



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

Nagendrakumar Singanallur | Research Scientist

J. Horsington, M. Eschbaumer, P.A Durr, **N.B. Singanallur**, P. Jansen van Vuren, W. Vosloo

CSIRO HEALTH AND BIOSECURITY/TRANSBOUNDARY ANIMAL DISEASES MITIGATION TEAM
www.csiro.au



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
 - O₁/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 LFPK α V β 6 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

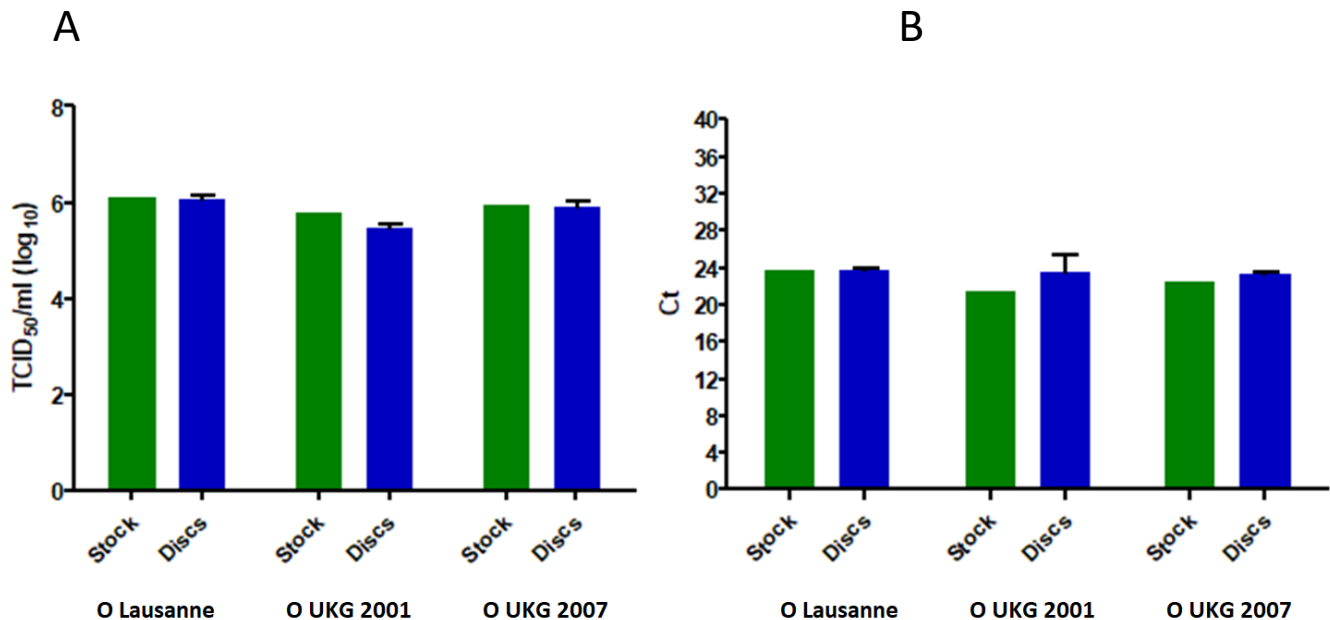




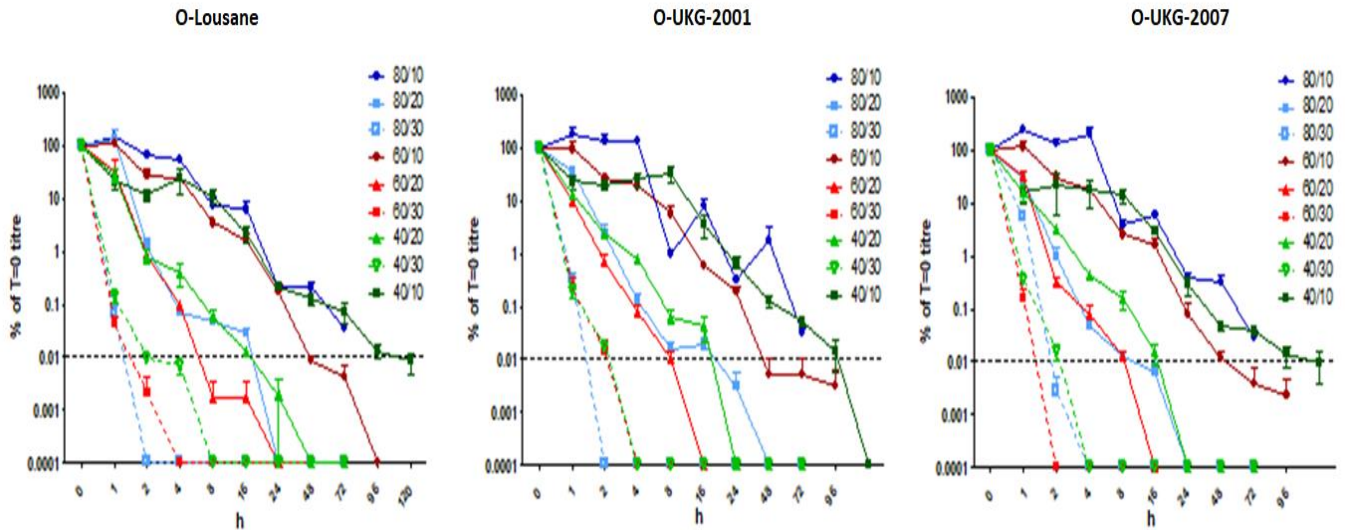
Comparison of stock virus and virus soaked onto filter paper discs

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



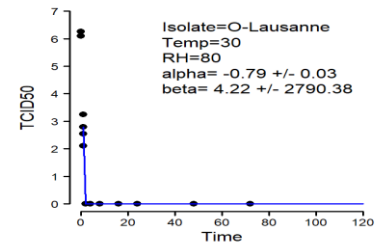
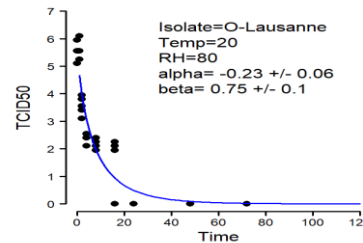
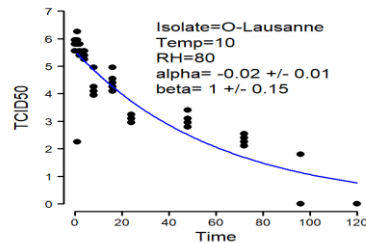
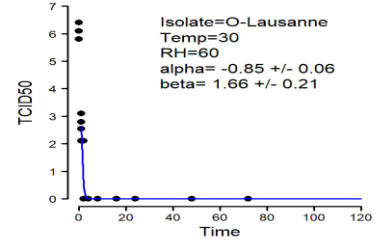
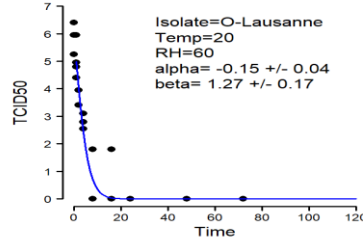
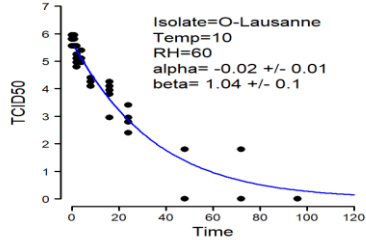
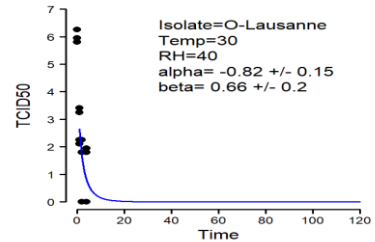
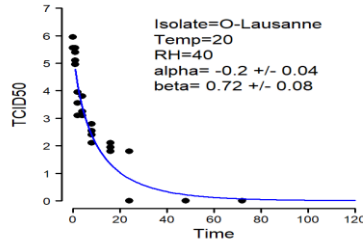
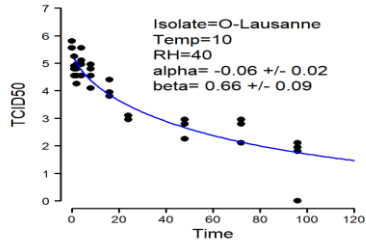
Decimal reduction time (linear model) of three strains of FMDV under different temperature and RH conditions

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

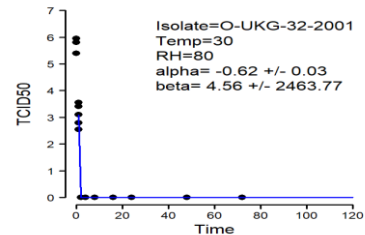
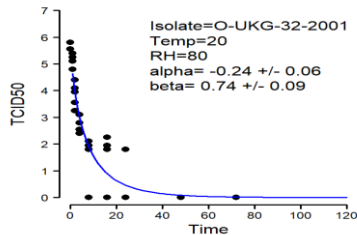
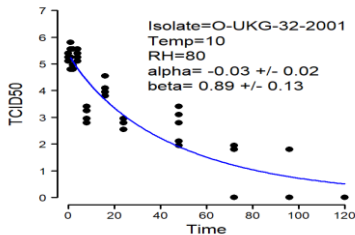
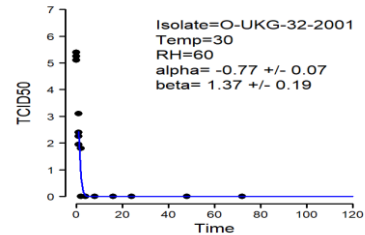
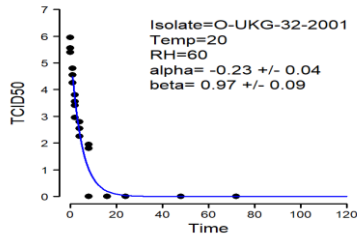
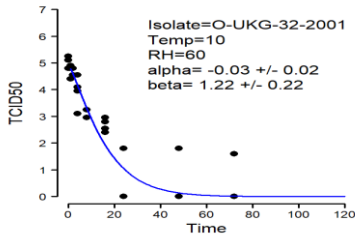
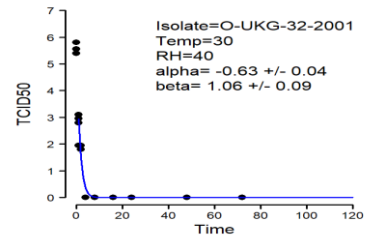
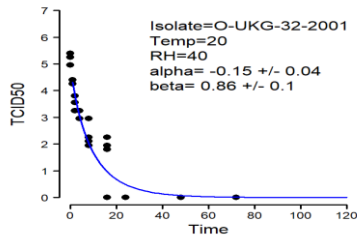
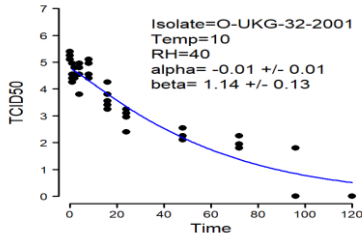


Weibull model – O Lausanne 65



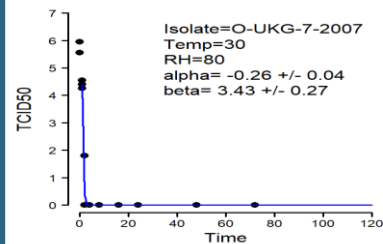
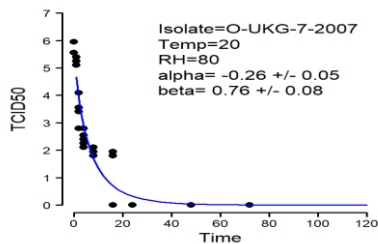
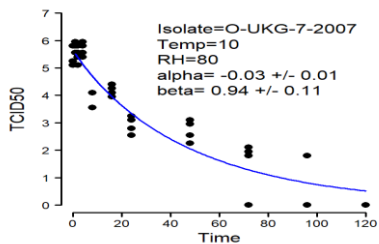
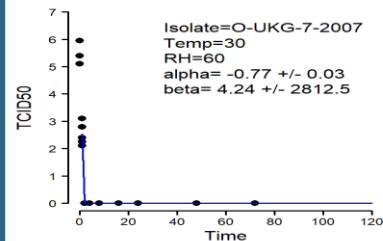
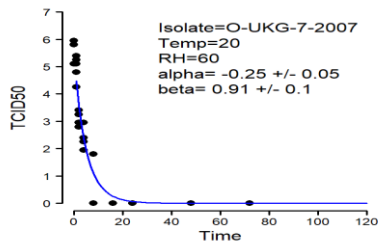
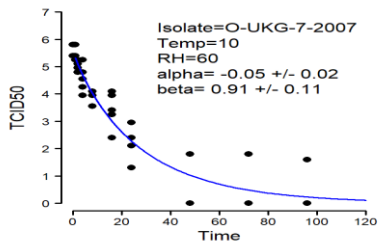
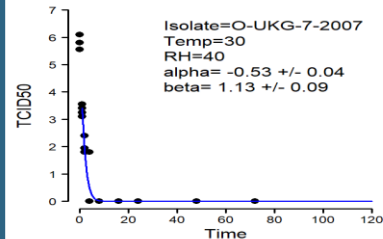
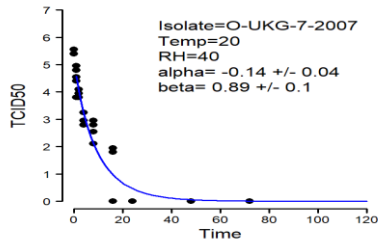
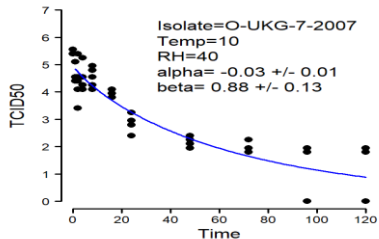


Weibull model – O UKG 2001





Weibull model – O UKG 2007



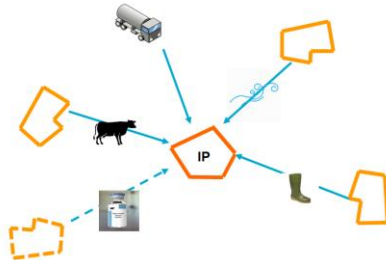


Conclusions

- 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

WIKI CONTACT US ABOUT US

SPREAD: System for Preparedness and Response to Emergency Animal Diseases

Stay logged in [Forgot password?](#)

[Register as new User](#) [Log in](#)

managers and scientists to run sophisticated scenarios of long-distance spread from their browsers. It is an essential biosecurity tool for preparing and responding to wind-borne threats.

News

What is happening in the TAPPAS project?

24-27th April 2016 2nd International Conference on One Medicine One Science, Big Data: The Language and Future of One Medicine One Science <https://oos-events.unn.edu/icosm>

13-14th April 2016 Upcoming presentation at Locate10 Conference, Melbourne. - TAPPAS - A web-based framework incorporating wind-borne dispersal into biosecurity surveillance

26 November 2015

TAPPAS V1.0 is released. Thank you to all of you from many organizations that have made this possible. TAPPAS is an enabling tool with the potential for diverse application. We encourage you to explore the full potential of TAPPAS. Don't hesitate to contact us with ideas for collaboration, application and improvement. As TAPPAS is undergoing a staged release it is currently not available for commercial use, and outputs are not to be published, without prior consent.

June 2015

ACCESS-Regional Current Conditions



This project is supported by Meat & Livestock Australia (MLA), through funding from the Australian Government Department of Agriculture as part of its Rural R&D for Profit program, and by producer levies from Australian FMD-susceptible livestock (cattle, sheep, goats and pigs) industries and Charles Sturt University (CSU), leveraging significant in-kind support from the research partners. The research partners for this project are the Commonwealth Science and Industrial Research Organisation (CSIRO), CSU through the Graham Centre for Agricultural Innovation, the Bureau of Meteorology (BOM) and the Australian Department of Agriculture, supported by Animal Health Australia (AHA). The project commenced in July 2016 and will conclude in June 2020.

**IMPROVED SURVEILLANCE, PREPAREDNESS AND RETURN TO TRADE FOR
EMERGENCY ANIMAL DISEASE INCURSIONS USING FOOD AND MOUTH DISEASE AS A MODEL**

PROJECT PARTNERS





Acknowledgements

- Peter Caley (Data 61, CSIRO)

- GFRA 2019