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temperature EFFECTING YEAST GROWTH

**Rationale**

Yeast is a single cell organism that is part of the fungi kingdom. Yeast can be found world-wide in soils and on the surfaces of plants. There are a lot of varieties of yeast that are used produce goods that to contribute to the economy. Yeasts is used in bread, beer and wine. The fungi feed on the sugar and produce alcohol and carbon dioxide. To produce bread the carbon dioxide is needed to make the bread rise.

Fungi are eukaryotic organisms and they produce asexually by budding. A small bump protrudes from the parent cell, enlarges, matures and detaches. All yeast needs food, moisture and a controlled warm environment in order to ferment.

(yeast Definition & Uses, 2022)

Most microbes such as yeast and bacteria have an optimal temperature range in which they grow best. If the temperature gets too high, they can grow slower and even cease growing. If the temperature is to low, then it can die. The temperature range does vary for different organisms. Temperature is one of the most important factors that influence the growth of yeast. (Akinbobola, 2022)

The below experiment tested yeast samples at three different temperatures 4 degrees, 25 degrees and 30 degrees to determine how temperature effects the growth of the population.

**Research question**

Does an increase in the temperature of a yeast solution result in an increase in population of yeast reproduced over a 4 day period?

**Original experiment**

The original experiment was done to determine the effect the amount of food resources has on a population. The growth of the population in a simple ecosystem was measured. A Spectrophotometer was used to measure the optical density of the population. The experiment was done using two test tubes, one which contained 10 mL of distilled water and one which contained 2% sucrose solution.

**Modification to the methodology**

In the original experiment two samples were taken, in the first sample distilled water was added to a yeast solution. In the second sample 2% sucrose solution was added to the yeast solution. After 4 days a spectrophotometer set to 600nm was used to measure the absorbance.

Redirection

In the original experiment the independent variable was the food resource. The original experiment was done to determine what the effect of the amount of food resource had on a population change. In the revised experiment the independent variable is the temperature and all variable were controlled as per the original experiment which will minimize error. Controlling the variables will ensure reliability of the data collected.

Refined by :

The original experiment had a small sample size of only one sample per solution tested. In this experiment we have used 3 samples per temperature tested, the increase in sample size will improve the reliability of the data collected. Three samples were made for each temperature. Increasing the number of trials per sample to 3 will ensure sufficient data is collected in order to calculate the mean, standard error and confidence levels. The ability to be able to calculate and average enhances reliability and validity of the data.

In this experiment the samples were exposed to three temperatures to analysis the effect that temperature has on the population. In the original experiment the sample were only exposed to two independent variables. The increase in independent variables enhances the reliability and validity of the data.

**Safety and ethical issues**

Risk

* Injury due to breakage of glassware

Management

* Wearing appropriate PPE and handle glassware with care
* Placing glassware in the middle of bench.

Risk

* Contamination of the sample by not controlling variables.

Management

* Make sure hands and equipment are washed and dried adequately.

There were no elements used in the experiments that required ethical consideration.

**Processed Data**

The data was analyzed by performing calculations in excel to determine the

Mean

Standard Deviations and

Standard Error

Correlation coefficient

Coefficient of determination

The growth as well as the percentage of change were calculated.

See Appendix 1 for formulas used

Table 1: Sample Calculations

|  |  |
| --- | --- |
| **Calculation** | **Example** |
| Percentage change | Percentage change 4 degrees = (1.38 -1.24)/1.24 = 11.1 |
| Mean | Mean of 4 degrees on Day 1 = (0.138+0.141+0.091)/3 = 0.123 abs |
| Standard Deviation (SD) | Excel functions were used to calculate standard deviation (STDEV function) – see Appendix 1 |
| Standard error | Standard error is calculated as standard deviation divided by the cubed root of the sample size  4 Degree SE = 0.0.028/1.73 = 0.16 |
| Correlation coefficient (r) | Excel functions were used to calculate standard deviation (CORREL function) – see Appendix 1 |
| Coefficient of determination (R) | R is calculated by squaring r  -0.832\*-0.832= 0.693 |

Table 2: Processed Data for the effect of temperature on the growth of Yeast population.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Absorbance of yeast sample (abs ) | | | | | |
|  |  | Replicate | 4 degrees | 25 degreed | 30 degrees |
| Day 1 |  | 1 | 1.242 | 1.147 | 1.259 |
|  |  | 2 | 1.232 | 1.229 | 1.417 |
|  |  | 3 | 1.265 | 1.157 | 1.258 |
|  |  |  |  |  |  |
| Day 4 |  | 1 | 1.380 | 1.528 | 1.626 |
|  |  | 2 | 1.373 | 1.613 | 1.460 |
|  |  | 3 | 1.356 | 1.539 | 1.456 |
|  |  |  |  |  |  |
| Difference day 1-4 |  | 1 | 0.138 | 0.381 | 0.367 |
|  |  | 2 | 0.141 | 0.384 | 0.043 |
|  |  | 3 | 0.091 | 0.382 | 0,198 |
|  |  |  |  |  |  |
|  |  | Average change | 0.123 | 0.382 | 0.203 |
|  |  | Standard Deviation | 0.028 | 0.002 | 0.162 |
|  |  | Standard Error | 0.016 | 0.000 | 0.094 |
|  |  | Average Growth | 9.91% | 32.49% | 15.95% |
|  |  |  |  |  |  |
|  |  | Correlation coefficient (r) | -0.832 | 1.000 | -0.477 |
|  |  | Coefficient of determination ( R ) | 0.693 | 1.000 | 0.228 |

Figure 1:Yeast growth at different temperature day 1 and day 4 (error bar represented by standard error)



Figure 2:Percentage change in yeast between day 1 and day 4 at different temperatures.

Table 2 suggests that reliability of the data is high as the standard deviation and the standard errors are low. The standard deviation range between 0.162 and 0.002 and standard error range between 0.162 and 0.001. This indicates that there is a high precision of data and the data is consistent.

The correlation coefficient (r) ranges from -0.0832 to 1. The correlation coefficient at 25 degrees is 1 or if rounded to a high decimal number 0.9999 which indicates that the data lies on a perfectly straight line. A r of 1 is very unlikely and does require further investigation to determine the accuracy. The lowest correlation coefficient of -0.477 is at 30 degrees this indicates that there is a weak correlation between the variables. The coefficient of determination is 23% at 30 degrees which indicates that only 23 % of variances in the dependent variable can be predicted from the independent variable. This does indicate that a linear model may not be best to model this data at 30 degrees.

As detailed in table 2 the percentage change at 4 degrees is a increase of 9.916% , at 25 degrees an increase of 32,492% and at 30 degrees an increase of 15,974 %. At 30% the yeast has grown but at a lesser percentage than at 25 degrees, this indicates the 30 degrees is too a high a temperature and the yeast has ceased to grow.

It can be concluded from the data that the temperature that the yeast solution is maintained at does affect the population growth. The increase in the temperature does increase the population growth but only to an optimum point after which the growth decrease.

**Evaluation**

Limitations

All 9 samples contained 3 drops of yeast solution which was added using a bulb pipette. The test tubes were then swirled to mix and a 1ml sample taken to measure the yeast population. Sample 1 and sample 3 at 25 degrees as can be seem on Appendix 1 are lower than all the other sample readings and contribute to the lower mean determined for day 1 at 25 degrees. The lack of consistent mixing of the samples may also contribute to increasing the standard error. There was no control to ensure all samples were mixed equally.

Readings were only taken on day 1 and day 4. There is no analysis of the data between these days to understand if the change was gradual or reached a maximum and then decreased or could possibly have increased more. Readings were also only recorded by one person, so there was to double checking of the accuracy of the measurement.

Reliability and Validity

The limitations mentioned above decrease the reliability and validity of the investigation. Although the error bars are not overlapping this does not ensure there is a substantial difference between the data. Reliability could be decreased by the mixing of the samples.

Suggested improvements and extensions.

Making extensions to the investigation will improve the limitations. Limitations might be removed or reduced by increasing the number of readings taken and also by increasing the duration of the experiment. Increasing the replicates would increase the reliability and validity. Readings done every day instead of only on day 4 would enable a better pattern to be developed and interpreted. The measure of the results could be done by more than one person, so as to double check if different readings are recorded. All this could increase reliability as the conditions would be more controlled.

The experiment could also be extended by measuring the growth at additional temperatures, adding a temperature less than 25 degrees but greater than 4 degrees and one between 25 degrees and 30 degrees would increase the reliability and validity.

**Conclusions**

The evidence suggests that the temperature does contribute to the population of yeast reproduced over a 4 day period. The evidence also suggests there is an optimum temperature of 25 degrees to maximize growth. Due to the limitations mentioned above some modification could be considered and further investigation performed, however the data does support the conclusion that as the temperature increases so does the yeast population. There is a limitation that above a certain temperature an increase in temperature will not result in additional increase in population growth.

**Reference List**

yeast | Definition & Uses. (2022). Retrieved 20 February 2022, from https://www.britannica.com/science/yeast-fungus

Akinbobola, D. (2022). The effect of temperature on yeast growth. Grin.com. Retrieved 12 March 2022, from https://www.grin.com/document/1094178.

**Appendix 1.**

Raw data and formulas used to determine Mean, Standard Deviation, Standard Error , correlation coefficient and coefficient of determination.

A picture containing graphical user interface

Description automatically generated