

NOTES ON THE USE OF THE QMRA – MONTE CARLO PROGRAMS FOR WASTEWATER USE IN AGRICULTURE



QMRA-MC_UnrestrictedIrrigation_Norovirus

Open the program file and click ‘enable macros’.¹ There is one sheet: QMRA_Dose_Response.

Determination of Norovirus infection risks

- The program calculates the median and 95-percentile norovirus infection or disease risks from consuming every n days a variable quantity of lettuce irrigated with wastewater of a quality specified as a single log range of *E. coli* numbers – e.g., 10^x – 10^{x+1} per 100 ml.
- In the yellow boxes in columns 3 and 4 enter your chosen range of values for:
 - E. coli* numbers per 100 ml (usually, but not necessarily, a single log range²);
 - Norovirus numbers per 10^5 *E. coli* [see 4 below];
 - The volume of wastewater remaining on 100 g lettuce after irrigation (ml);
 - The quantity of lettuce consumed on each occasion (g per day);
 - The norovirus die-off between last irrigation and consumption, if any (log units);
 - Consumer exposure – i.e., the consumption of wastewater-irrigated crops every n days (enter your value of n in both boxes);
 - The proportion of exposed consumers who become ill (if this is set to 1, then the program effectively determines the infection risk; if set to <1, then it calculates the disease risk) – enter your value (1 or any value <1) in both boxes; and
 - The number of simulations required (usually 1000 or 10,000).

► Click on any empty cell to confirm your choices.
- Click the box “Do Monte Carlo Simulation”, wait a minute or two, then read the median (50-percentile) and 95-percentile risks of norovirus infection per person per year under “PI Annual” in column 3 (the maximum and minimum risks determined in the MC simulation are also given).
- The basic approach in this program follows that developed by Professor Hillel Shuval and colleagues³ which assumed a constant ratio of pathogen numbers to *E. coli* numbers (1 rotavirus

¹In Excel 2007 click on ‘Options ...’ to the right of ‘Security warning. Some active content has been disabled’; then select ‘Enable the content’ and click on ‘OK’.

²You can specify a larger range if you wish – e.g., 10^x – 10^{x+n} per 100 ml; alternatively you could set a single fixed value in both boxes – e.g., $y \times 10^x$.

³Shuval, H. I., Lampert, Y. & Fattal, B. (1997). Development of a risk assessment approach for evaluating wastewater reuse standards for agriculture. *Water Science and Technology* **5** (11–12), 15–20; abstract available at: <http://www.iwaponline.com/wst/03511/wst035110015.htm>

per 10^5 *E. coli*). As described above, a range of pathogen numbers per 10^5 *E. coli* is used in this program (e.g., 0.1–1 norovirus per 10^5 *E. coli*). However, you can set the norovirus number per 10^5 *E. coli* in both yellow boxes to 10^5 , so that you are equating norovirus and *E. coli* numbers and thus effectively determining the risks resulting from a wastewater quality of 10^x – 10^{x+1} (or 10^x – 10^{x+n}) noroviruses per 100 ml.

5. This program uses the norovirus dose-response data kindly provided by Dr Peter Teunis.⁴

6. This program uses the **Benke and Hamilton** method for calculating the annual risk of infection.⁵ This method firstly determines an annual risk of infection by doing a Monte Carlo simulation with the number of simulations set equal to the number of days of exposure per year (this is rounded down to an integral value), and it then repeats this 1000 (or 10,000) times and determines the resulting 50- and 95-percentile annual norovirus infection risks.

Prepared by Duncan Mara, February 2009

⁴Teunis, P. F. M., Moe, C. L. and others (2008) Norwalk virus: How infectious is it? *Journal of Medical Virology* **80** (8), 1468–1476 [Note: Norwalk virus is another name for norovirus]; abstract available at: <http://www3.interscience.wiley.com/journal/119877125/abstract>.

⁵Benke, K. K. and Hamilton, A. J. (2008). Quantitative microbial risk assessment: uncertainty and measures of central tendency for skewed distributions. *Stochastic Environmental Research and Risk Assessment* **22**, 533–539; abstract available at: <http://dx.doi.org/10.1007/s00477-007-0171-9>.