Survival of Serotype O FMDV under different conditions of controlled temperature and humidity

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Picture courtesy: Manda

Introduction

- Incursion of FMD into previously free countries or regions have been attributed to
  - Import of livestock from FMD endemic regions (Italy 1993)
  - Illegally imported meat products (UK -2001)
  - Inadvertent release from a laboratory (UK 2007)
  - Long-distance wind dispersion (UK 1981; Denmark 1982; Maragon *et al.*, 1994)

Wind dispersion models – Australian context

- Long-distance wind dispersion has been implicated as a major cause of the transboundary spread of foot-and-mouth disease virus (FMDV).
- However, in countries like Australia, it is necessary to also consider the temperature extremes and low relative humidity in modelling long-distance and short-distance spread.
- With the available data on the effects of temperature and relative humidity on FMDV survival, it is difficult to model short-distance spread of the virus between susceptible populations in Australia.
- The objective of this work was to obtain data to validate wind dispersion predictions, based on the impact of the interaction between temperature and humidity on FMDV using virus strains that were implicated to spread by wind dispersion.

Materials and methods

- Three strains of viruses
  - O_1/Lausanne 65 (from the 1966-67 Outbreaks in Switzerland and elsewhere in Europe)
  - O/UKG/2001 (from the 2001 UK outbreaks where wind dispersion was considered to be important in the initial stages of the epidemic (in Northumberland), but not in the later stages)
  - O/UKG/2007 (from the 2007 UK outbreak that did not involve wind dispersion)
- Three temperature (Temp) conditions – 10, 20 & 30°C
- Three Relative Humidity (RH) conditions – 80, 60 & 40 per cent

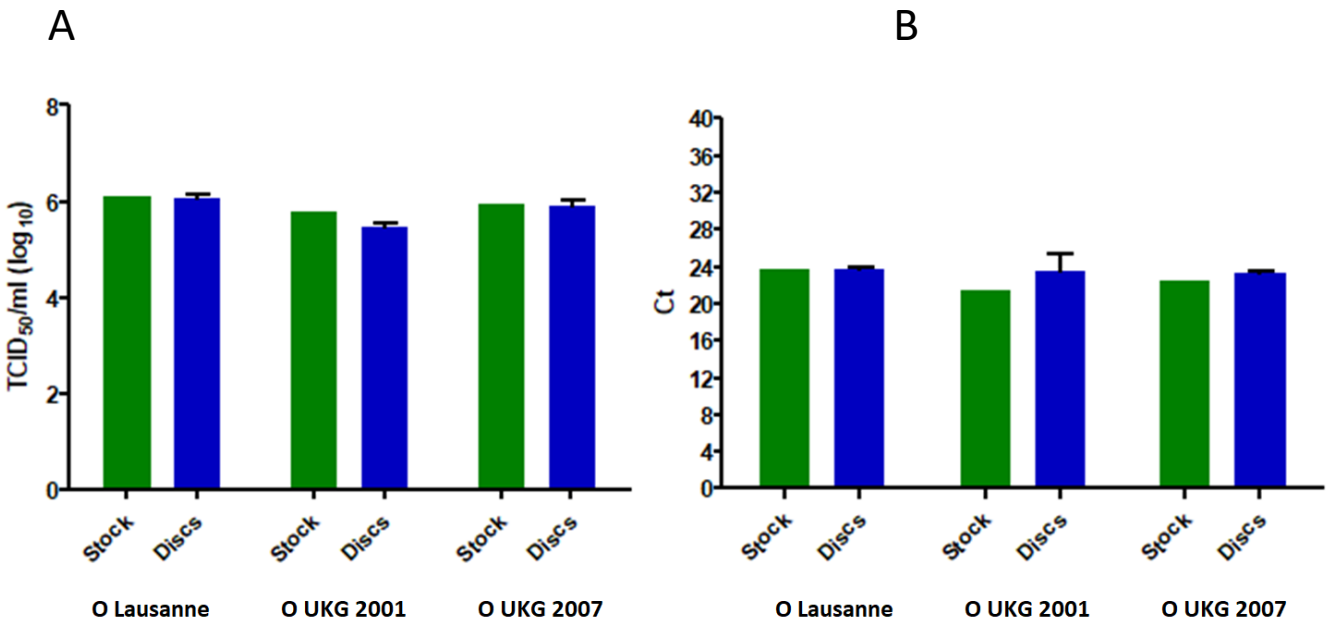
Virus stability experiments

- Experiments were performed using an Constant Climate Chamber where the temperature and RH can be controlled
- Virus soaked filter paper discs punched out of filter paper were used as carriers to represent a porous inanimate environmental surface
- Virus-soaked disks were incubated for ten different time intervals (0, 1, 2, 4, 8, 16, 24, 48, 72, 96 and 120 h)
- Recovered virus was titrated using LFPKαVβ6 cells
- Quantitative real-time RT-qPCR
- Studies to assess cross contamination in the chamber
- P1 region sequencing to confirm that no genome mutations had occurred during the production of virus stocks

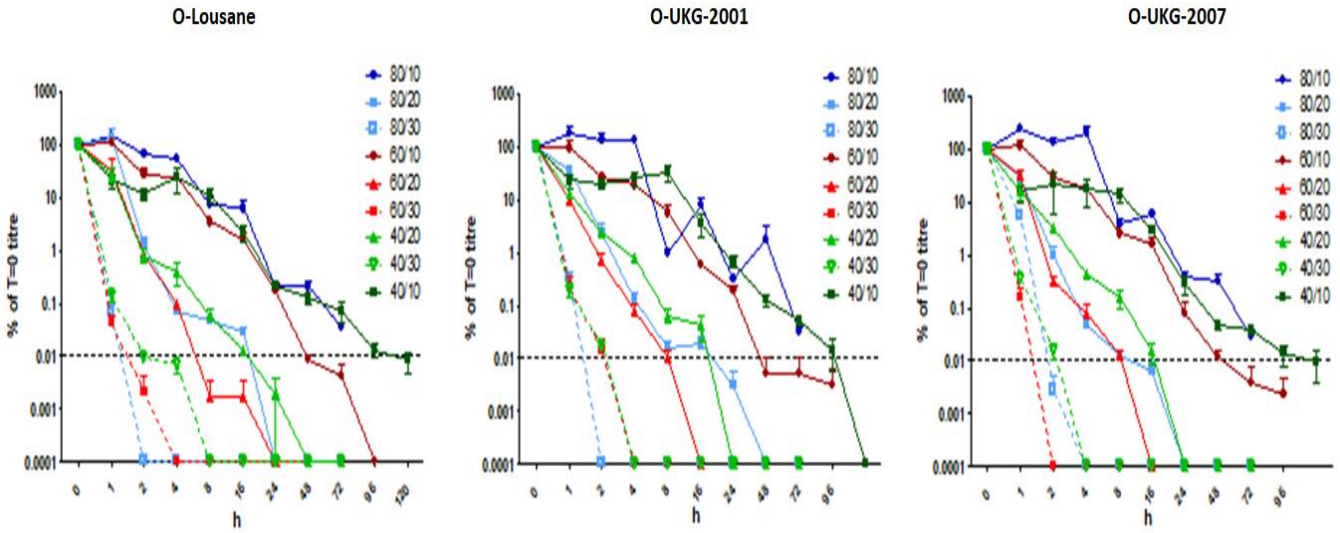
Comparison of stock virus and virus soaked onto filter paper discs

A – Virus titration on LFBK cells;

B – Ct values based on a real-time RT-PCR



Effect of RH and Temp on different strains of FMD serotype O viruses: Percentage decrease in virus concentration with increasing time



Modelling inactivation kinetics – Temp and RH effects

- Three models were fitted to study the inactivation kinetics
  - Linear regression model
  - Bi-phasic regression model
  - Weibull non-linear regression model

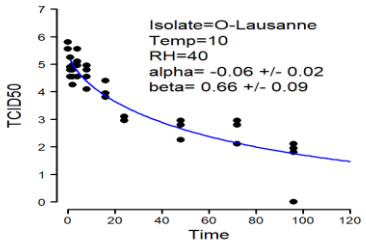
- Decimal Reduction Time (D) was estimated

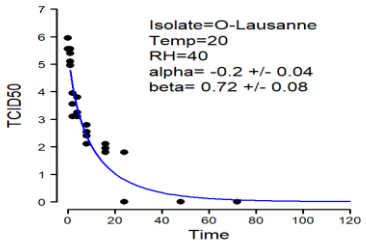
Decimal reduction time (linear model) of three strains of FMDV under different temperature and RH conditions

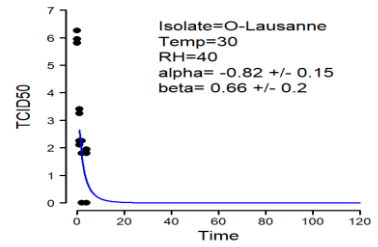
***D* value (decimal reduction time), which is the time required to inactivate 90% of the virus, indicating the thermal resistance of a microorganism**

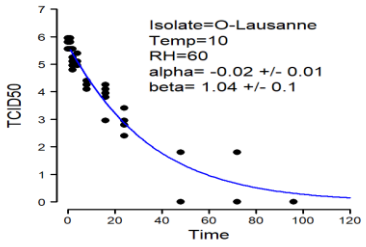
	D value								
	O-Lausanne			O-UKG-2001			O-UKG-2007		
	80% RH	60% RH	40% RH	80% RH	60% RH	40% RH	80% RH	60% RH	40% RH
10°C	20.81	16.65	22.93	22.86	19.01	21.19	22.29	18.41	21.87
20°C	4.34	4.09	8.25	4.55	4.26	9.23	4.13	4.27	8.81
30°C	0.33	0.35	0.76	0.35	0.44	0.72	0.38	0.36	0.73

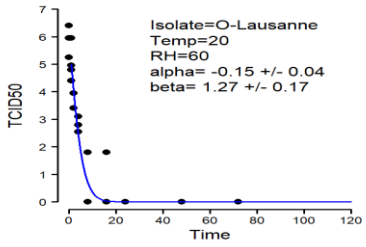
Weibull model – O Lausanne 65

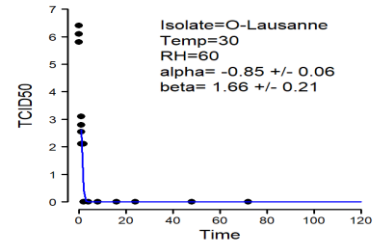


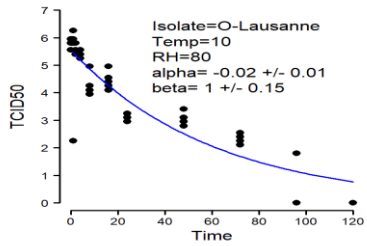


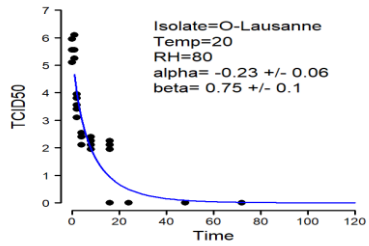


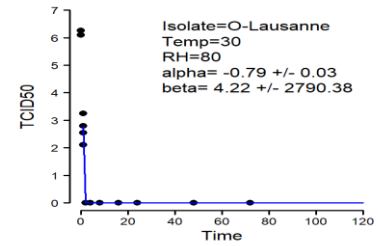




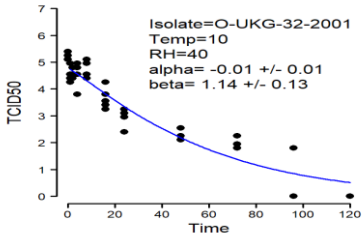


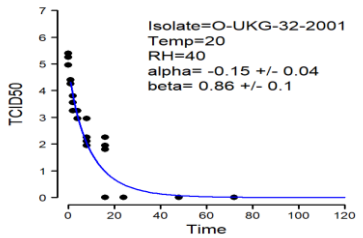


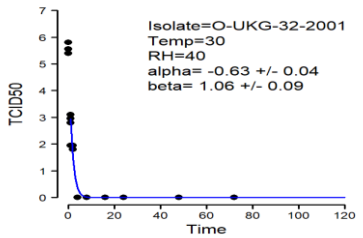


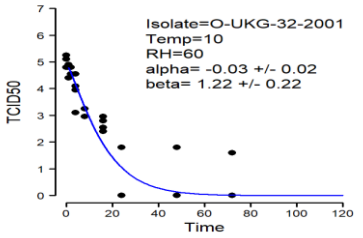


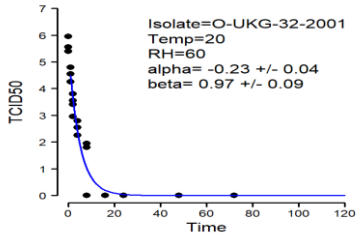
Weibull model – O UKG 2001

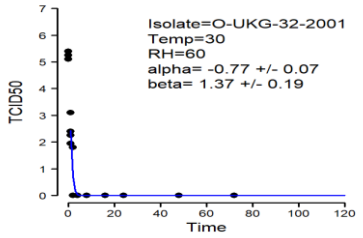


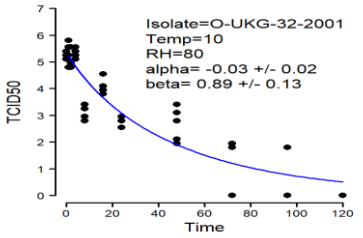


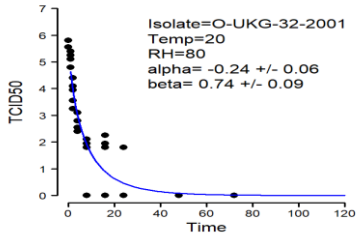


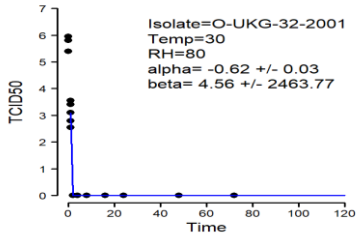




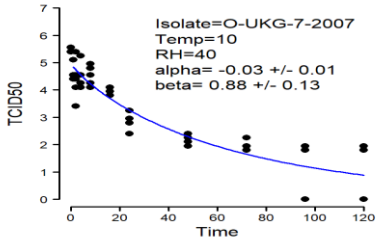


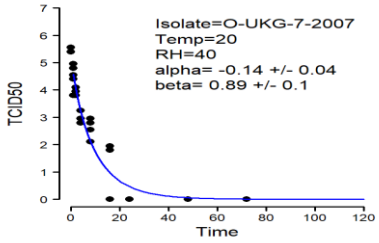


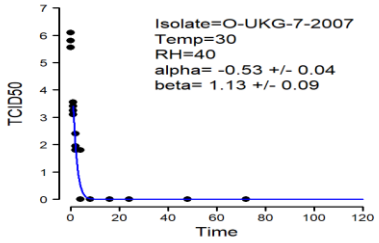


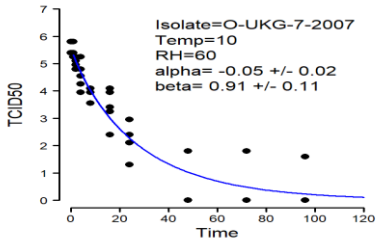


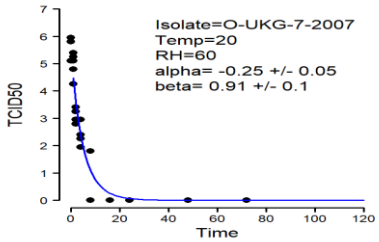
Weibull model – O UKG 2007

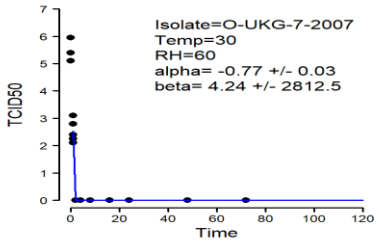


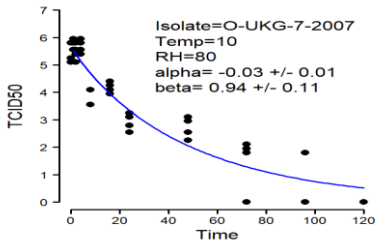


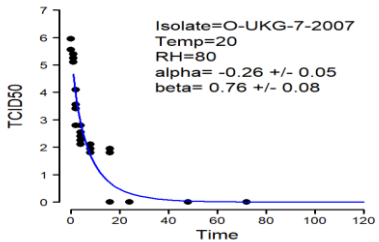


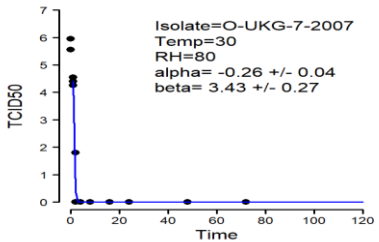










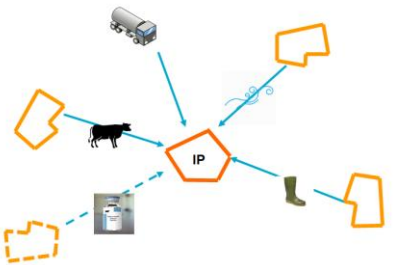


Conclusions

- Virus survival was significantly impacted by increasing temperatures, whereas changes in relative humidity appeared to have less effect.
- At 10°C, the virus remained viable for 96– 120 h.
- At 20°C all three viruses were inactivated after 48 hours incubation at 80% and 40% RH respectively, while complete inactivation was already achieved after 24 hours incubation at 60% RH.
- At 30°C, most viruses were inactivated after 2–4 h incubation.
- There was no apparent difference in stability between the three type O viruses, as demonstrated by similar inactivation curves at different temperature and humidity conditions (Weibull model).

Further work

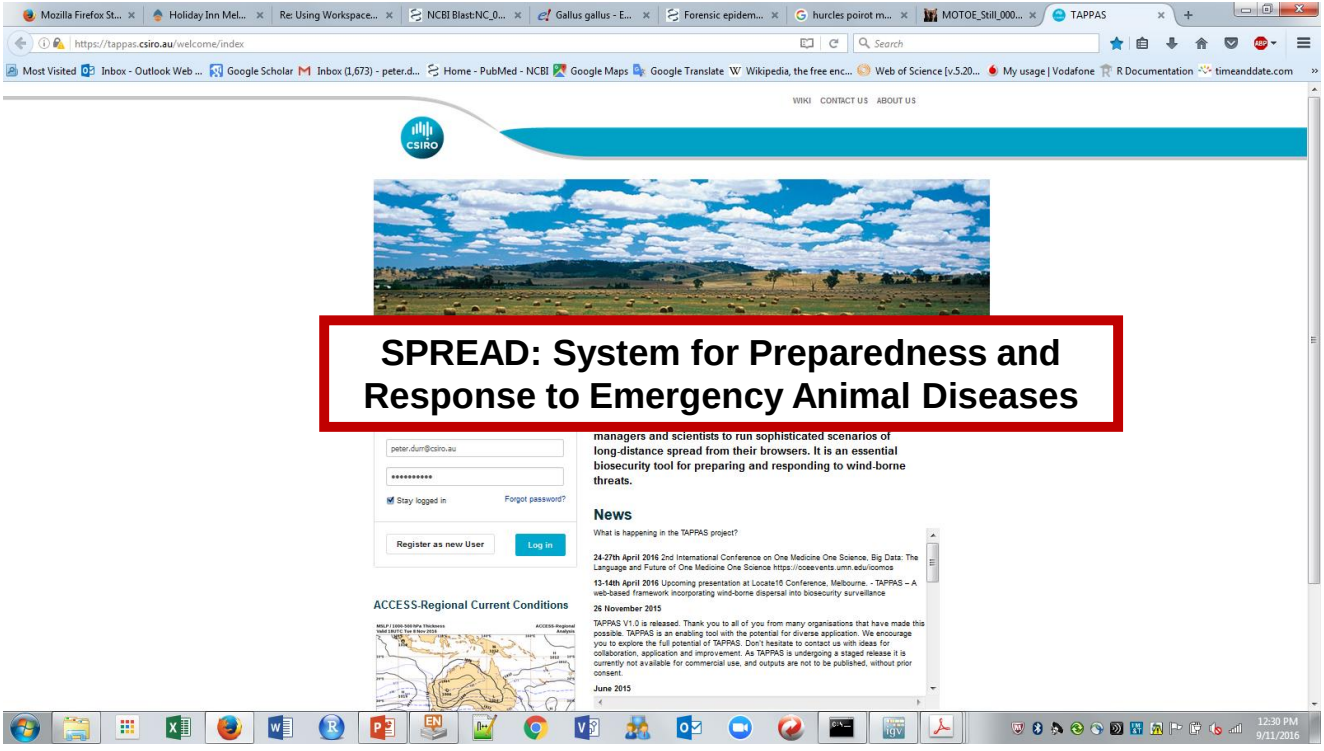
- Complete the analysis with Linear and Bi-phasic models
- Validating these models with data available on each of the outbreak scenarios
- Model spread to rule-in or rule-out wind-borne spread (short or long distance)
- Expand to also include more contemporary strains and serotypes



The two key “paths of transmission” questions:

- How did the virus spread to the farm?
- From which specific farm did the virus come from?

Using a web-based application to bring all the data together



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- GFRA 2019