

How to Calculate a Geometric Mean

By Dave Feldman, DEQ

Most MPDES permits in Montana require permittees to calculate a geometric mean when more than one bacterial (fecal coliform or E. coli) sample is collected during a reporting period (7-day or 30-day). I wrote this article to help people understand the geometric mean.

Why does Montana Require the Geometric Mean for Bacteria?

We use the geometric mean to summarize bacteria data because those data are so variable. Bacteria can grow at an exponential rate very quickly under the right conditions. The geometric mean value will not be overly influenced by large fluctuations from between one data point and the next.

How the Geometric Mean is Calculated?

The math behind the standard is simpler than it appears at first glance. The calculation is similar to an average. However, instead of adding the numbers together and dividing by the number of values, you multiply the numbers together and take the root of the number of them together. This is known as a geometric mean. The geometric mean allows for an unbiased “average” that does not put as much weight on one or two numbers that are different from the rest used to calculate the final number. Here is what the geometric mean formula looks like:

$$\sqrt[n]{\prod_{i=1}^n X_i}$$

In this equation *n* is the number of samples you collect, and *X* is the value of each sample.

Here is another way to view the equation:

$$\sqrt[n]{X_1 X_2 X_3 X_4 \dots X_n}$$

Here is an example: You collected five water grab samples over a one-week time period, and tested them for *E. coli*. You found these *E. coli* concentrations:

| Sample Number | E. coli (cfu/100 ml) |
|---------------|----------------------|
| 1 | 10 |
| 2 | 100 |
| 3 | 300 |
| 4 | 15 |
| 5 | 4 |

Here is the geometric mean for these data:

$$\sqrt[5]{10 \times 100 \times 300 \times 15 \times 4} = 28.25$$

Notice that while the difference between the minimum and maximum values is large, the geometric mean of 28.25 is relatively low in this example.

Yes, There is an Easier Way to Calculate the Geometric Mean

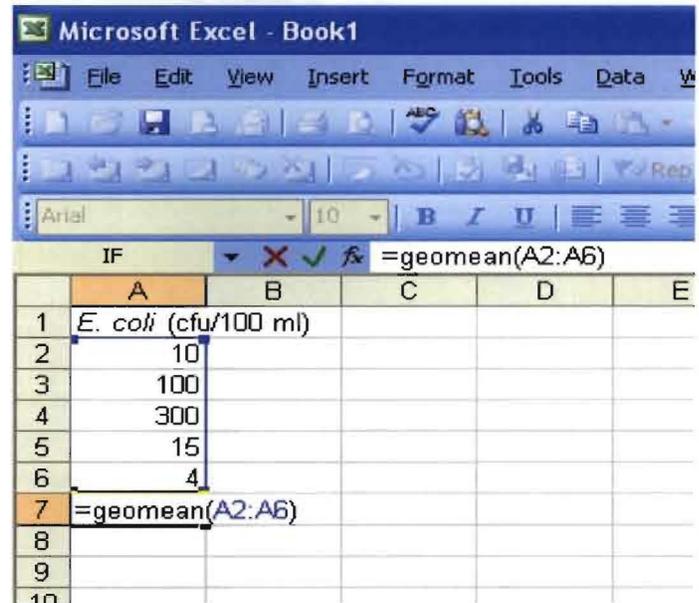
There is an easier way to determine the geometric mean of a bacteria dataset using MS Excel.

The command “geomean” will automatically calculate the geometric mean for a dataset. Simply input your data into

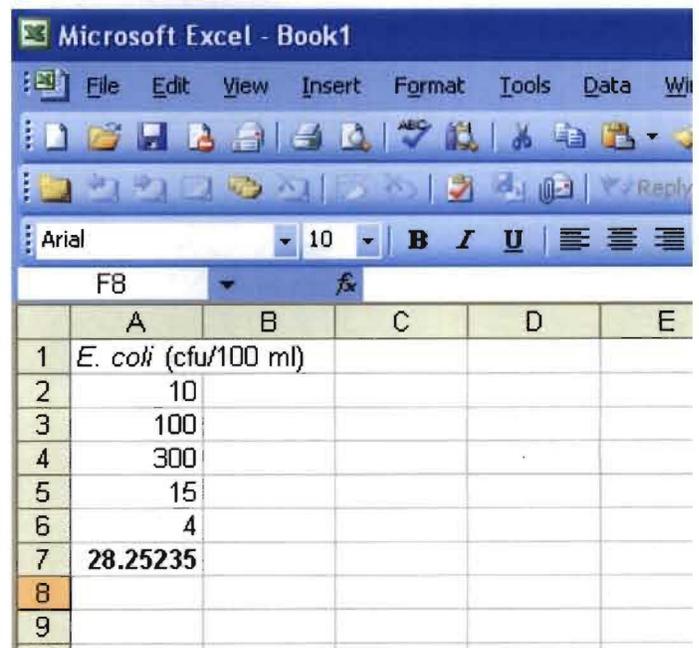
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in an Excel spreadsheet, type the command “=geomean” and select the cells with the numbers you want calculated in parentheses (see example):



Press enter and Excel will calculate the geometric mean for the dataset:



I sincerely hope this article helps you understand how to calculate a geometric mean. If you have any questions, please contact me at (406) 444-6764, or dfeldman@mt.gov. ■