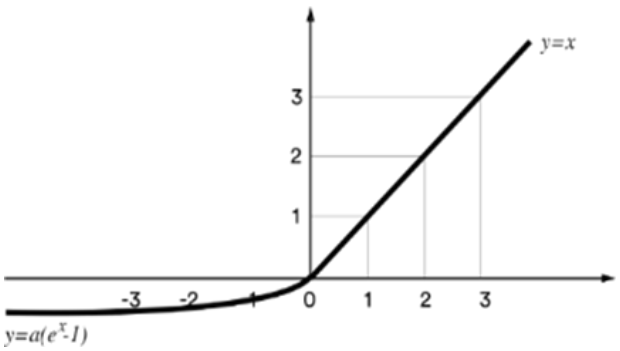
Table 3. The ANN hyperparameters used in this study

	Control	50cc	75cc	100cc
Hyperparameters	100	100	100	100
Number of neurons	1000	1000	1000	1000
Epoch number	4	4	4	4
Batch size	0.2	0.2	0.2	0.2
Test size	0.2	0.2	0.2	0.2
Validation split	12	10	10	10
Number of hidden layers for LRelu	12	10	12	10
Number of hidden layers for Elu (a=0.1)	msle	msle	msle	Msle
Loss function	adam	adam	adam	Adam
Optimization function	LRelu / Elu	LRelu / Elu	LRelu / Elu	LRelu / Elu)
Activation function	Control	50cc	75cc	100cc

msle: Mean square logarithmic error

There are different models in Machine Learning process. These models are selected for the studied dataset such as an image, data prediction. Here we used the sequential model. A Sequential model is appropriate for a plain stack of layers where each layer has exactly one input tensor and one output tensor [21]. Epoch term is used the number of passes of the entire training dataset. Dataset is used grouped into batches. If the dataset belongs to a huge dataset, then the batch number especially becomes important. Epoch could be thought as the iteration number. The dataset can be randomly chopped to the validation set and test size. There are also activation function and the optimization function. The activation function decides the activation of the next neuron according to the value of neuron. We used two different activation function, Leaky Relu (Leaky Rectified Linear Unit) [22] and Elu (Exponential Linear Unit) [23] in this study. Leaky Relu activation function is focused to zero, and there are no killed neurons. The function has 0.01x for the negative value. Elu activation function includes an exponential term with an parameter and there are no killed neurons. was selected as 0.1 in this study. However, it runs slowly in terms of the calculation time since it includes an exponential term.

Table 4. Activation functions and its properties

Mathematical definition of the activation function 1	The behaviour of the activation function 2
$h_{Leaky\mathrm{ReL}}(x) = \max(0.01x, x)$	
$h_{ELu} = \begin{cases} a(e^x - 1), x < 0 \\ x \quad\quad\quad , x \geq 0 \end{cases}$	

The optimization function is selected as adam (adaptive moment estimation) [24] optimization function. Adam is a replacement optimization algorithm for stochastic gradient descent for training deep learning models. It combines the best properties of the AdaGrad and RMSProp algorithms to provide the optimization algorithm which can handle sparse gradients on noisy problems. Another hyperparameter is the loss function. This function calculates the error per epoch. According to the error value the weights and bias are rearranged to get minimum error. The loss function behaviours are given every ANN result for the interested in data.

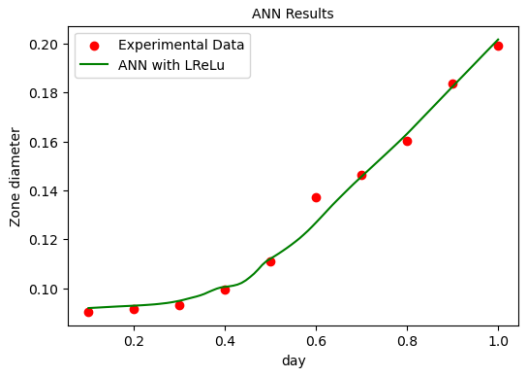


Figure 13 The ANN result for control data with LReLu

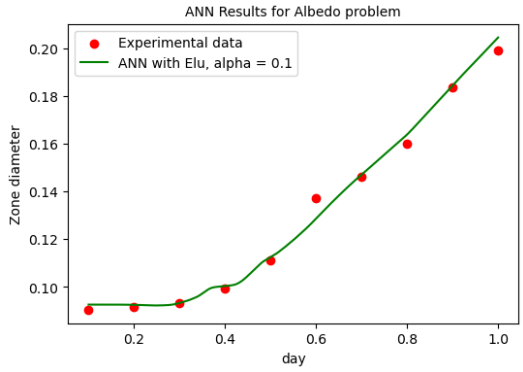


Figure 14 The ANN result for control data with ELu

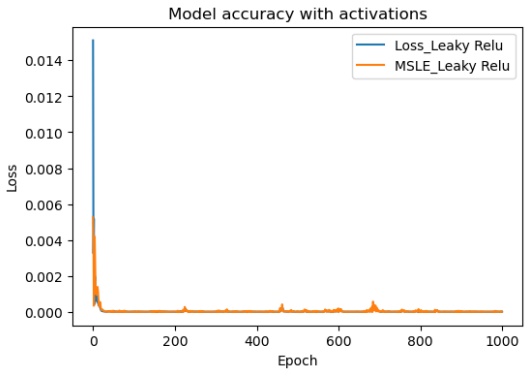


Figure 15 The Loss for control data with LReLu

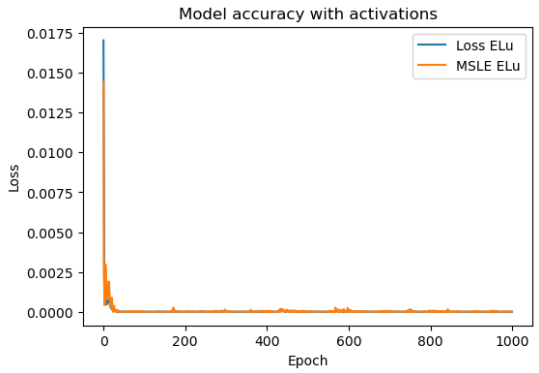


Figure 16 The Loss for control data with Elu

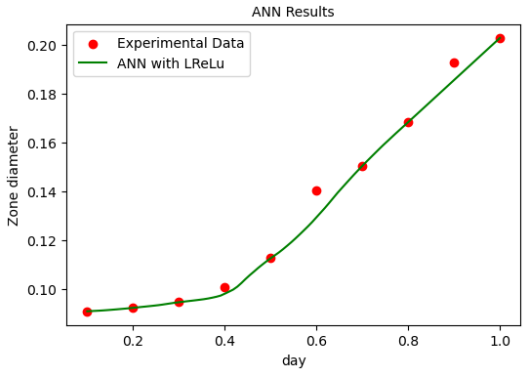


Figure 17 The ANN result for 50cc data with LReLu

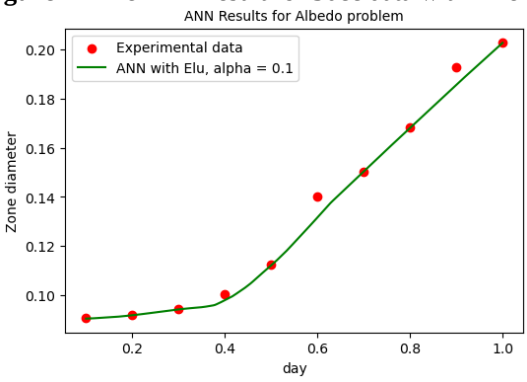


Figure 18 The ANN result for 50cc data with Elu

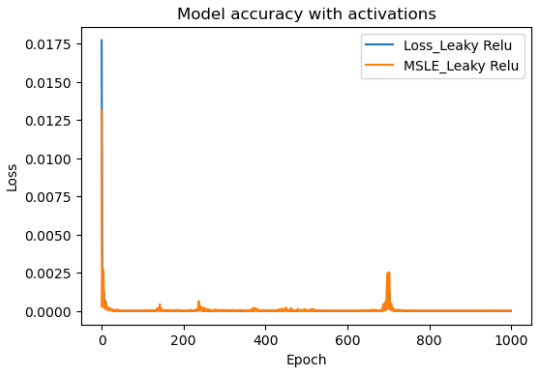


Figure 19 The Loss for 50cc data with LReLu

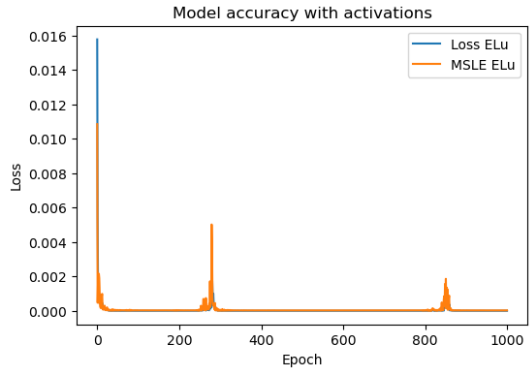


Figure 20 The Loss for 50cc data with Elu

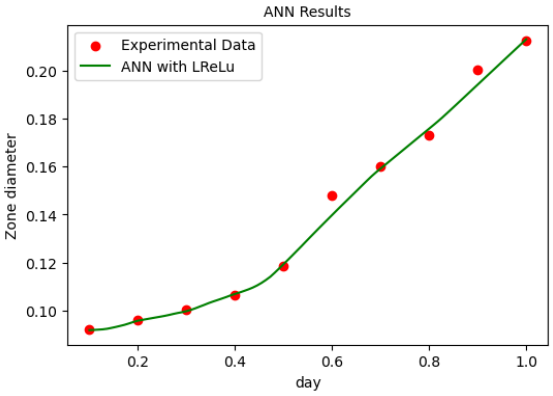


Figure 21 The ANN result for 75cc data with LReLu

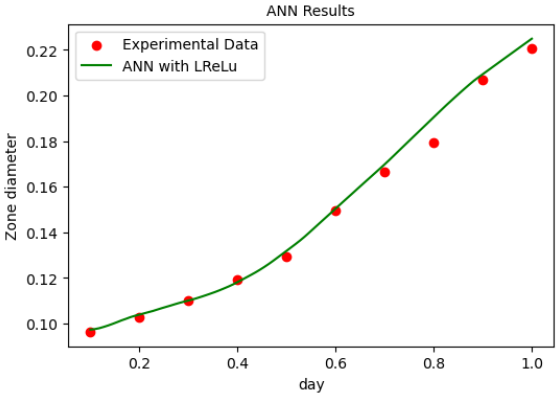


Figure 25 The ANN result for 100cc data with LReLu

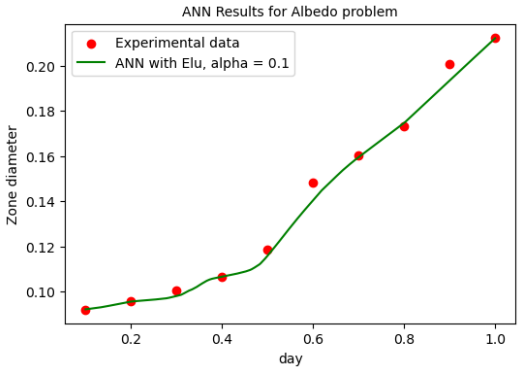


Figure 22 The ANN result for 75cc data with ELu

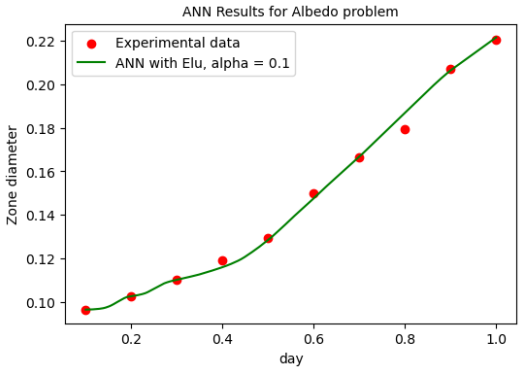


Figure 26 The ANN result for 100cc data with Elu

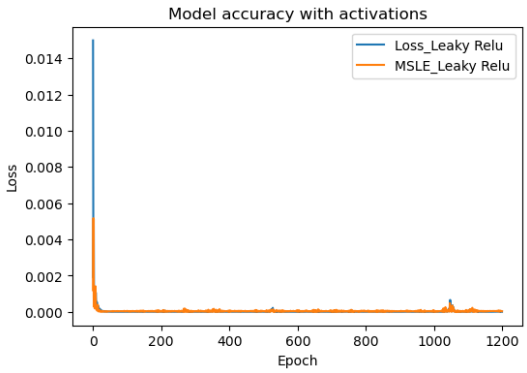


Figure 23 The Loss for 75cc data with LReLu

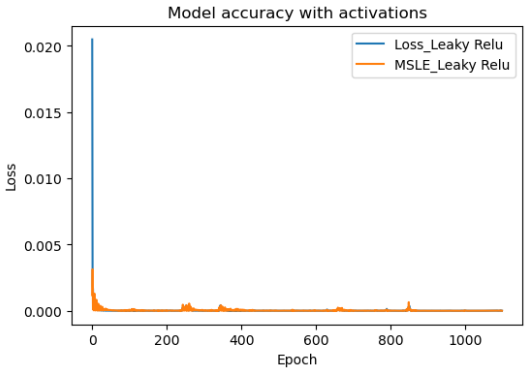


Figure 27 The Loss for 100cc data with LReLu

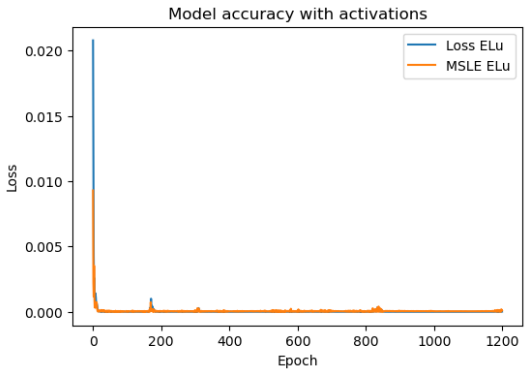


Figure 24 The Loss for 75cc data with Elu

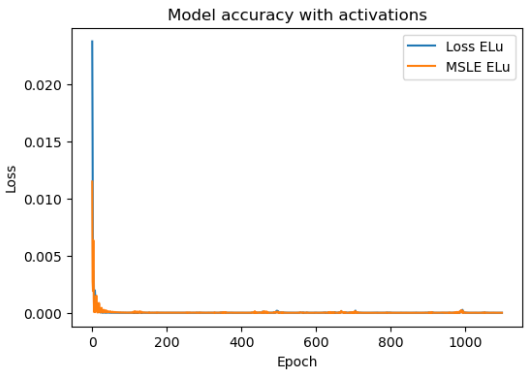


Figure 28 The Loss for 100cc data with Elu

Tables 5-8 represent the comparison of the training data (experimental data) and the predicted data both PR and ANN. We can predict the data for different times. The predictions are given in Tables 9-12

Table 5. Possible flood flow rates of E26A010 AGI

Day	Target	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1	9.05	9.159895	9.082434	9.051624	9.050000
2	9.15	8.890245	9.070988	9.164109	9.086722
3	9.31	9.291894	9.278984	9.31168	9.309999
4	9.94	10.20067	10.05866	9.94251	9.940000
5	11.12	11.47488	11.39742	11.12378	11.12000
6	13.71	12.99533	13.07279	12.82565	12.81362
7	14.62	14.66527	14.80729	14.62633	14.62000
8	16.02	16.41048	16.42339	16.42755	16.44286
9	18.36	18.1792	17.99845	18.22413	18.23862
10	19.93	19.94213	20.01959	19.93881	19.93000

Table 6.The comparison of the experimental data, PR and ANN predictions for 50cc

Day	Target	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1	9.08	9.152622	9.113469	9.081257	9.061183
2	9.22	9.049149	9.140508	9.221422	9.199373
3	9.45	9.414446	9.407921	9.452195	9.434942
4	10.06	10.26924	10.19745	9.800414	9.805772
5	11.25	11.5826	11.54345	11.25175	11.22337
6	14.02	13.27197	13.31112	12.93047	13.16891
7	15.01	15.20314	15.27492	15.03398	15.03921
8	16.83	17.19026	17.19679	16.82635	16.80187
9	19.26	18.99584	18.90448	18.5477	18.5489
10	20.28	20.33073	20.36989	20.27195	20.25528

Table 7. The comparison of the experimental data, PR and ANN predictions for 75cc

Day	Target	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1	9.2	9.297308	9.222462	9.189361	9.214143
2	9.59	9.389266	9.563907	9.58306	9.556547
3	10.05	9.939691	9.927217	9.980069	9.803448
4	10.66	10.93388	10.79666	10.69566	10.65839
5	11.86	12.32442	12.24957	11.93395	11.58418
6	14.81	14.03122	14.10607	13.97941	14.04297
7	16.02	15.94151	16.07873	15.91545	15.94393
8	17.32	17.9098	17.92227	17.5758	17.46046
9	20.05	19.75791	19.58327	19.40751	19.33819
10	21.24	21.275	21.34985	21.29476	21.20565

Table 8. The comparison of the experimental data, PR and ANN predictions for 100cc

Day	Target	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1	9.65	9.658881	9.661804	9.737173	9.643672
2	10.26	10.24923	10.24241	10.39709	10.25676
3	11.01	10.97083	10.97131	11.01324	11.01534
4	11.92	11.9261	11.93145	11.82436	11.59534
5	12.93	13.16844	13.17136	13.19254	12.84031
6	14.98	14.70224	14.69931	15.04465	14.75891
7	16.65	16.48286	16.4775	16.98433	16.67183
8	17.92	18.41663	18.41614	19.04833	18.68821
9	20.69	20.36089	20.36771	20.93521	20.63604
10	22.05	22.12392	22.12099	22.49164	22.15119

Table 9. The predictions for control

Predictions-Day	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1.00	9.159895	9.082434	9.051624	9.050000
1.25	9.019725	9.096348	9.073997	9.050697
1.50	8.930018	9.089783	9.10161	9.054023
1.75	8.887816	9.077265	9.133728	9.064962
2.00	8.890245	9.070988	9.164109	9.086722
2.25	8.934520	9.080964	9.195367	9.116143
2.50	9.017945	9.115175	9.232083	9.159989
2.75	9.137910	9.179723	9.26773	9.221025
3.00	9.291894	9.278984	9.31168	9.309999
3.25	9.477464	9.415756	9.372495	9.402710
3.50	9.692274	9.591412	9.508907	9.513886
3.75	9.934066	9.806054	9.732154	9.720457
4.00	10.20067	10.05866	9.94251	9.940000
4.25	10.49000	10.34723	10.12466	10.16175
4.50	10.80007	10.66895	10.47141	10.44006
4.75	11.12897	11.02035	10.82195	10.77727
5.00	11.47488	11.39742	11.12378	11.12000
5.25	11.83607	11.79580	11.43860	11.49753
5.50	12.21090	12.21090	11.84305	11.92394
5.75	12.59781	12.63808	12.32830	12.36770
6.00	12.99533	13.07279	12.82565	12.81362
6.25	13.40208	13.51070	13.30147	13.26153
6.50	13.81678	13.94790	13.74257	13.72082
6.75	14.23822	14.38099	14.18311	14.17253
7.00	14.66527	14.80729	14.62633	14.62000
7.25	15.09693	15.22494	15.07411	15.06778
7.50	15.53223	15.63309	15.52544	15.52705
7.75	15.97034	16.03205	15.97673	15.98751
8.00	16.41048	16.42339	16.42755	16.44286
8.25	16.85199	16.81017	16.87808	16.8967
8.50	17.29426	17.19703	17.32834	17.34991
8.75	17.7368	17.59036	17.77746	17.80065
9.00	18.1792	17.99845	18.22413	18.23862
9.25	18.62112	18.43167	18.66617	18.67267
9.50	19.06234	18.90257	19.1027	19.09695
9.75	19.5027	19.42607	19.52349	19.51821

Table 10. The predictions for 50cc

Predictions-Day	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1.00	9.152622	9.113469	9.081257	9.061183
1.25	9.085882	9.124612	9.104403	9.083791
1.50	9.045602	9.126357	9.137318	9.112902
1.75	9.033014	9.128774	9.176832	9.148807
2.00	9.049149	9.140508	9.221422	9.199373
2.25	9.094834	9.168856	9.270057	9.252855
2.50	9.170696	9.219842	9.318975	9.310759
2.75	9.277159	9.298294	9.384991	9.369883
3.00	9.414446	9.407921	9.452195	9.434942
3.25	9.582579	9.551388	9.506618	9.48294
3.50	9.781377	9.730395	9.563956	9.524736
3.75	10.01046	9.945752	9.646337	9.598458
4.00	10.26924	10.19745	9.800414	9.805772
4.25	10.55693	10.48476	10.05346	10.07586
4.50	10.87255	10.80627	10.48546	10.40646
4.75	11.2149	11.16	10.89019	10.81675
5.00	11.5826	11.54345	11.25175	11.22337

Continuation of Table 10

Predictions-Day	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
5.25	11.97405	11.95369	11.59031	11.66359
5.50	12.38746	12.38746	11.99102	12.15025
5.75	12.82083	12.84119	12.43789	12.66101
6.00	13.27197	13.31112	12.93047	13.16891
6.25	13.73847	13.79337	13.45685	13.69178
6.50	14.21774	14.28401	14.01626	14.14508
6.75	14.70696	14.77913	14.53596	14.588
7.00	15.20314	15.27492	15.03398	15.03921
7.25	15.70307	15.76778	15.50601	15.48676
7.50	16.20334	16.25432	15.96201	15.92571
7.75	16.70034	16.73153	16.39946	16.36376
8.00	17.19026	17.19679	16.82635	16.80187
8.25	17.66909	17.64795	17.25533	17.23946
8.50	18.1326	18.08346	17.68609	17.67636
8.75	18.57639	18.50237	18.11666	18.11259
9.00	18.99584	18.90448	18.5477	18.5489
9.25	19.38612	19.29036	18.97897	18.98155
9.50	19.74221	19.66146	19.41024	19.40719
9.75	20.05889	20.02016	19.8415	19.83278

Table 11. The predictions for 75cc

Predictions-Day	PR 3th order	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1.00	9.356154	9.297308	9.222462	9.189361	9.214143
1.25	9.28351	9.277741	9.351777	9.218353	9.278126
1.50	9.254001	9.286336	9.440706	9.302257	9.362338
1.75	9.265866	9.323439	9.506491	9.42391	9.459305
2.00	9.317343	9.389266	9.563907	9.58306	9.556547
2.25	9.406668	9.483907	9.625407	9.674099	9.599531
2.50	9.53208	9.607323	9.701271	9.763546	9.642313
2.75	9.691816	9.759349	9.799751	9.87405	9.693686
3.00	9.884114	9.939691	9.927217	9.980069	9.803448
3.25	10.10721	10.14793	10.0883	10.1518	10.01678
3.50	10.35935	10.38351	10.28605	10.34624	10.27865
3.75	10.63876	10.64576	10.52207	10.51768	10.54749
4.00	10.94368	10.93388	10.79666	10.69566	10.65839
4.25	11.27236	11.24692	11.10897	10.86683	10.75988
4.50	11.62302	11.58384	11.45715	11.09962	10.87912
4.75	11.99391	11.94344	11.83849	11.4507	11.10683
5.00	12.38326	12.32442	12.24957	11.93395	11.58418
5.25	12.78932	12.72532	12.6864	12.43985	12.2034
5.50	13.21031	13.14457	13.14457	12.95821	12.8421
5.75	13.64448	13.58048	13.6194	13.47318	13.45736
6.00	14.09007	14.03122	14.10607	13.97941	14.04297
6.25	14.54531	14.49484	14.5998	14.48046	14.59396
6.50	15.00844	14.96926	15.09595	14.9752	15.07872
6.75	15.47769	15.45226	15.59021	15.47092	15.53709
7.00	15.95132	15.94151	16.07873	15.91545	15.94393
7.25	16.42754	16.43454	16.55823	16.33059	16.32511
7.50	16.90461	16.92877	17.02623	16.74572	16.70478
7.75	17.38076	17.42147	17.4811	17.16082	17.08292
8.00	17.85422	17.9098	17.92227	17.5758	17.46046
8.25	18.32324	18.39077	18.35037	18.00028	17.92745
8.50	18.78605	18.86129	18.76734	18.46383	18.39868
8.75	19.24088	19.31812	19.17662	18.9355	18.86893
9.00	19.68599	19.75791	19.58327	19.40751	19.33819
9.25	20.1196	20.17717	19.99412	19.87963	19.8065

Continuation of Table 11

Predictions-Day	PR 3th order	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
9.50	20.53996	20.57229	20.41792	20.35176	20.27383
9.75	20.94529	20.93952	20.86549	20.8238	20.74022
10.00	21.33385	21.275	21.34985	21.29476	21.20565

Table 12 . The predictions for 100cc

Predictions-Day	PR 4th	PR 5th	ANN LeakyRelu	ANN Elu
1.00	9.658881	9.66180	9.73717	9.643672
1.25	9.801609	9.79872	9.84296	9.670229
1.50	9.945966	9.93994	10.02869	9.783303
1.75	10.09442	10.08727	10.23185	10.06459
2.00	10.24923	10.24241	10.39709	10.25676
2.25	10.41249	10.40696	10.54101	10.36320
2.50	10.58607	10.58240	10.70776	10.61037
2.75	10.77168	10.77011	10.86871	10.87412
3.00	10.97083	10.97131	11.01324	11.01534
3.25	11.18481	11.18714	11.17180	11.13578
3.50	11.41477	11.41857	11.35488	11.26510
3.75	11.66161	11.66644	11.56670	11.42306
4.00	11.92610	11.93145	11.82436	11.59534
4.25	12.20876	12.21415	12.10944	11.80192
4.50	12.50996	12.51491	12.42146	12.08020
4.75	12.82986	12.83396	12.79208	12.44222
5.00	13.16844	13.17136	13.19254	12.84031
5.25	13.52547	13.52699	13.60130	13.29994
5.50	13.90055	13.90055	14.06532	13.80419
5.75	14.29307	14.29155	14.55486	14.27680
6.00	14.70224	14.69931	15.04465	14.75891
6.25	15.12707	15.12297	15.53171	15.25207
6.50	15.56640	15.56145	16.01779	15.73215
6.75	16.01885	16.01346	16.49954	16.20307
7.00	16.48286	16.47750	16.98433	16.67183
7.25	16.95668	16.95185	17.49714	17.17154
7.50	17.43837	17.43456	18.01591	17.67681
7.75	17.92579	17.92347	18.53261	18.18273
8.00	18.41663	18.41614	19.04833	18.68821
8.25	18.90836	18.90994	19.56341	19.19452
8.50	19.39828	19.40195	20.05232	19.70020
8.75	19.88349	19.88901	20.52439	20.18993
9.00	20.36089	20.36771	20.93521	20.63604
9.25	20.82720	20.83435	21.32573	21.01559
9.50	21.27895	21.28498	21.71568	21.39460
9.75	21.71247	21.71537	22.10367	21.77313
10.00	22.12392	22.12099	22.49164	22.15119

3. Conclusion and Suggestions

The fact that the mycelial development of the groups to which kombucha mushroom was added was good, the mushroom mycelia were more resistant to diseases and pests and the mushroom mycelia developed faster, and as a result, it will provide serious advantages in producing mycelia that are more resistant to both time and diseases when used in seed mycelia production [25]. With the increase in commercial cultivation of Agaricus bisporus in Turkey, the need to both increase its yield and develop species that are resistant to diseases and pests has emerged. In this study, the addition of Kombucha mushroom at the seed mycelium stage contributed to both the development of durable mycelia and increased yield. There are limited studies in this field. Our study will lead to future studies.

The PR and the ANN application is used to teach the machine. After this teaching process we can

ask the predictions of new data. This new data can be used to improve the Agaricus bisporus cultivation. Thus, the cultivation efficiency can be improved. Moreover, similar studies can be investigated without any numerical analysis methods. Although we have restricted data, the founded results are good.

Although PR results may seem better, PR results are not good the out of range. But its results can be used for only the dataset range. While ANN results are good both the dataset range and the out of the range of the dataset according to the results. We could have better results but then ANN but then the ANN becomes overflow. This overflow is an unwanted situation. If we compare the ANN results in terms of the activation function, it can be seen that the results with the Elu activation function is better. The reason of that the activation of the next neuron in the network.

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Contributions of the authors

Fatih Kutluer : investigation, Methodology, Visualization, Writing- Review&Editing. Ramazan Güngüneş: Investigation, Methodology, Software, Visualization, Writing-Review&Editing.

Conflict of Interest Statement

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

The study is complied with research and publication ethics

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