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TTI-use in Monitoring Flight Catering and other foods

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What is a Smart Label?

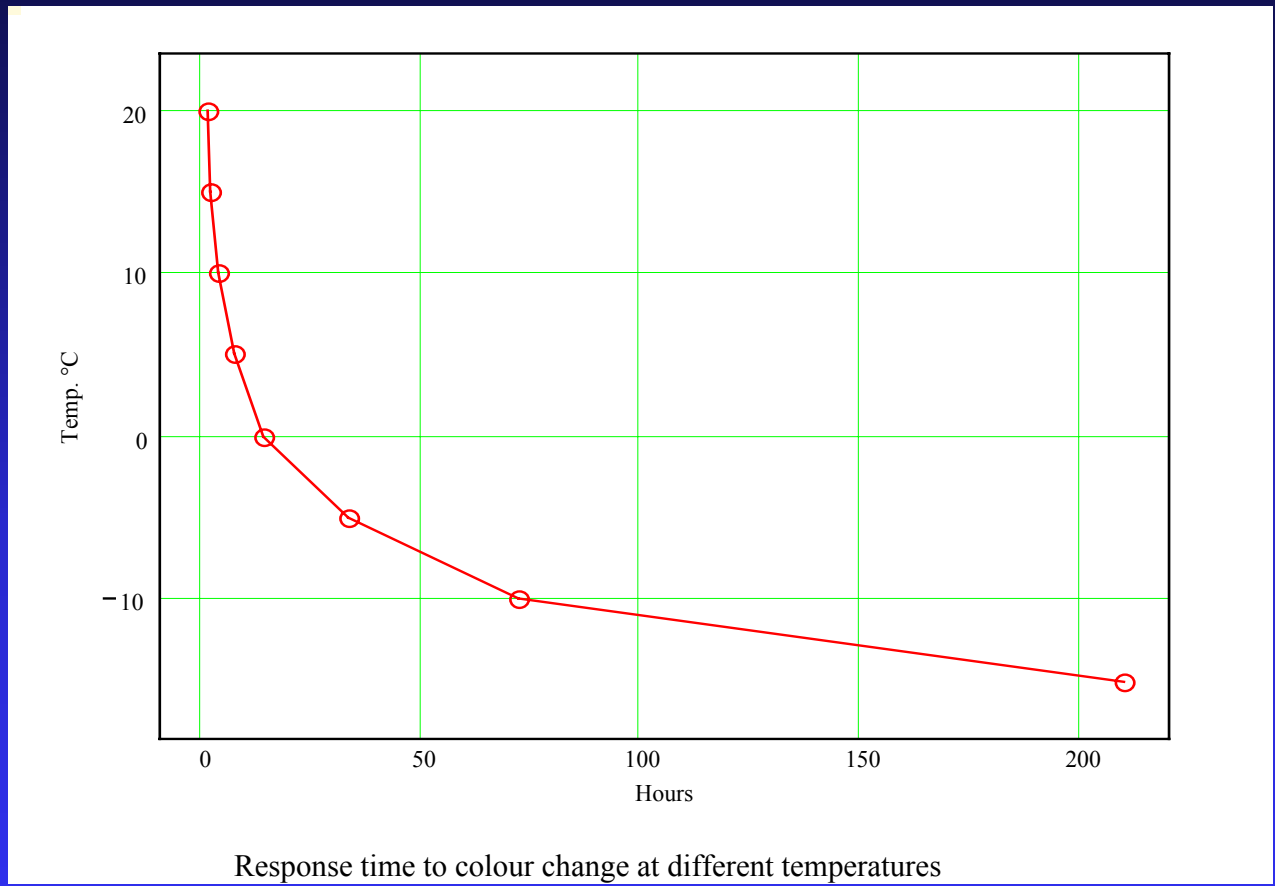
- It is a time temperature indicator (TTI) showing the accumulated time and temperature exposure.
- Smart Label technology integrates data logging and alarm functions

Vitsab® Smart Labels

Response time of smart label at different temperatures

Temp °C	Response time hours
20	1
15	2
10	3.5
5	7.2
0	14
-5	33
-10	72
-15	210

Plot of response time to colour change



Response time to colour change at different temperatures

Arrhenius equation

$$k = A \cdot e^{-\frac{Ea}{R \cdot T}}$$

$$\ln k = \ln A - \frac{Ea}{R} \cdot \frac{1}{T}$$

k = rate of reaction

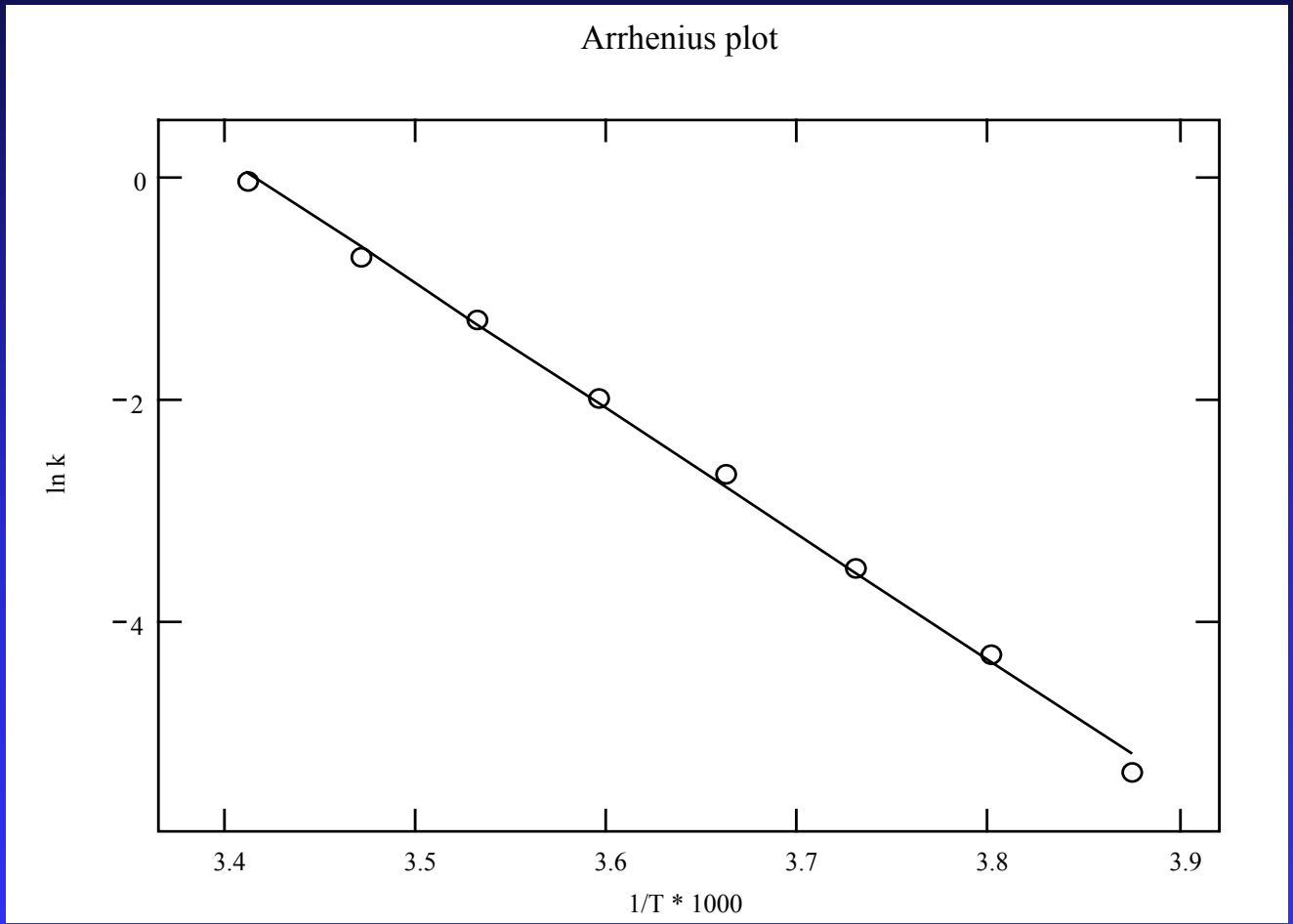
A = constant of the equation

R = universal gas constant

T = absolute temperature °K

Ea = Arrhenius energy of activation

Arrhenius plot of experimental data



What are Smart Labels used for?

- Monitoring cold chain transports
- Complement to best before or use by dating

Logged temperature profile of air shipment

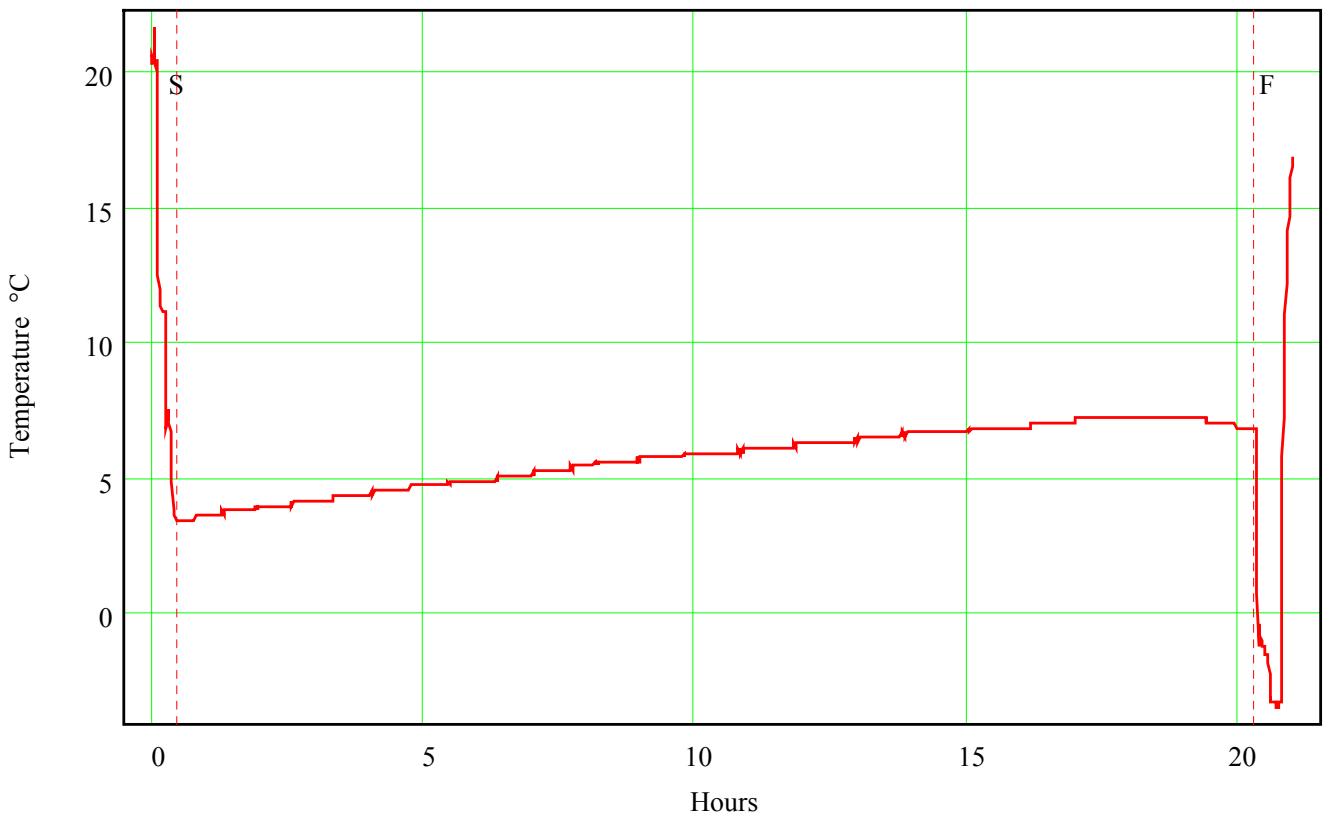


Fig. 4 Logged temperature profile during air shipment

Logged temperature profile of road shipment

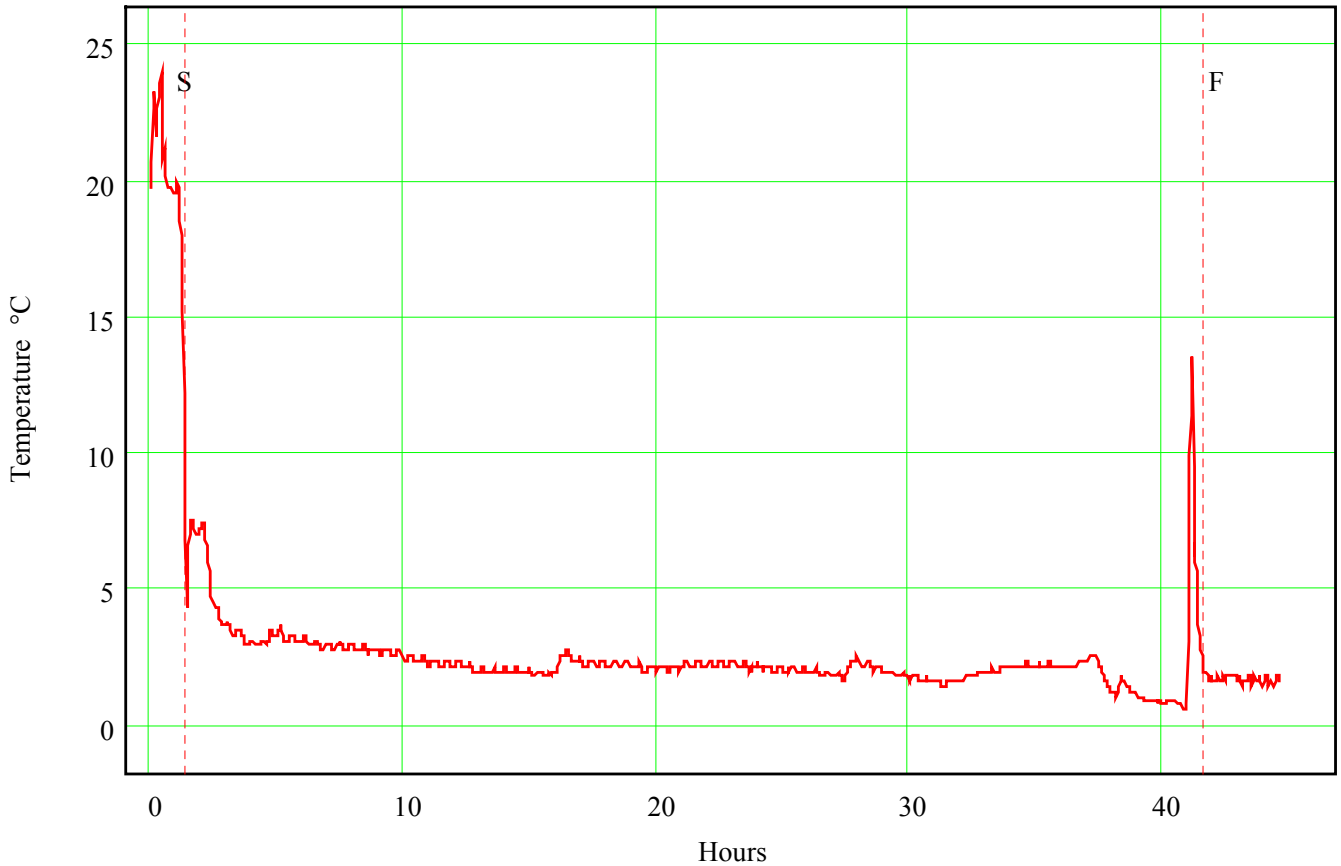


Fig. 5 Logged temperature profile during road shipment

Formula for Numerical Integration

$$f(A) := \left[\sum_{n=s+1}^{n-1} e^{-\frac{Ea}{R \cdot T_{(n-1)}}} + \frac{1}{2} \cdot \left(e^{-\frac{Ea}{R \cdot T_s}} + e^{-\frac{Ea}{R \cdot T_n}} \right) \right]$$

$f(A)$ = total value of integration

n = number of data points

s = starting point of integration

T_i = temperature of each logged point

Comparison of cool chain quality between air and surface transport

	Transport time hours	Corresponding transport time at +5 °C hours
Cool chain requirement		48
Air shipment	20	23
Surface (truck)	40	26

Logged temperature profile of air shipment

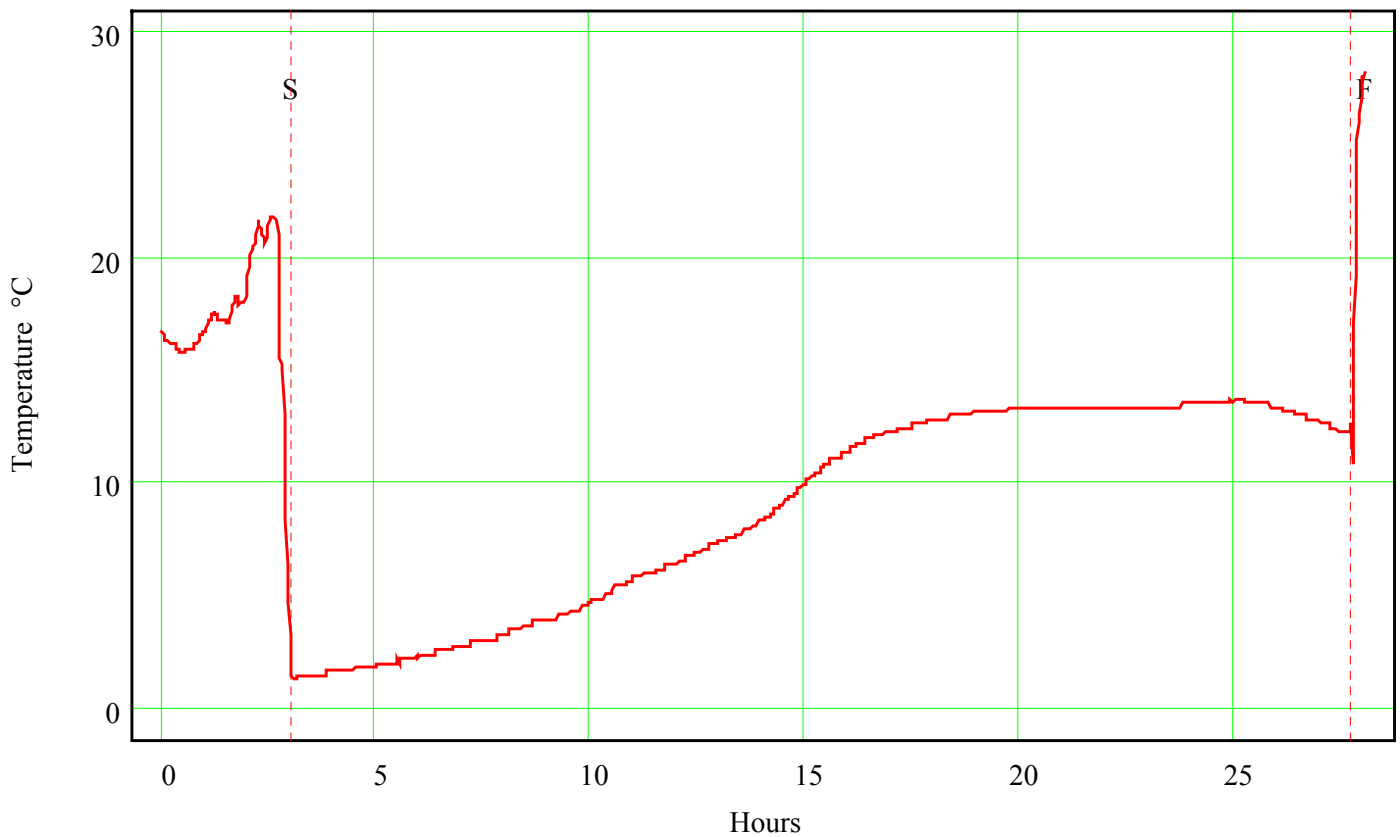


Fig. 6 Logged temperature profile of air shipment

Cool Chain quality of 2nd air shipment

	Transport time hours	corresponding transport time at +5 °C hours
Cool chain requirement		48
Air shipment	25	61

Food regulations for catered food

All meals from kitchen consumed within	24 hours
Exposure to temperatures above 10 °C	max 4 hours

Bacterial growth is the general concern behind health and food regulations

Low temperatures such as give no or slow growth of bacteria	2 – 8 °C
Shelf life (safe to eat) below 8 °C	2 – 3 days

British Airways TTI requirements for their in flight catered food

- 24 hours at 7 °C
- 4 hours above 10 °C

Temperature profile from data logger

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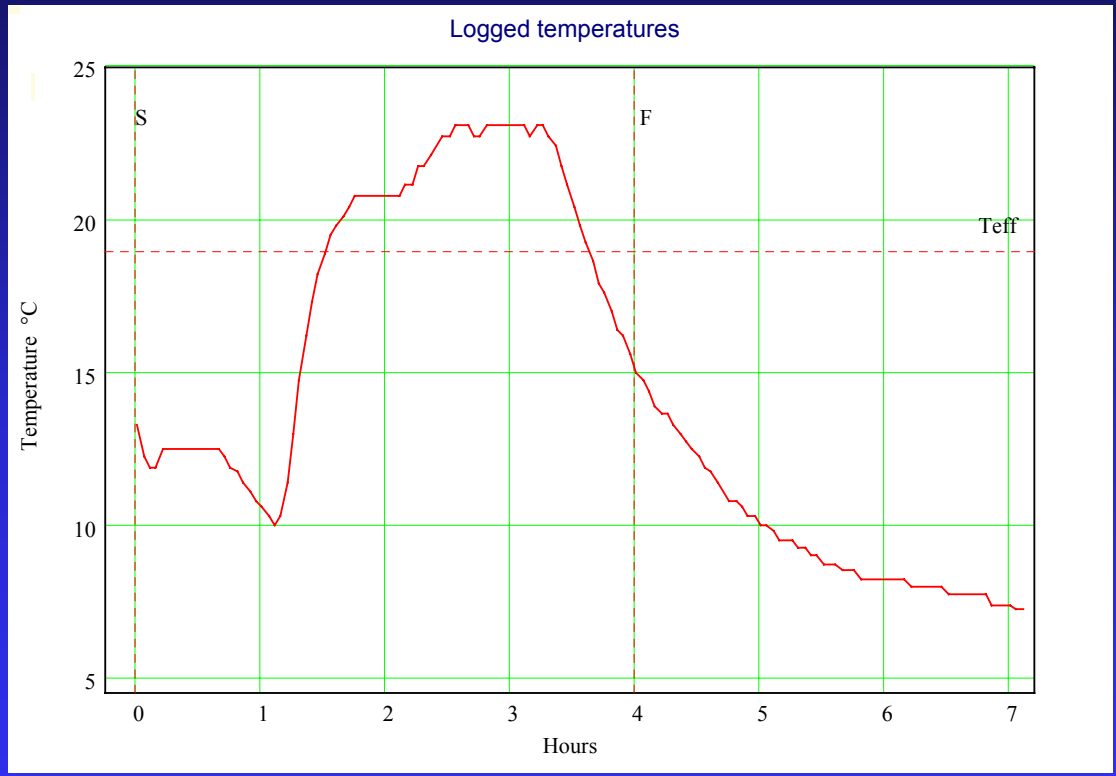
Temperature profile in food trolley during return flight Kingston to LHR



For the indicated monitoring time

Teff = 19.0 °C

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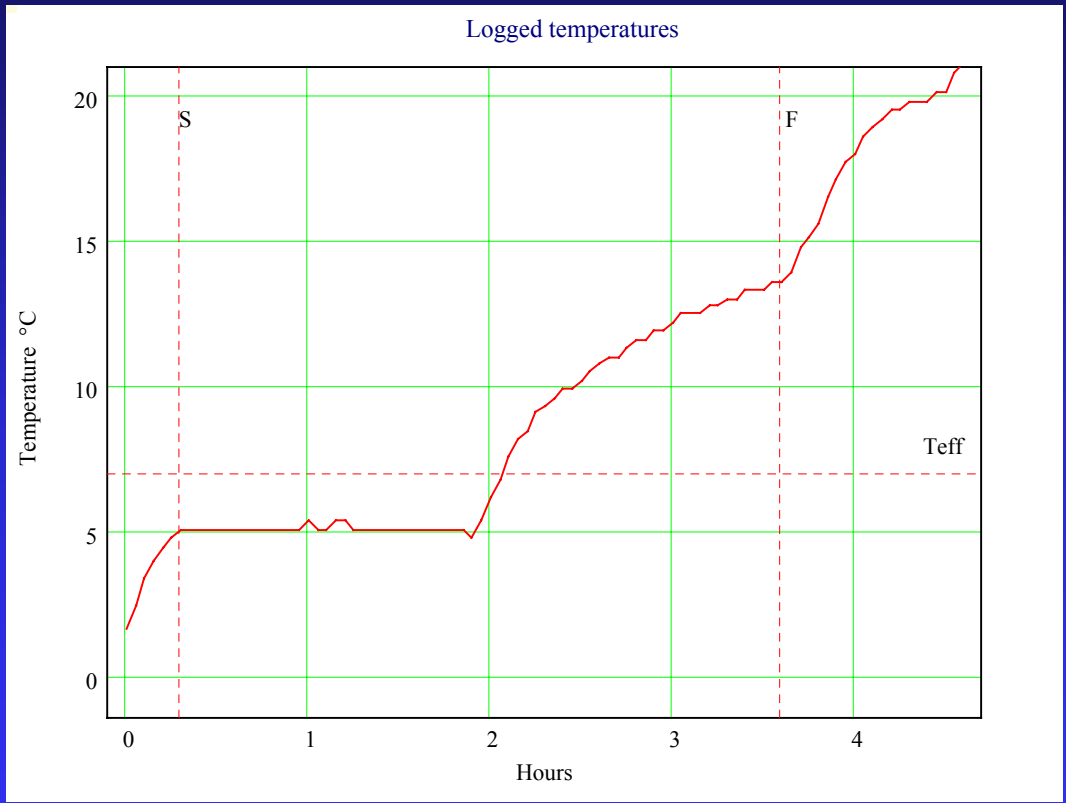
Temperature profile of trolley with meals during flight - Tiblisi to LHR



Homebound		
Reading	Hours	Event
0	0.0	Logger placed in trolley
6	0.3	Transport to aircraft
38	1.9	Loading of aircraft
46	2.3	Take off
72	3.6	Service ended
89	4.5	Logger retieved

For the indicated monitoring time

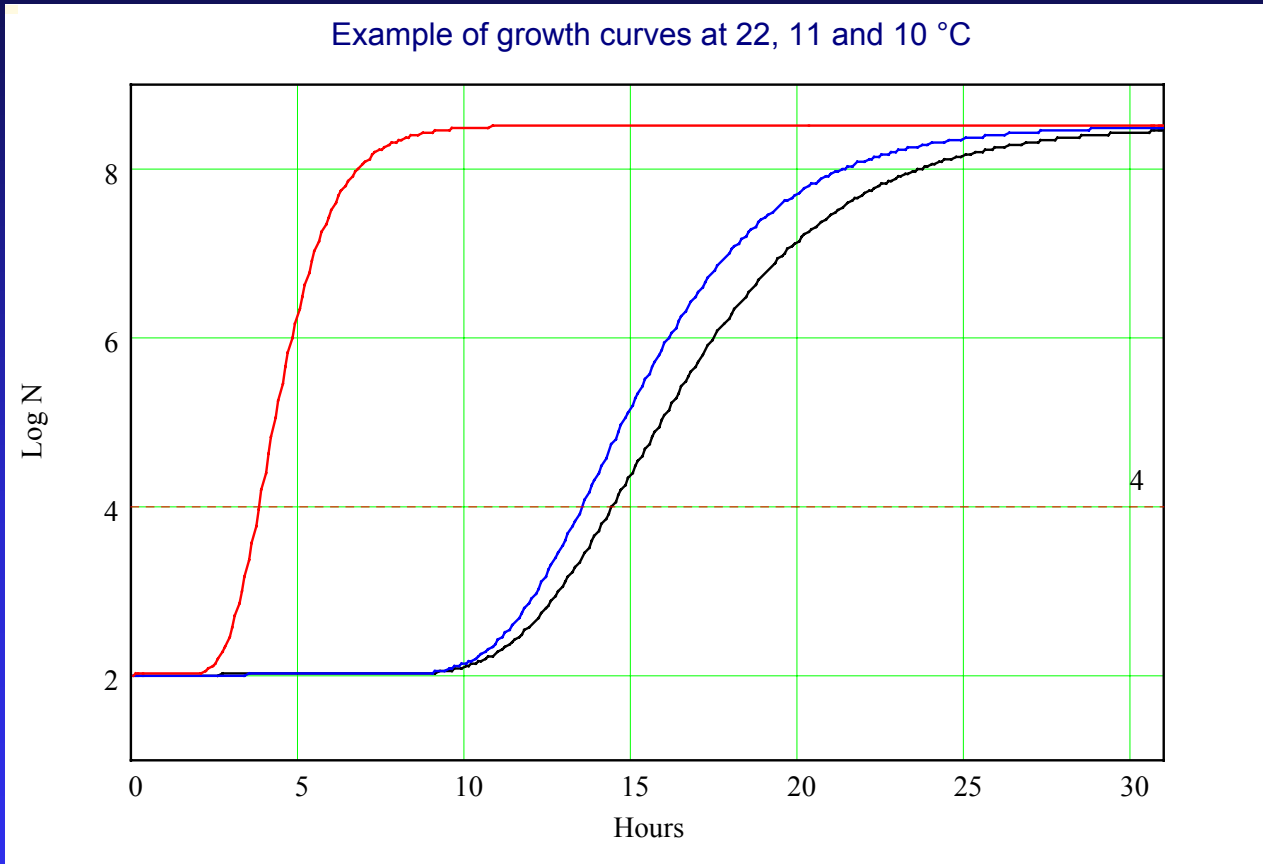
Teff = 7.0 °C

Important points to assess health risk

Number of bacteria that will cause harm

Time to reach harmful level

Growth of bacteria at different temperatures



Type of meals evaluated for bacterial growth

Chefs Salad
Chicken Liver Canapé
Mustard and Pommery Mayonnaise
Prawn and Mango Salad
Queen of Pudding
Treacle tart

Predictive challenge test using Food Micromodel developed by Leatherhead Food Research Association

	Time (hours) to reach a maximum level of 1000 cfu/g			
° C	Staph. aureus	Listeria monocytogenes	Bacillus cereus	Flight Label run time (hours)
22	8	18	18	3.2
15	22	72	96	8.0
10	72	156	144	15.8

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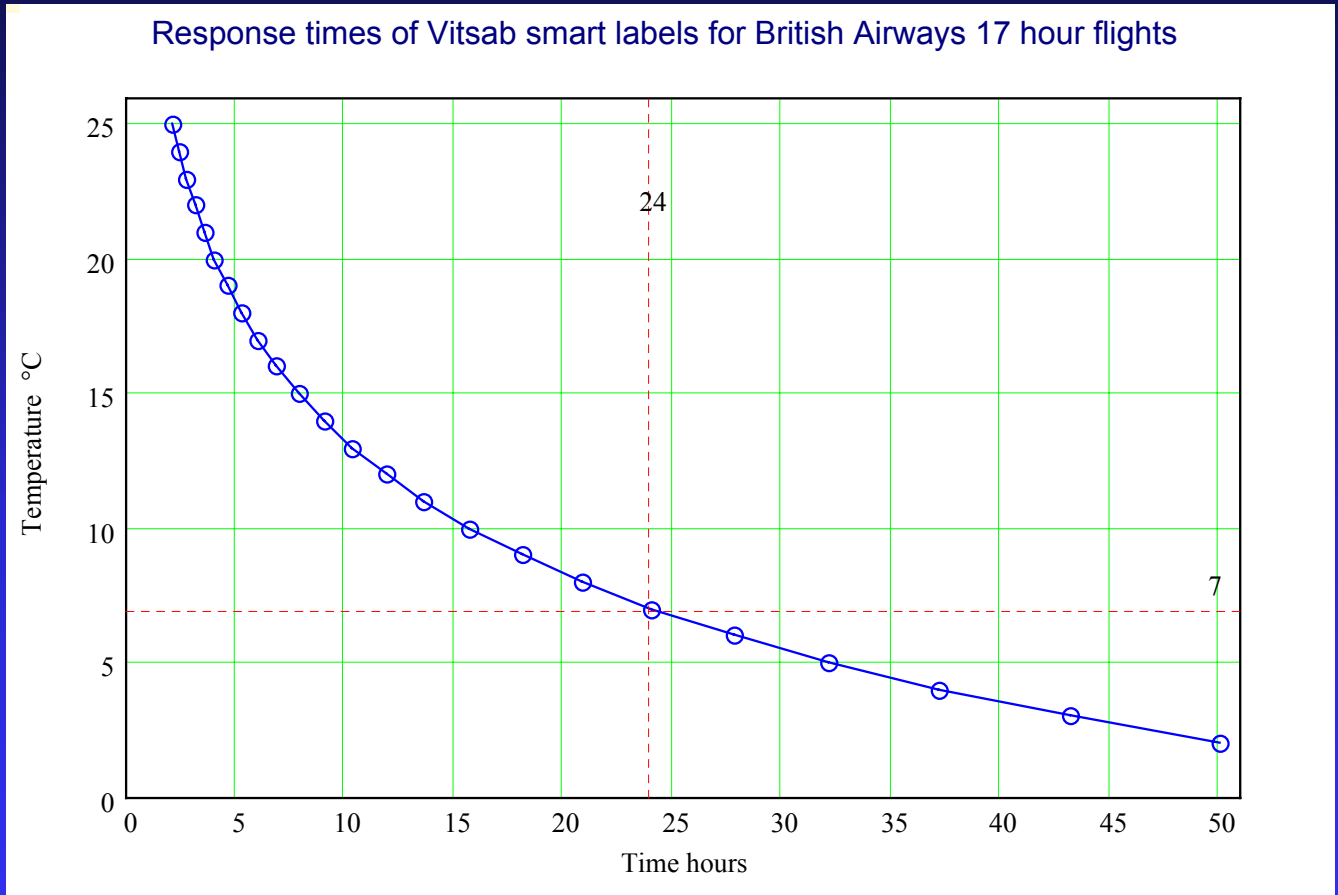
Flight label temperature characteristics



t =	hours (t) =
22	3.1
21	3.5
20	4.0
19	4.6
18	5.2
17	6.0
16	6.8
15	7.8
14	9.0
13	10.3
12	11.8
11	13.6
10	15.6
9	18.0
8	20.8
7	24.0
6	27.7
5	32.1

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Vitsab® Flight Label

Smart Label concept for monitoring catered meals on board BA flights

Developed in co-operation with British Airways

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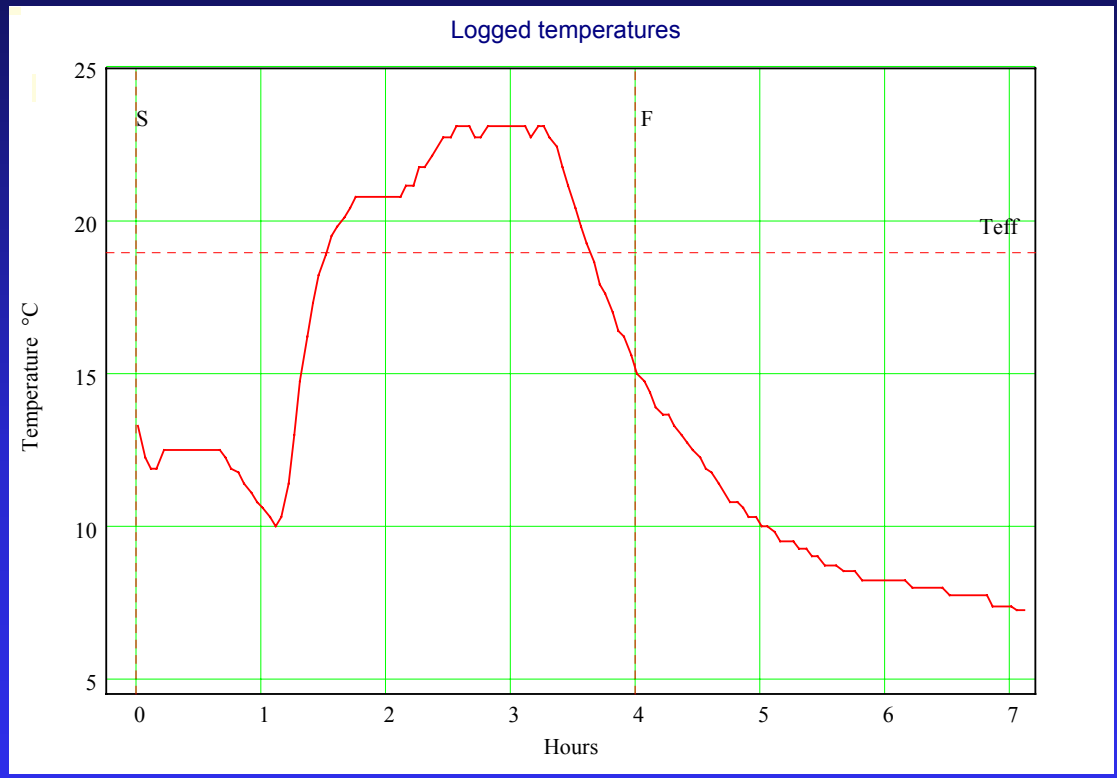
Flight Label in trolley onboard aircraft

Temperature profile in food trolley during return flight Kingston to LHR



For the indicated monitoring time

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Flight Label uses 85 % of its total response or run time

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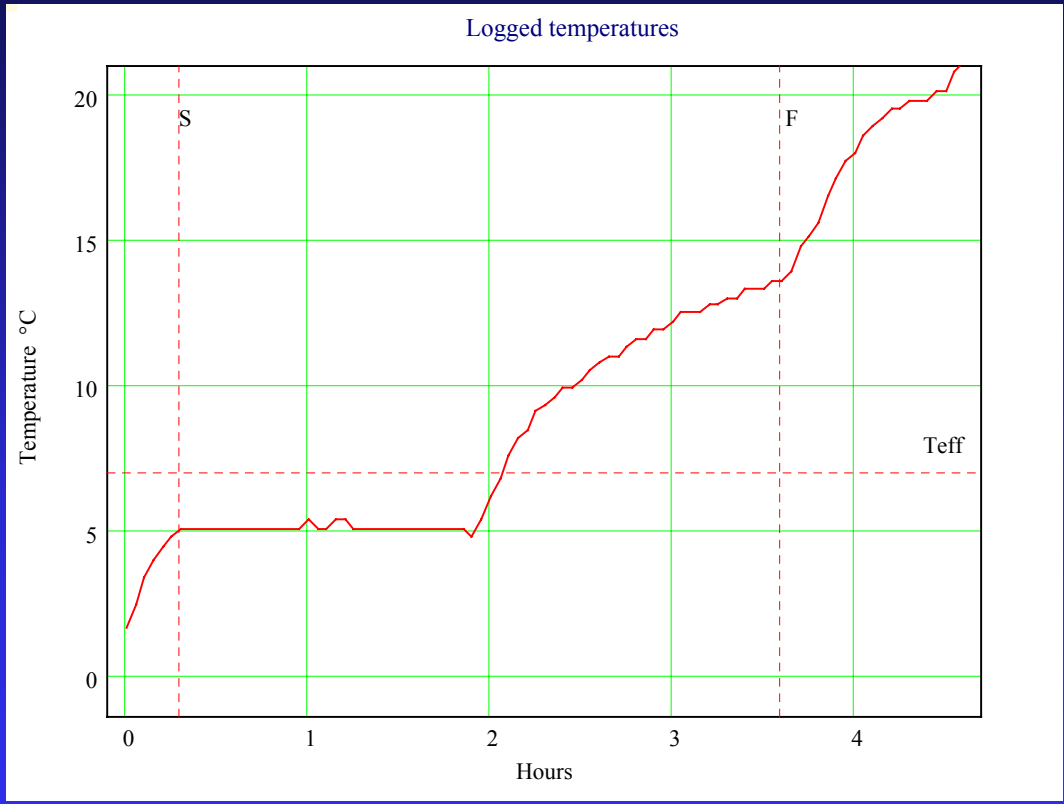
Temperature profile of trolley with meals during flight - Tiblisi to LHR



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72	3.6	Service ended
89	4.5	Logger retieved

For the indicated time

Teff = 7.0 °C

Flight Label uses 22 % of its total response or run time

Return of yellow flight labels applied at London airports Heathrow and Gatwick during mid September – October 2003

Departing airport	Smart labels found yellow on board
London Heathrow	0.43 %
London Gatwick	1.19 %

Commercial benefits of flight labels

1. Protection of public and cabin crew
2. Protection against civil and criminal actions in case of a food poising case for the company (BA)
3. In the future it will allow the airline (BA) to operate with return catering
4. It will allow the airline (BA) to manage un-planed effects at airports (delays etc.)

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Reduced Oxygen Packed Seafood

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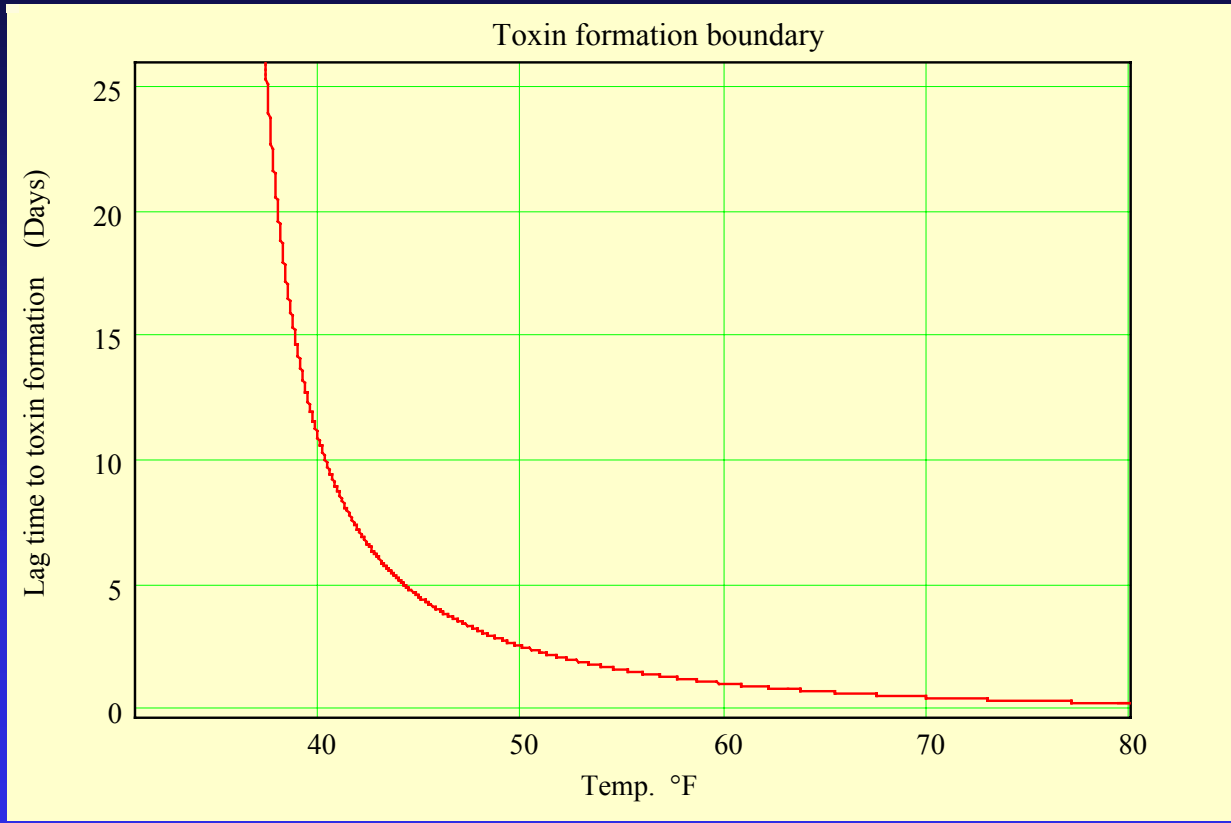
Time and temperatures conditions for toxin formation by *Clostridium botulinum*

Skinner & Larkin J. Food Protection **61**:9, 1154-1160, **1998**



$$\log(LT) = 0.65 - 0.0525 \cdot t + 2.74 \cdot \frac{1}{t}$$

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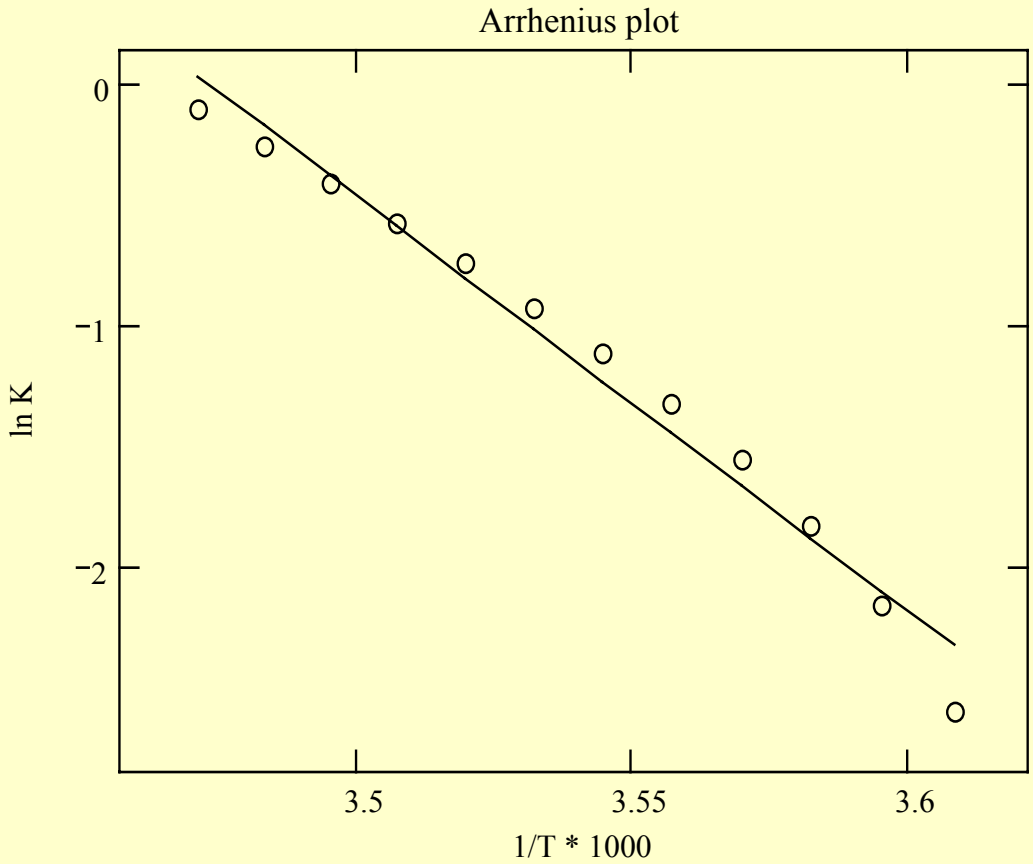
TTI characteristics of Toxin formation of Clostridium botulinum

°C Days

Data =

4	13.3
5	8.62
6	6.19
7	4.72
8	3.74
9	3.03
10	2.51
11	2.1
12	1.77
13	1.51
14	1.29
15	1.11



Data from Skinner & Larkin J. Food Protection 61:9, 1154-1160, 1998

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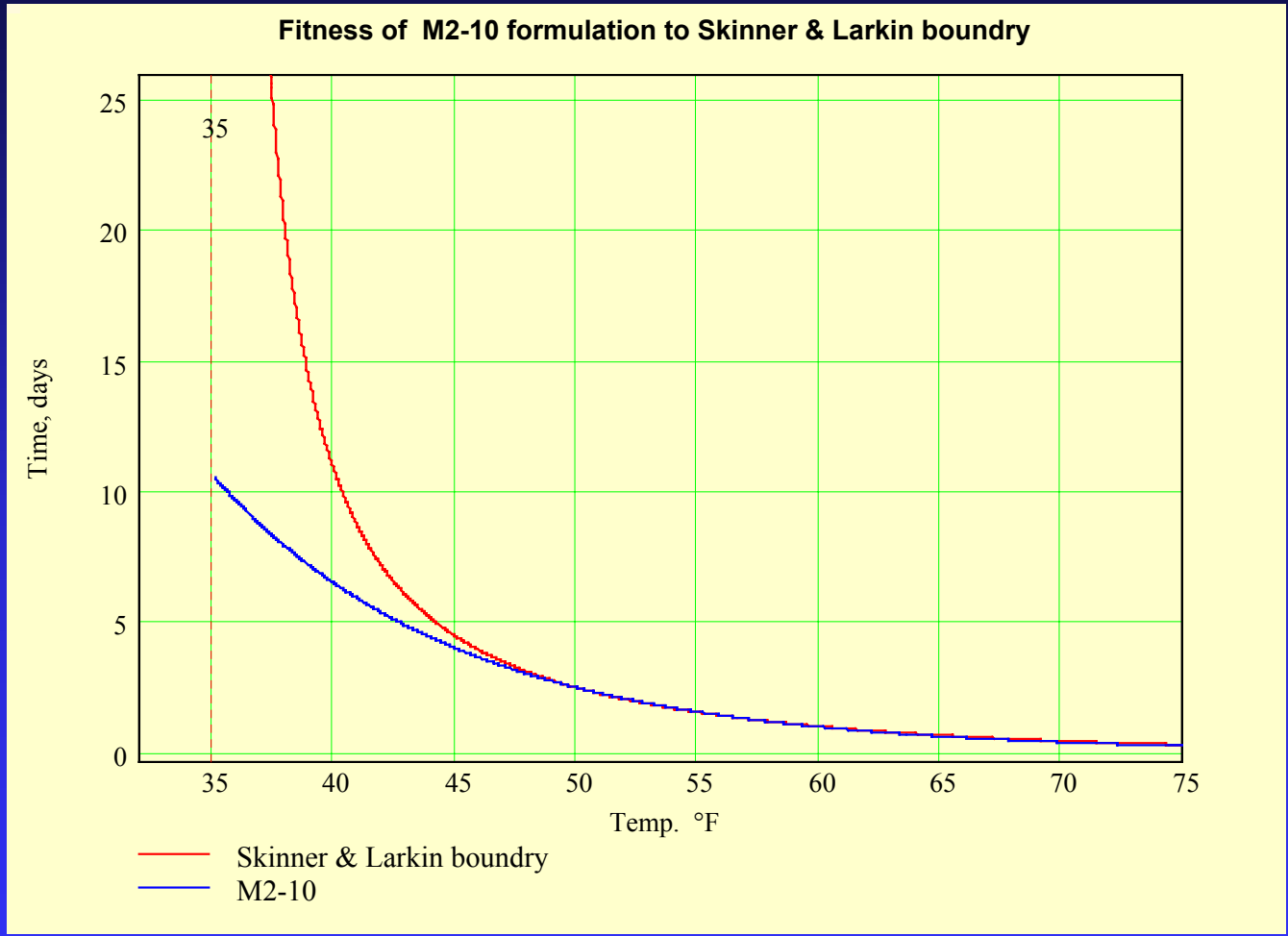
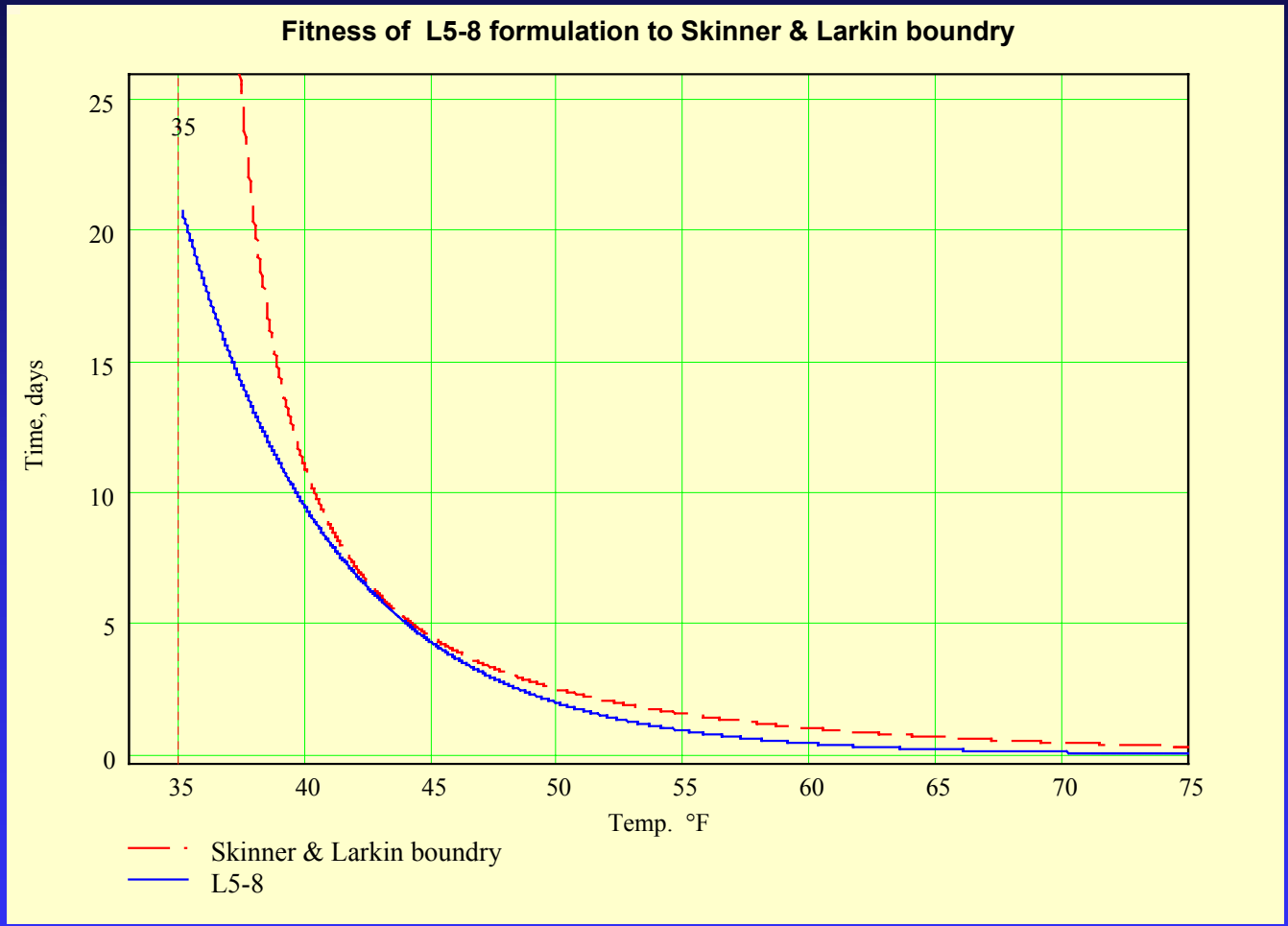
Application of a standard TTI formulation to *Clostridium bototulinum* toxin formation



Adaptation of a new Vitsab TTI formulation to *Clostridium botulinum* toxin formation



Use of TTIs or Smart Labels applied to fresh and perishable food products

- Smart Labels have a dynamic response to temperature changes.
- Smart Labels are a powerful and cost effective tool to monitor cold transport of a variety of fresh foods including ready to eat and MAP seafood.
- Smart Labels give a time and temperature response reflecting actual changes in food products

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