In-Plant Deli Meat Model

1. Input data

The input data for the in-plant deli meat model is contained in the MS Excel file "inplant input data.xlsx". The file contains six worksheets, five of which are used to define the input data. Each worksheet contains a "comment" column that describes the variables.

1.1 Control worksheet

This worksheet contains the parameters that setup and control the model simulation.

Table 1.1 Control Worksheet Parameters

Variable	Meaning
SaveDetail	TRUE or FALSE. If TRUE, saves the data for all lots simulated in "individual lot results.csv". Note that for large number of lots simulated, this file can be quite large.
PlotsToDisk	TRUE or FALSE. If TRUE, saves plots to disk as png files.
nlot.total	Total number of lots to simulate for analysis
seedRN	Random number seed as integer
deltaProb	Delta probability for quantile outputs as fraction. Smaller value adds more output details.
runName	Folder name to store results

1.2 Dose Response worksheet

The dose-response model is based on a one parameter exponential model following FAO-WHO (20??).

Table 1.2 Dose-Response Parameters

Variable	Meaning
nservings	Total number of annual servings or RTE meat. Used to estimate number of illnesses.
frac.susceptible	Fraction of population susceptible to listeriosis
r.healthy.q50	Median r value of exponential dose response model for healthy population.
r.healthy.q05	5% quantile r value of exponential dose response model for healthy population.
r.healthy.q95	955% quantile r value of exponential dose response model for healthy population.
r.susceptible.q50	Median r value of exponential dose response model for susceptible population.
r.susceptible.q05	5% quantile r value of exponential dose response model for susceptible population.
r.susceptible.q95	95% quantile r value of exponential dose response model for susceptible population.

1.3 Parameters worksheet

This worksheet contain the various parameters needed for the model.

Table 1.3 Miscellaneous Parameters

Value	Units	Meaning
Effect.PPMax		Maximum post processing lethality effectiveness
Effect.PPMin		Minimum post processing lethality effectiveness
LotMassMax	Pounds	Maximum lot mass
LotMassMin	Pounds	Minimum lot mass
LotMassSampled	Grams	Mass of product sampled for testing
MinFCSLs	cfu/cm^2	Minimum Listeria species concentration tracked on food contact surface.
nDaysPerTP	Days	Defines time period for testing frequency. Usually one month.
nLotsInit		Number of lots run to initialize the FCS concentrations. These lots are discarded prior to risk analysis.
nLotsPerDay		Number of lots produced per day.
ProbOf1		Probability (as fraction) of testing positive if 1 cfu in sample.
ReportLagLspp	days	Reporting lag for Listeria species testing.
ReportLagLm	days	Reporting lag for Listeria monocytogenes testing.
Sanitize.between.lots		Sanitation effectiveness (as fraction) between lots.
Sanitize.between.days		Sanitation effectiveness (as fraction) between days.
Sanitize.enhanced		Sanitation effectiveness (as fraction) for enhanced sanitation.
Lm.maxconc.5	cfu/g	Maximum Lm centration achievable in deli meat when stored <5°C
Lm.maxconc.5.7	cfu/g	Maximum Lm centration achievable in deli meat when stored between 5°C and 7°C
Lm.maxconc.7	cfu/g	Maximum Lm centration achievable in deli meat when stored >7°C
max.lm.consumed	cfu/g	Maximum Lm concentration in serving before it would be disposed of by consumer.
mu.RetailSliced		Mean for retail sliced product. Used to adjust retail sliced product for cross contamination.
sigma.RetailSliced		Standard deviation for retail sliced product. Used to adjust retail sliced product for cross contamination.
mu.Prepackaged		Mean for prepackaged product. Used to adjust retail sliced product for cross contamination.
sigma.Prepackaged		Standard deviation for prepackaged product. Used to adjust retail sliced product for cross contamination.
FracRetailSlice		Fraction of RTE deli meats that are retail sliced (as opposed to prepackaged).
fracTurkey		Normalized fraction of RTE deli meat sold that is turkey.
fracHam		Normalized fraction of RTE deli meat sold that is ham.
fracBeef		Normalized fraction of RTE deli meat sold that is beef.

1.4 Distributions worksheet

The distributions worksheet provides a flexible approach for defining the input distributions.

Table 1.4 Distributions Columns

Column name	Meaning
Parameter	The parameter variable being defined. See table below.
Distribution	The name of the distribution to use. Available names are: binomial, empiric, exponential, fixed, laplace, logistic, lognormal, normal, triangular, uniform, weibull
EmpiricName	The name of the column providing the empiric distribution. There are two associated columns: thre empiricName itself and the empiricName with a "Prob" appended, e.g. "servingSize" and "servingSizeProb". The prob column contains the cumulative probability while the empiricName column contains the values of the parameter.
Parameter1, parameter2, and parameter3	The parameters for the corresponding distribution. See table below. For example, parameter1 for a normal distribution is the mean, parameter2 is the standard deviation, and parameter3 is not used.
Units	The required units for the parameter resulting parameters

Table 1.5 Distribution Parameters

Parameter	Units	Meaning
egr 5C turkey with GI	log10 cfu/d	Exponential growth rate at 5°C for turkey with growth inhibitor.
egr 5C turkey without GI	log10 cfu/d	Exponential growth rate at 5°C for turkey without growth inhibitor.
egr 5C ham with GI	log10 cfu/d	Exponential growth rate at 5°C for ham with growth inhibitor.
egr 5C ham without GI	log10 cfu/d	Exponential growth rate at 5°C for ham without growth inhibitor.
egr 5C beef with GI	log10 cfu/d	Exponential growth rate at 5°C for beef with growth inhibitor.
egr 5C beef without GI	log10 cfu/d	Exponential growth rate at 5°C for beef without growth inhibitor.
lag time 5C turkey with GI	days	Lag time before growth at 5°C for turkey with growth inhibitor.
lag time 5C turkey without GI	days	Lag time before growth at 5°C for turkey without growth inhibitor.
lag time 5C ham with GI	days	Lag time before growth at 5°C for ham with growth inhibitor.
lag time 5C ham without GI	days	Lag time before growth at 5°C for ham without growth inhibitor.
lag time 5C beef with GI	days	Lag time before growth at 5°C for beef with growth inhibitor.
lag time 5C beef without GI	days	Lag time before growth at 5°C for beef without growth inhibitor.
home storage time, retail sliced	days	Consumer home storage time for retail sliced product.

home storage time, prepackaged	days	Consumer home storage time for prepackaged product.
home storage temperature	°C	Consumer home storage temperature.
time, plant to retail	days	Time from plant to retail.
temperature, plant to retail	°C	Temperature from plant to retail.
transfer coefficient	log10 scale	Transfer coefficient in plant from FCS to product
Lspp load during contamination	log10 cfu/cm^2	
Lm Lspp ratio		Ratio of Listeria species to Listeria monocytogenes in plant
FCS swab area	cm^2	FCS swabbed for testing
FCS area	cm^2	Total FCS area
contamination event duration	days	Duration of each contamination event
time between contamination events	days	Time between successive contamination events
serving size	grams	Consumer RTE serving size

Table 1.6 Meanings for Distribution Parameters

Available distributions	**Parameter 1**	**Parameter 2**	**Parameter 3**	**Comment**
binomial	probability of success per trial	---	---	
Empiric	---	---	---	Enter column name containing the data in 'empiricName'. Assumes another column exists with 'empiricNameProb' containing the cumulative probability
exponential	rate (lambda)	---	---	
Fixed	fixed value to return	---	---	
Laplace	location	scale	---	
Logistic	location	scale	---	
lognormal	mean on log10 scale	standard deviation on log10 scale	---	
Normal	mean	standard deviation	---	
triangular	minimum	mode	maximum	uses rTriangle() function in code
Uniform	minimum	maximum	---	
Weibull	shape	scale	---	

1.5 Plants worksheet

The Plants worksheet contains the data for each plant type, i.e. the combination of plant size(large, small, very small) and the alternative used (both post processing and growth inhibitor, either post processing or growth inhibitor, sanitation only).

Table 1.7 Plant Parameters

Column	**Meaning**
cat.ID	Alternative and plant size, L=Large, S=Small, VS=Very small, PP=postprocessing lethality, GI=growth inhibitor
LotMassMean	Mean lot mass for plant/alternative type in lb
LotMassSD	Standard deviation of lot mass for plant/alternative in lb
fracProduction	Fraction of total production from this plant/alternative type. Column should sum to 1.
nFCSSamplesPerTP	number of food contact surfaces analyzed per time period (month)
nLotSamplesPerTP	number of lot samples analyzed per time period (month)
FCSSeqTrigger	number of sequential positive food contact surfaces before triggering actions
fracPP	fraction of plant type implementing post processing
fracGI	fraction of plant type implementing growth inhibitors
Action.FCSEnhancedClean	TRUE or FALSE. Does action include enhanced cleaning?
Action.FCSTestNextFCS	TRUE or FALSE. Does action include testing the next available FCS?
Action.LotDispose	TRUE or FALSE. Does action include disposing positive lot?
Action.LotTestNextLot	TRUE or FALSE. Does action include testing the next available lot?
Action.FCSForceLotTest	TRUE or FALSE. Does a FCS positive trigger a lot test?
Action.TestAndHoldAll	TRUE or FALSE. Are lots held awaiting FCS results?

2. Output data

By default, the model creates six output workbooks as csv files.

Table 2.1 Output data files

Output file name	**Use**
Processing results.csv	Provides prevalences and summary fractions of production type (with and without post processing and growth inhibitor.
Results count summary.csv	Provides breakdown counts on number of lots by production and testing results.
Summary quantiles by alternative.csv	Provides quantile concentrations leaving plant, leaving retail, and at consumption for the 4 alternatives.
Summary quantiles by intedrvention.csv	Provides quantile concentrations leaving plant, leaving retail, and at consumption for the different interventions.
Summary results risk.csv	Provides the risks to the susceptible and health populations and the estimate number of illnesses.
Summary results by altenative.csv	Provides the risk per serving for each of the plant size and alternative combinations.

Optionally, an additional output workbook “individual lot results.csv” is created if SaveDetail in the control worksheet is set to TRUE. This file contains all the data for each individual lot simulated. Note that if the number of lots simulated is larger than 1,048,575, the resulting file may be too large for Excel to read completely. The file size will also be quite large.

Optionally, five graphs are created (as png file) if PlotsToDisk in the control worksheet is set to TRUE.

Table 2.2 Optional graph outputs

Graph file name	**Interpretation**
Fractions.png	A bar graph of the fraction of lots at retail by intervention.
Prevalences.png	A bar graph of prevalences of FCS, after post-processing, and at retail.
Quantiles lmra.png	Cumulative density plots of L. monocytogenes concentrations at consumption for the different interventions.
Sample time series.png	An example of the contamination event time series. Three stacked graphs illustrating the FCS L. species concentration, the FCS L. species testing results, and the retail L. monocytogenes concentration over time as lots.
Tests.png	A stacked series of lots depicting the number of lots tested and number positive, the number of FCS tested and the number positive, and the number of lots produced. Each graph is by the plant size and alternative combination.