# Smart Packaging Solutions for Freshness Monitoring of packet chicken meat


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# A Problem in India and other developing country

## 10kg spoilt meat seized from shawarma shop

TNN / May 6, 2022, 03:51 IST

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## How to know if the chicken you are about to eat has gone bad

TIMESOFINDIA.COM | Last updated on -Feb 23, 2022, 20:00 IST

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THE TIMES OF INDIA

# Factor affecting the spoilage of packet meat

## Consumer handling

(temperature control is variable in a home environment).

## Improper supply chain

## Transportation and poor storage conditions

(elevated temperatures and relative humidity's can shorten shelf life)



Good or spoiled ???

## Way to monitor spoilage

- A method of indicating freshness of meat is based on **colour**, **visual appearance and smell**
- **End to end** temperature monitoring during supply chain and its maintains

It is challenging to find the quality of chicken meat

# What can be a solution ?

## Smart packaging solution

**Colorimetric based Time temperature Indicator**

Can we have smart technology simply by **visualizing** it gives insight in to quality of pasteurized packed milk packet?

- It will be benefited to manufacturer to get the **costumer satisfaction** and the consumers will also be convinced with the benefit.

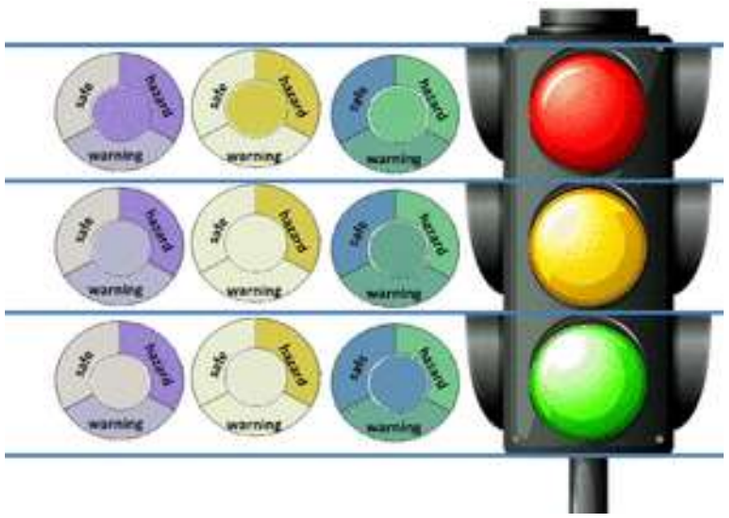
- Time temperature based indicators will be useful to manufacturers (Dairy) to identify the number of **sold milk in retail** shops and the remaining about to spoil milk can be **picked back** to dairy and used for production of other **by-products**.

# What is Time-temperature indicators (TTI) ???

◉ Time-temperature indicators (TTIs) are **smart labels** that are time and temperature sensitive, indicating and gathering product history.

◉ Shows the accumulated time-temperature history of a product

◉ Make sure consumers are getting packed meat with optimal quality, as determined by their aggregate temperature histories




Color code to **communication to consumer**

# Understanding Spoilage of Packet chicken meat

## Quality parameters for meat

- TVB-N (**T**otal **V**olatile **B**ase-**N**itrogen)
- TPC (Total Plate Count)

To determine end of shelf life parameter tested @ various storage conditions

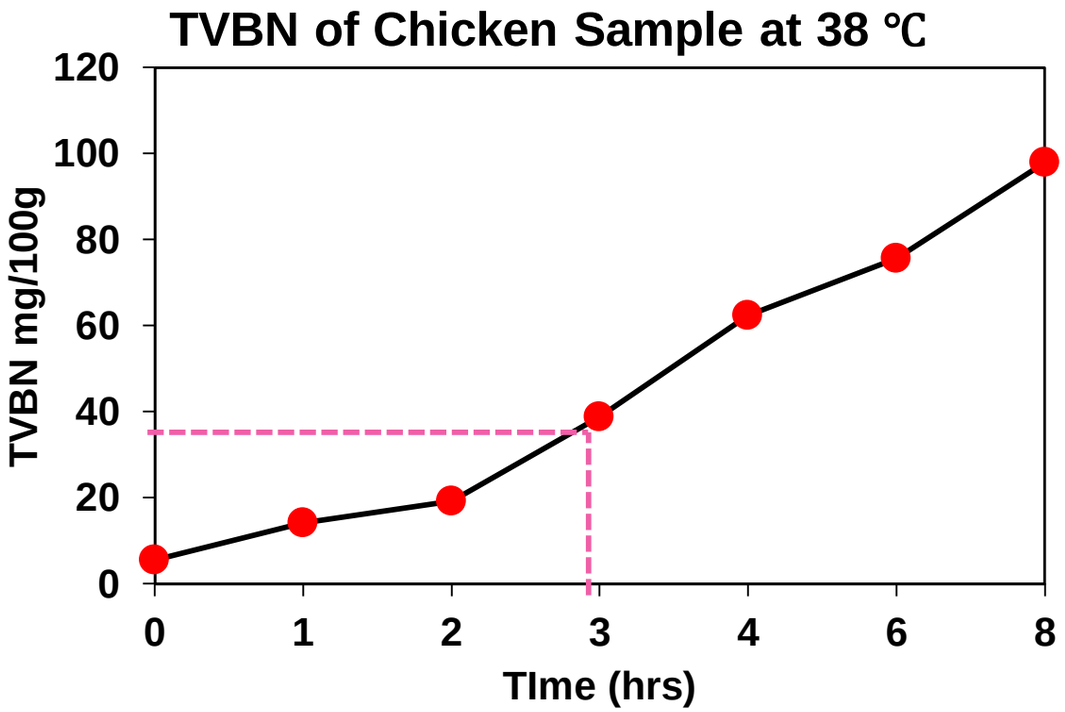
(Source: IS: 1479 (Part III), 1962 & FSSAI)

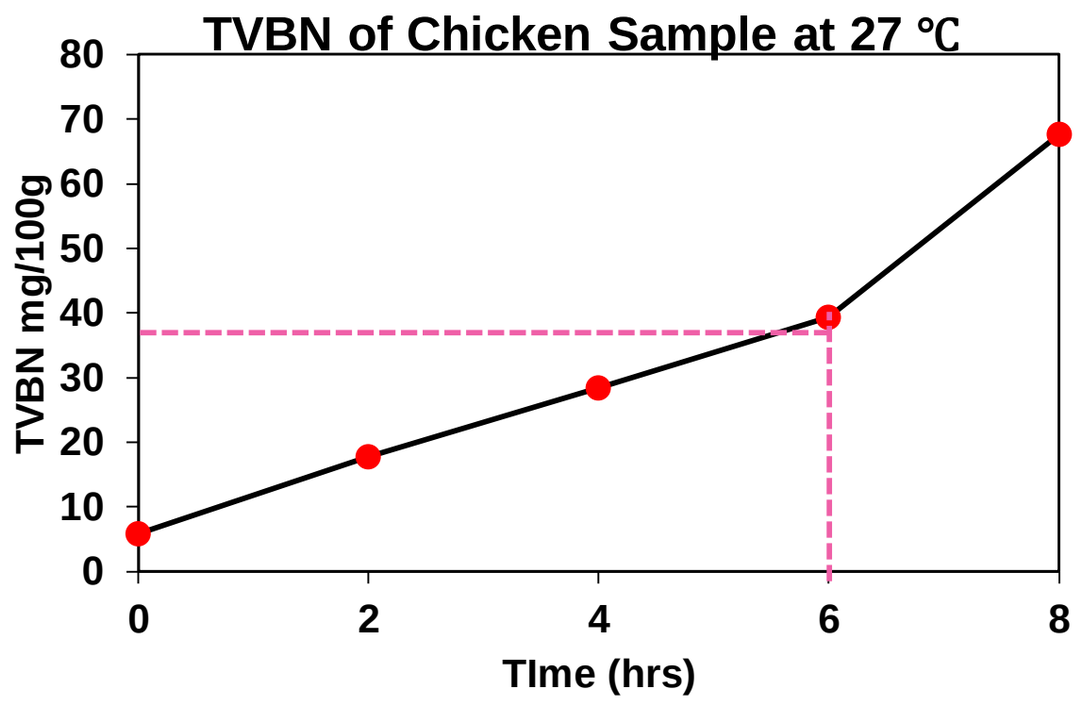
# Physico-chemical changes in meat with storage

- TVB-N (**T**otal **V**olatile **B**ase-**N**itrogen)
- TPC (Total Plate Count)

**At 38℃ and 27℃**

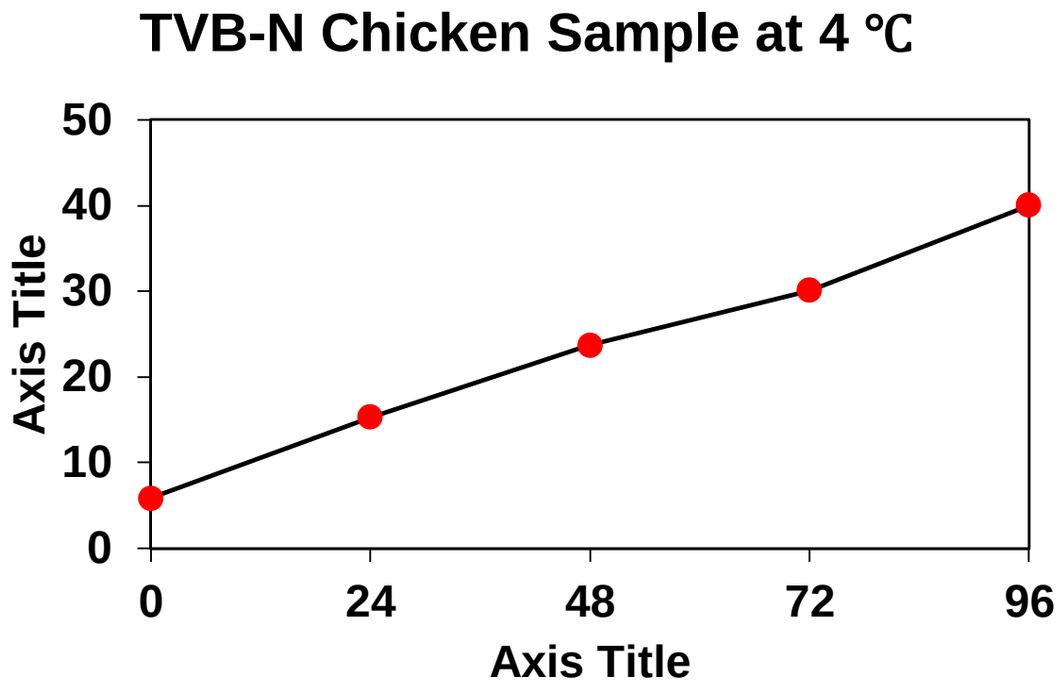
Plot of Time vs con TVB-N



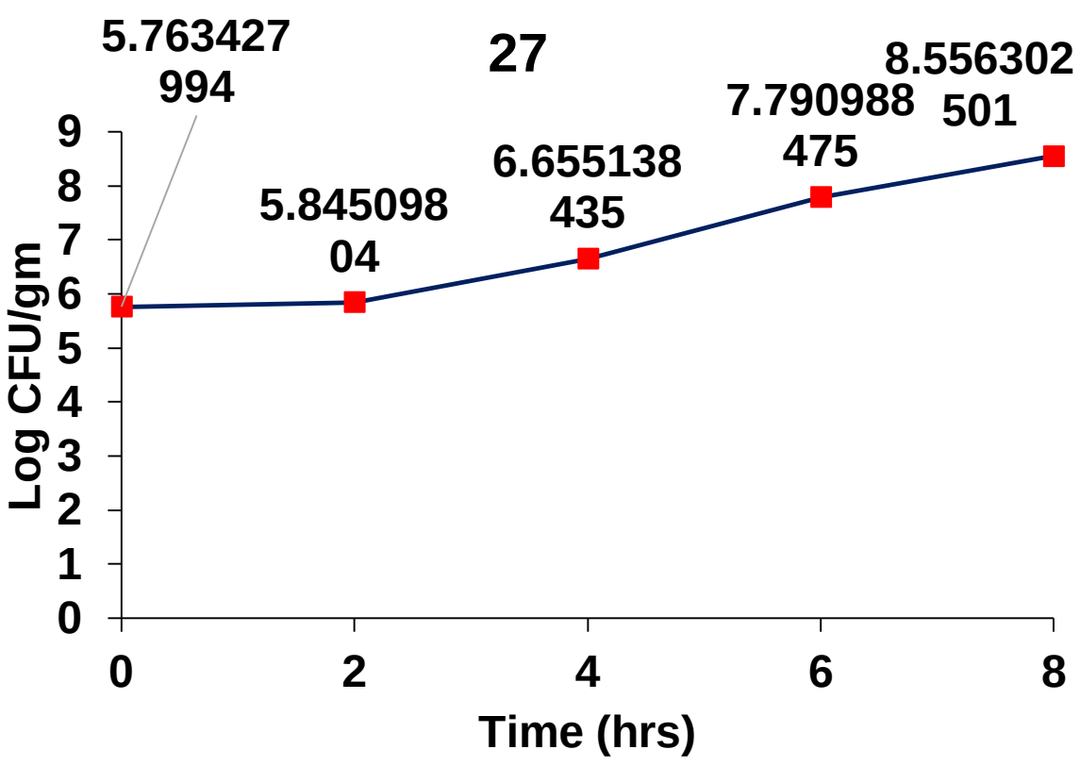



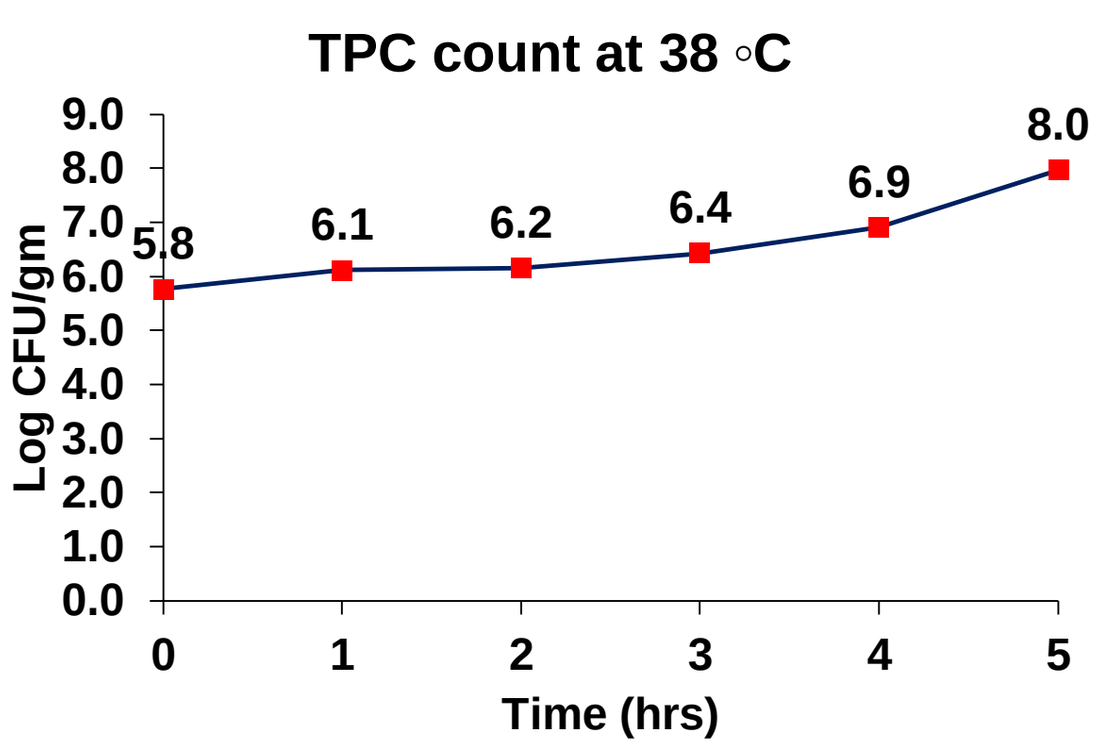

Acceptable levels of TVB-N in the range of 35 to 40 mg TVB-N/100 g

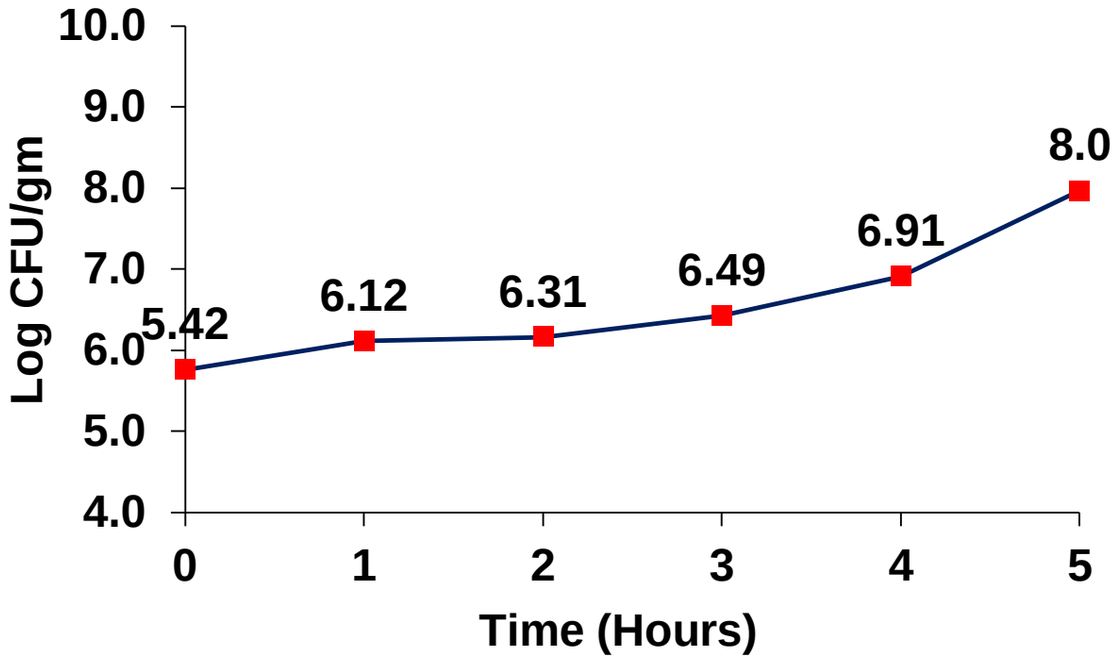
Ref: Christiana *et al*, Possible role of volatile amines as quality-indicating metabolites in modified atmosphere-packaged chicken fillets: Correlation with microbiological and sensory attributes. Food chemistry, 2007 ,104, 1622-1628.



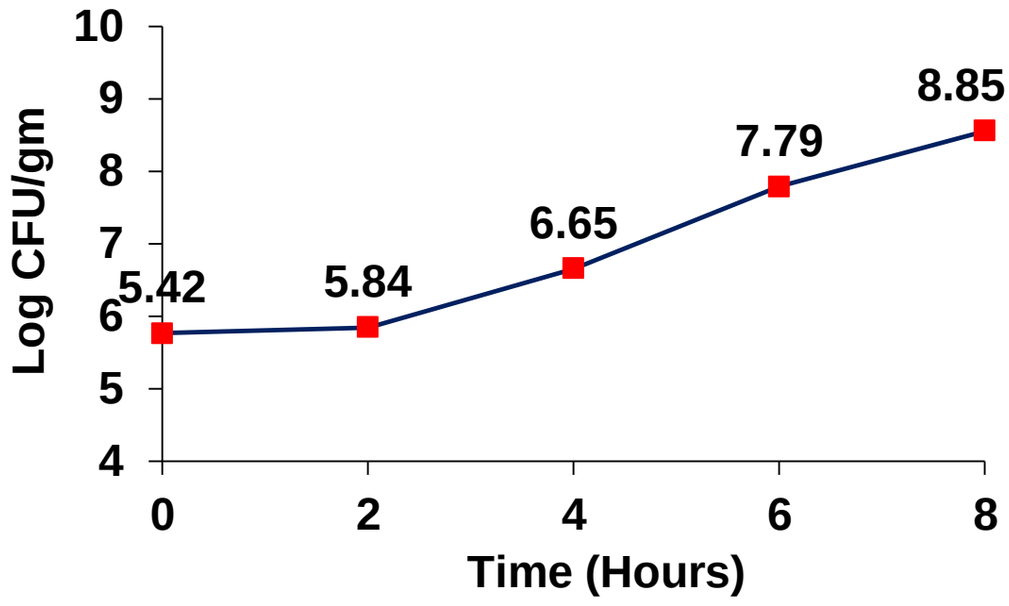

# Microbial analysis in chicken meat at 27±℃ and 38 ±℃



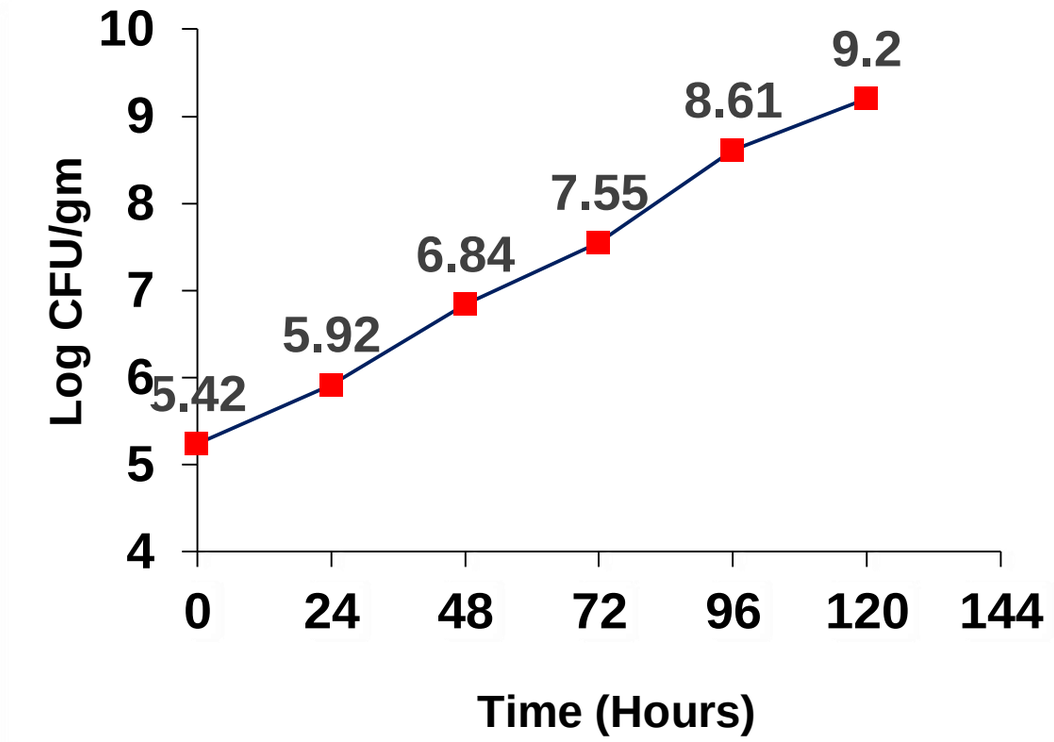






TVB at 37±4 ℃




TVB at 27±2 ℃




**TVB** at **4**±1 ℃

# Spoilage activation energy for meat at various storage conditions

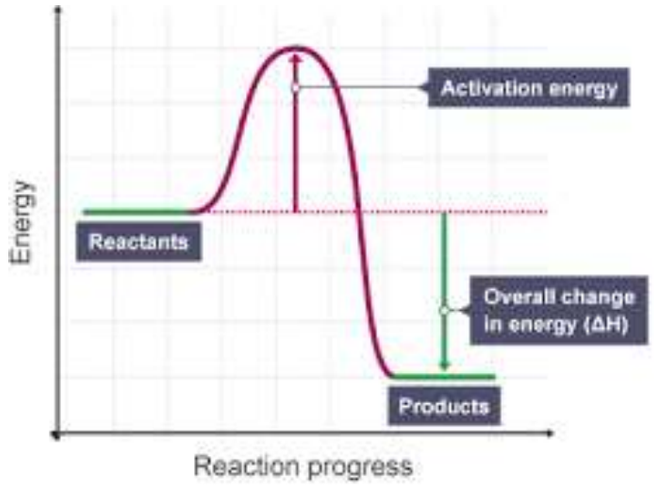
Accordance with the FSSAI and IS guidelines shelf life end point determined and activation energy of spoilage calculated

Similarly kinetic for meat spoilage between the microbiological load (TPC) verses time for different temperature

$$\log k = Ea/RT + \log A$$

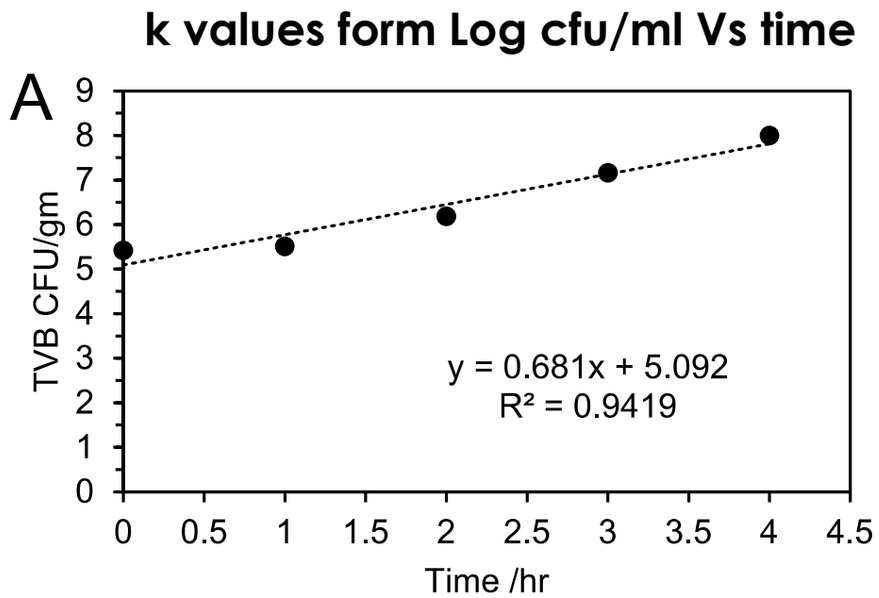
Where in,

1. k= rate constant
2. *A*= pre- exponential factor
3. $E_a$= activation energy
4. *R*= Universal gas constant
5. *T*= Absolute temperature (in kelvin)

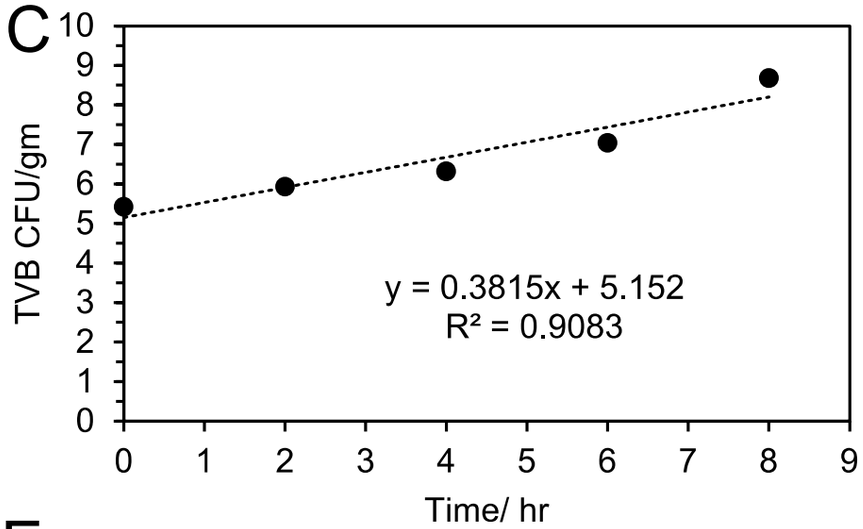


# Activation energy for spoilage chicken

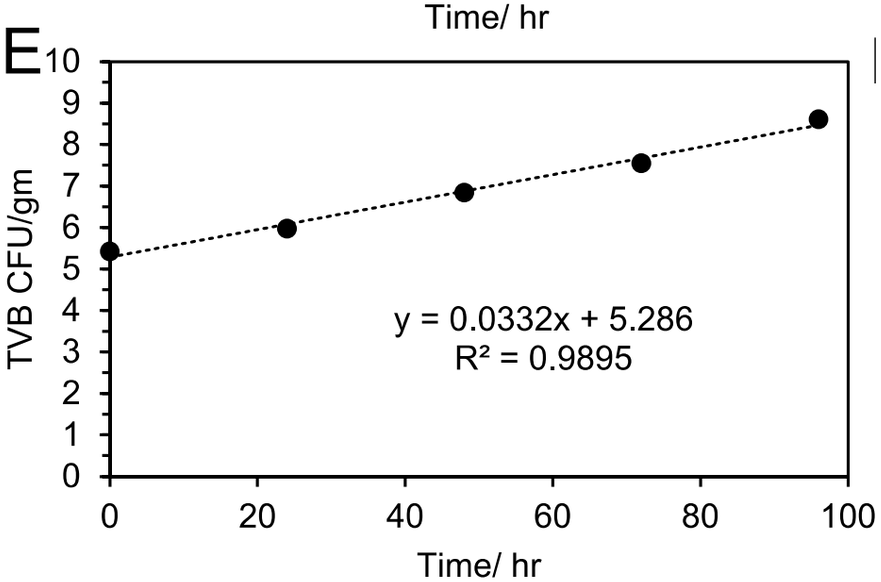
@37±4℃




@27±2 ℃



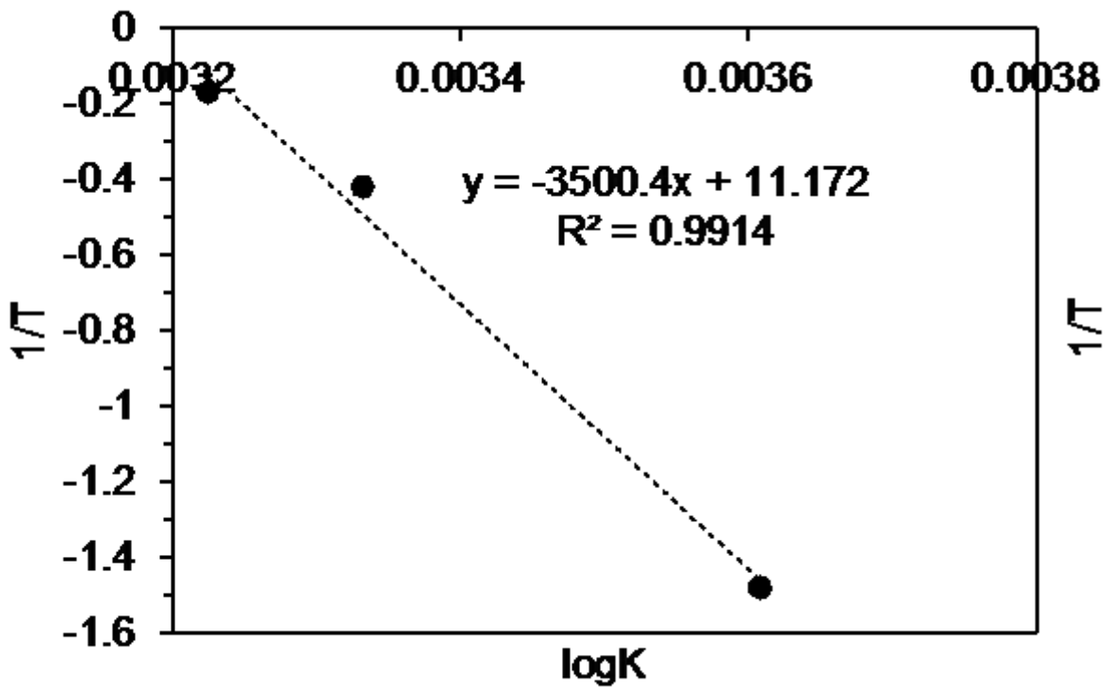

@4±1 ℃




Obtained k values at different temperature used for calculation of $E_a$

$$\log k = Ea/RT + \log A$$

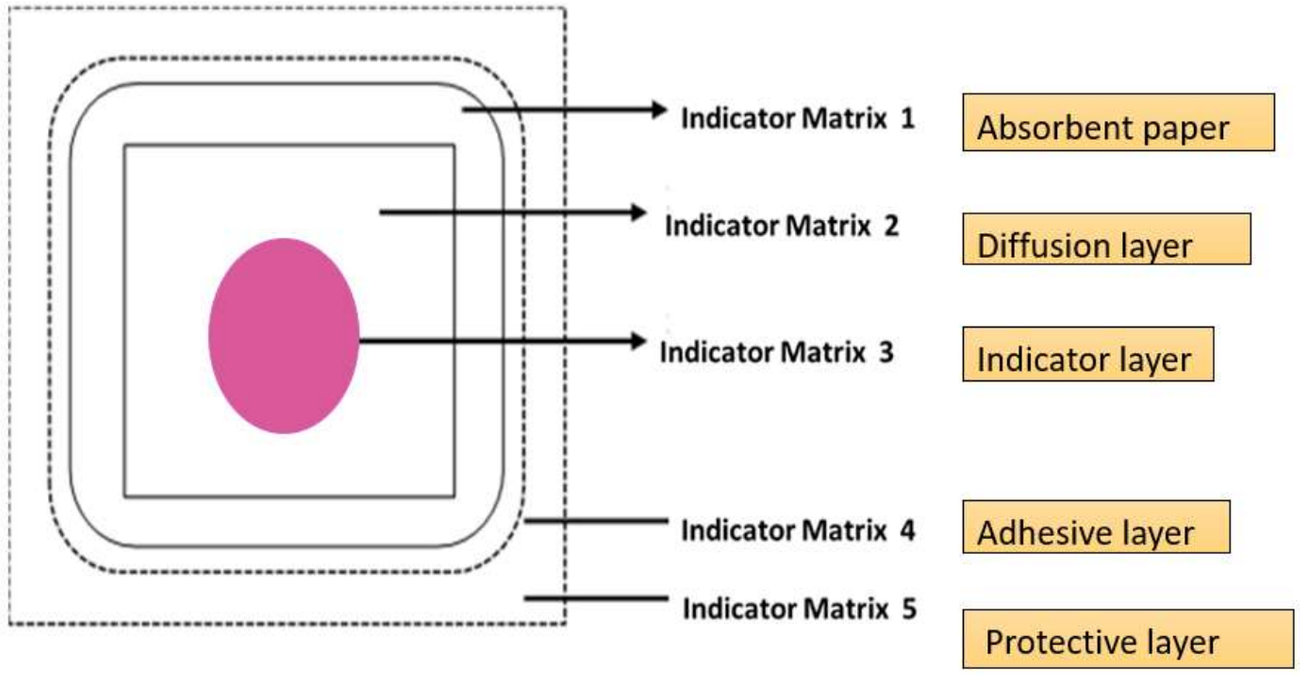
Plot of 1/t vs lnk, for the calculation of activation energy



# Paper Based TTI @CFTRI, Mysore

1. Absorbent paper
2. Diffusion matrix
3. Indicator matrix
4. Protective layer
5. calendared paper (peel able)

## Integration protocol





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# Advantages of developed TTI

- ✓ **Designed by understanding the spoilage kinetics**
- ✓ **On time activation** of TTI for monitoring the freshness
- ✓ TTI indicator does **not need any specific storage** condition
- ✓ **Visual detection** of freshness of Product based on color change of TTI
- ✓ **Economical TTI -** Raw materials are relatively cheaper than the present State of the Art

# Co-relation of Activation energy of TTI with meat spoilage

| TTI strip Code | Conc. of TTI Substrate (M) | Vol. of TTI Substrate dropped ($\mu$l) | Time of colour change at 37 ºC (hours) | Time of colour change at 27 ºC (hours) | Time of colour change at 4 ºC (hours) | Activation energy ($E_a$) |
|---|---|---|---|---|---|---|
| #1 | 0.05 | 5 | 5 | 9-10 | 110-120 | 10.13 |
| #2 | 0.1 | 5 | 4-5 | 8-9 | 96-110 | 19.79 |
| #3 | 0.25 | 5 | 4 | 7-8 | 80-100 | 12.10 |
| #4 | 0.5 | 5 | 3-4 | 6-7 | 70-90 | 7.57 |
| **#5** | **1.0** | **5** | **2** | **4-5** | **48-60** | **12.42** |
| #6 | 0.05 | 8 | 4-5 | 8-9 | 100-120 | 16.81 |
| #7 | 0.1 | 8 | 4 | 7-8 | 90-100 | 24.20 |
| #8 | 0.25 | 8 | 3-4 | 6-7 | 72-96 | 22.49 |
| #9 | 0.5 | 8 | 2-3 | 5-6 | 60-80 | 14.03 |
| #10 | 1.0 | 8 | 1-2 | 3-4 | 36-50 | 15.82 |
| #11 | 0.05 | 10 | 4-5 | 7-8 | 100-120 | 14.25 |
| #12 | 0.1 | 10 | 4 | 7-8 | 80-100 | 14.66 |
| #13 | 0.25 | 10 | 3-4 | 6-7 | 72-96 | 14.26 |
| #14 | 0.5 | 10 | 2-3 | 5-6 | 50-72 | 14.41 |
| #15 | 1.0 | 10 | 1-2 | 3-4 | 24-48 | 14.54 |

# Real time application on packed chicken meat


Dark brown colour
(Fresh chicken)


Intermediate brown and orange color
(Immediate consumption of chicken)


Orange color
(Spoiled chicken)

# *Thanks to....*

**Director**
*CFTRI*

CSIR, FOCUS (Food and Consumer Safety Solutions) mission mode Programme for Financial support

**Team FPT,**
*CFTRI*

**Sachin R C**
***SFS***