

# Preliminary studies on the efficiency of an environmentally-friendly fire-fighting agent based on starch

Paul Joseph, Dimitri Bakirtzis and Quentin Richard  
FireSERT, School of the Built Environment, University of Ulster,  
Newtownabbey, BT37 0QB, County Antrim, Northern Ireland, UK



# Summary

- ◆ **Introduction**
- ◆ **Methodology**
- ◆ **Results**
- ◆ **Discussion**
- ◆ **Conclusions**

# INTRODUCTION



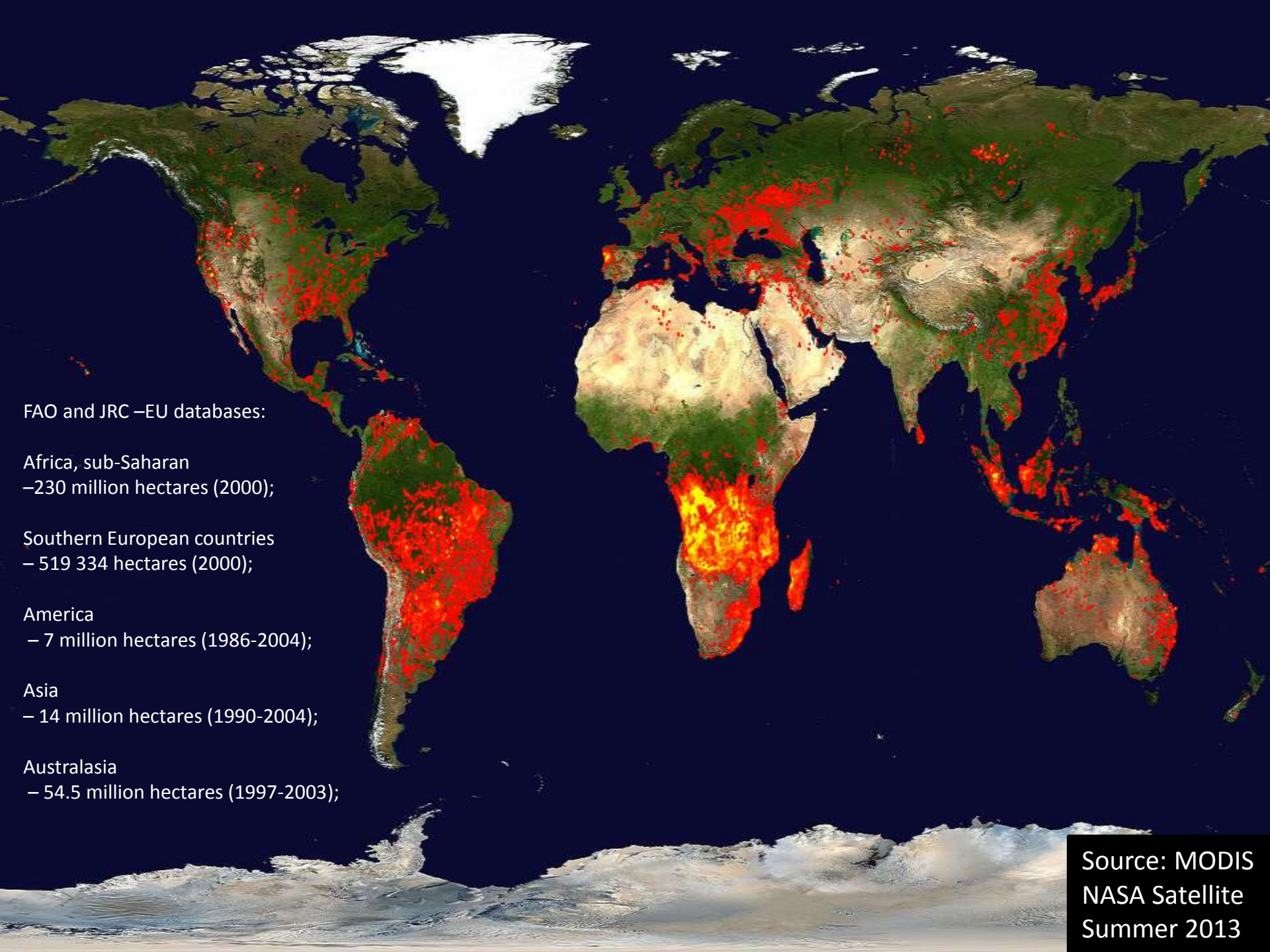
# Introduction

- ◆ **Wild land Fire, an issue**

- ◆ **A world wide concern**

- ◆ An increasing issue

- ◆ Impacts



FAO and JRC –EU databases:

Africa, sub-Saharan  
–230 million hectares (2000);

Southern European countries  
– 519 334 hectares (2000);

America  
– 7 million hectares (1986-2004);

Asia  
– 14 million hectares (1990-2004);

Australasia  
– 54.5 million hectares (1997-2003);

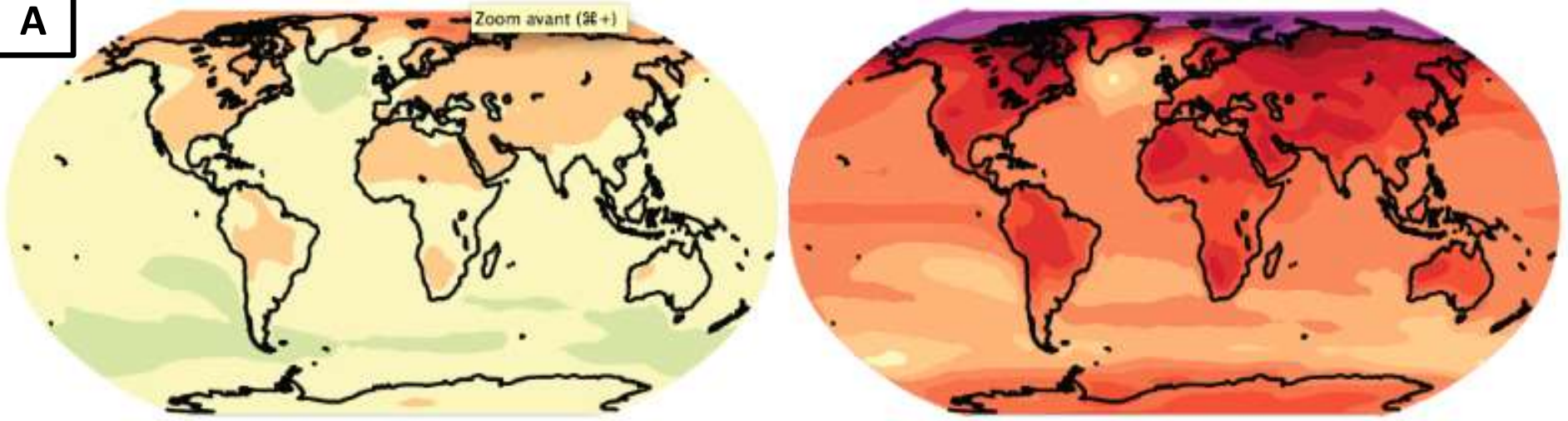
Source: MODIS  
NASA Satellite  
Summer 2013

# Introduction

- ◆ Wildland Fire, an issue
  - ◆ A worldwide concern
  - ◆ **An increasing issue**
  - ◆ Impacts

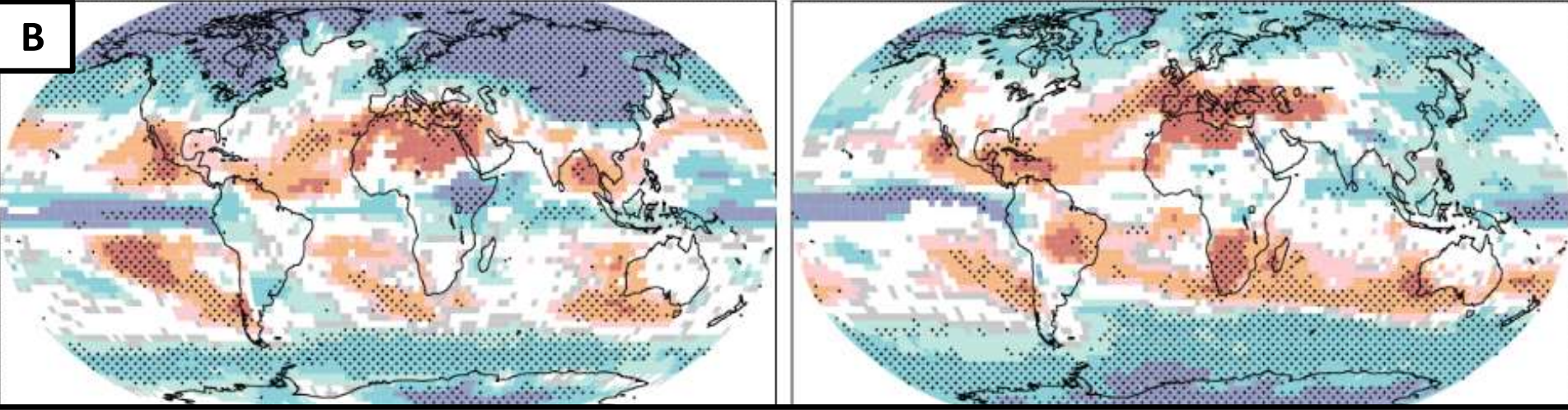
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5  
(°C)

A



%  
-20 -10 -5 5 10 20

B



**A – Projected surface temperature for the early (left) and late (right) 21st century.**  
**B – Relative changes in precipitation predicted for 2090-2099: winter (left); summer (right)**  
*Source: Intergovernmental Panel on Climate Change*

# Introduction

- ◆ Wildland Fire, an issue

- ◆ A worldwide concern

- ◆ An increasing issue

- ◆ **Impacts**



# Introduction

## Impacts of wildland fires

### 💧 **Impact on people**

- **General population (~ 57 casualties/year in the world)**
- **Firefighters, e.g. recent wildfire in Arizona leading to 19 losses**

### 💧 **Economic impacts (in the billion \$ range)**

- **Affect businesses, other economic activities and households**
- **Costs of fire suppression and re-forestation**

# Introduction

## Impacts of wildland fires

### 💧 And also the environmental impacts

- Extinction of fauna and flora
- Health of vicinal human pollution

### ➔ Other effects owing to chemical suppression !!!

Oregon, USA, 2002; an inadvertently dump of fire retardant occurred in a river leading to the immediate killing of all the river's fish



# Introduction

## Impacts of wildland fires

IS IT BETTER TO LET THE FIRE AFFECT THE ENVIRONMENT, AND  
EXTINGUISH BY ITSELF

OR

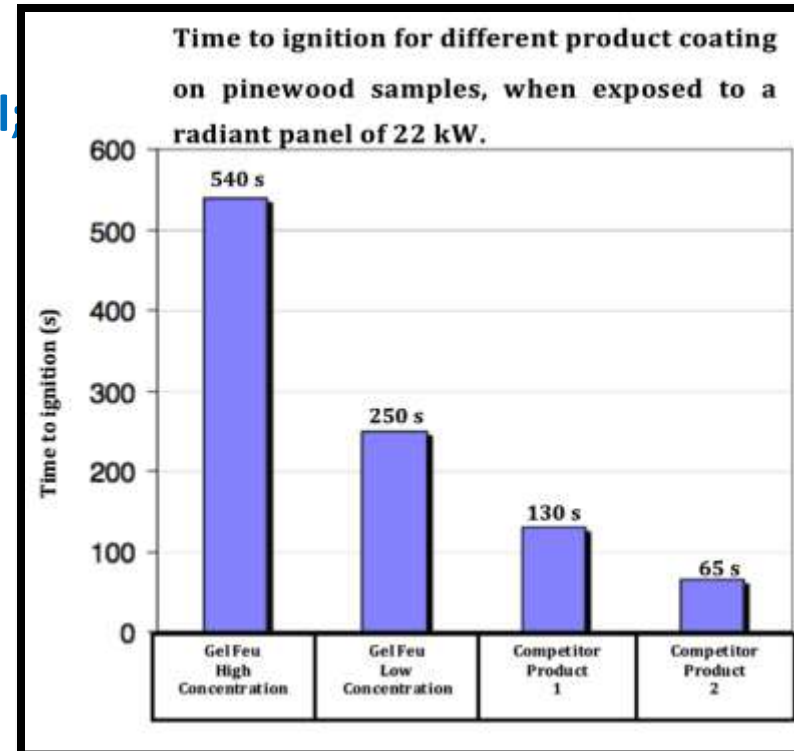
TO FIGHT IT WITH HARMFUL CHEMICAL PRODUCTS ???



# An alternative solution

💧 *Gel Feu* is an organic fire-fighting product created in France

- 100 % biodegradable, not toxic at all;
- Fire retardant/suppressant used;
- Easily available and cheap;
- Main compound = Potato starch



# Potato starch

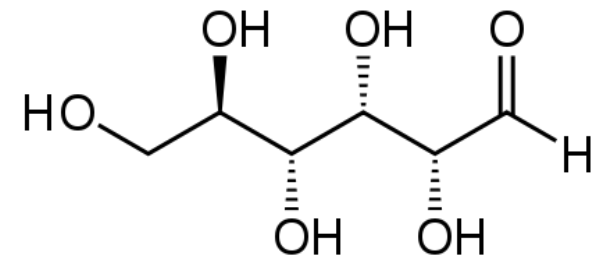
## What is starch ?

- Carbohydrate contained in plants (potatoes, wheat, rice,...)
- Created by photosynthesis and remains as an energy store

## Chemistry

- Complex carbohydrate (made of glucose units)
- Amylose (20 %); Amylopectin (80 %)

## Potato contains a lot of starch



# METHODOLOGY



# METHODOLOGY

◆ **Materials**

◆ Apparatus

◆ Protocol

# METHODOLOGY

## Materials

- ◆ **Potato starch**
  - Extracted from locally sourced potatoes
  - Tested as a dry powder and mixtures with water
- ◆ **Softwood/Hardwood**
  - Blended and coated





# METHODOLOGY

- Materials
- Apparatus**
- Protocol

# Apparatus

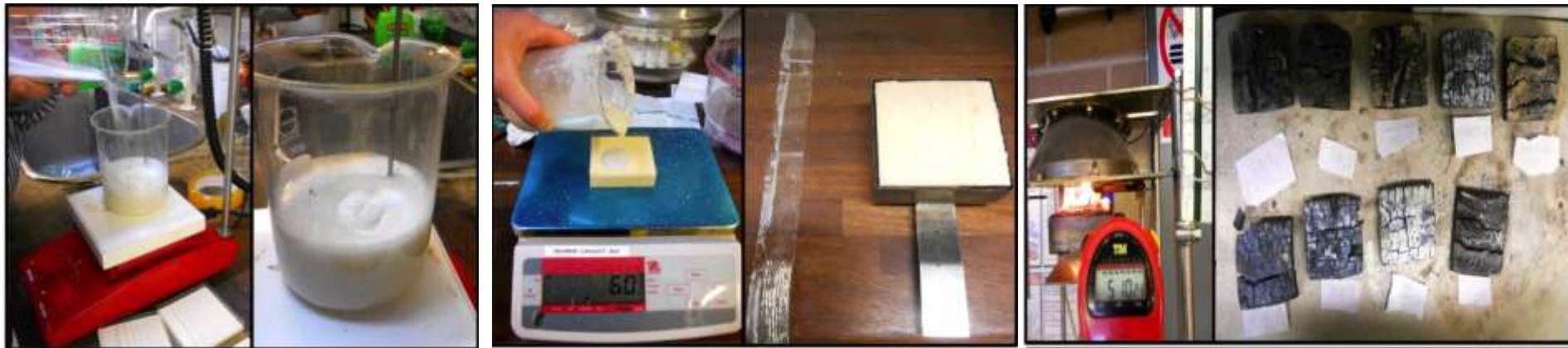
- ◆ **TGA / DSC**
  - 30 – 600 °C ; 10 °C /min in nitrogen atmosphere
  
- ◆ **Bench cone calorimeter (BS 476-13: 1987)**
  - 30 kW/m<sup>2</sup> ; Piloted ignition



# METHODOLOGY

- Materials
- Apparatus
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# Protocol

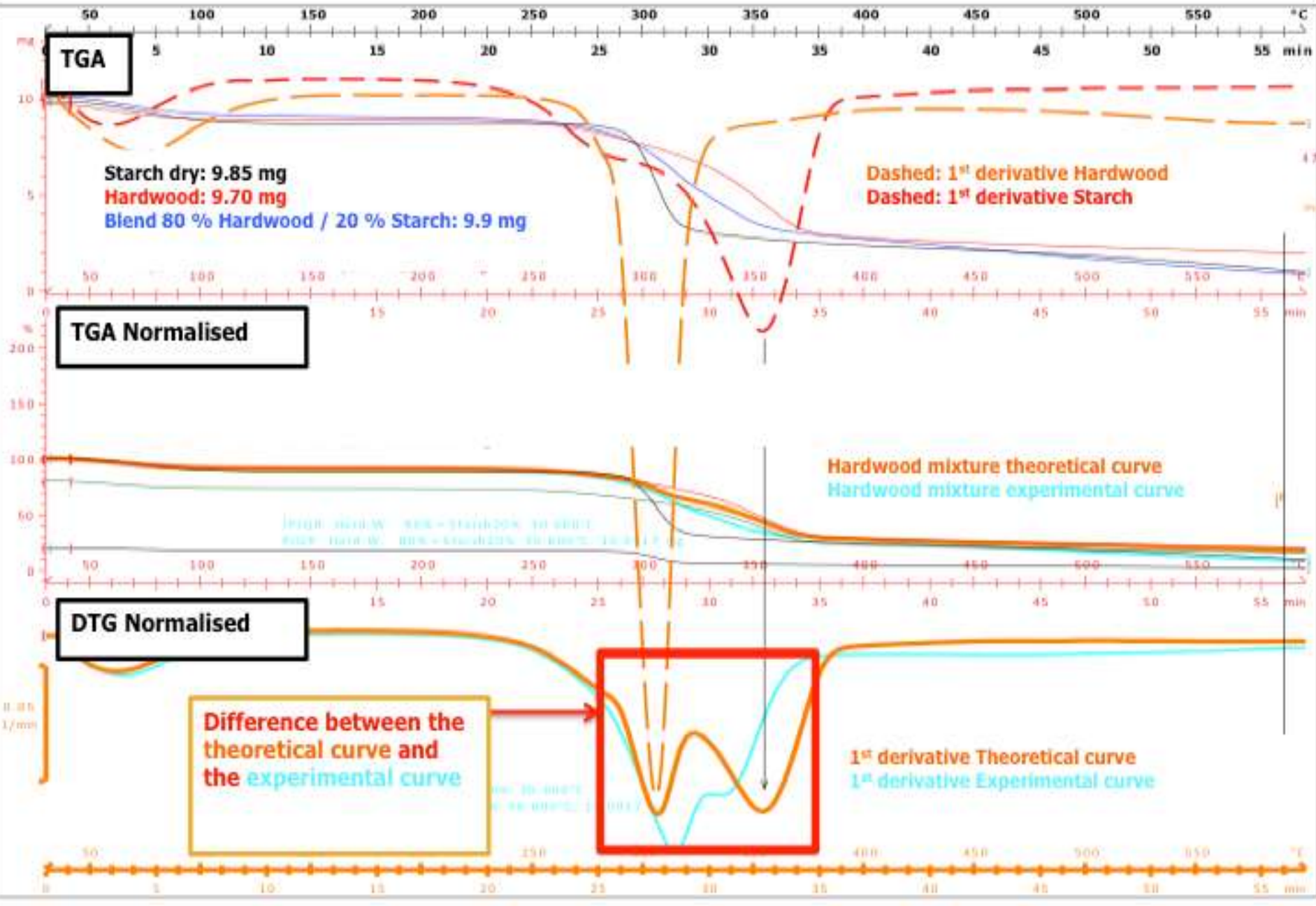


# RESULTS



# RESULTS

- **TGA**
- DSC
- Bench cone calorimeter

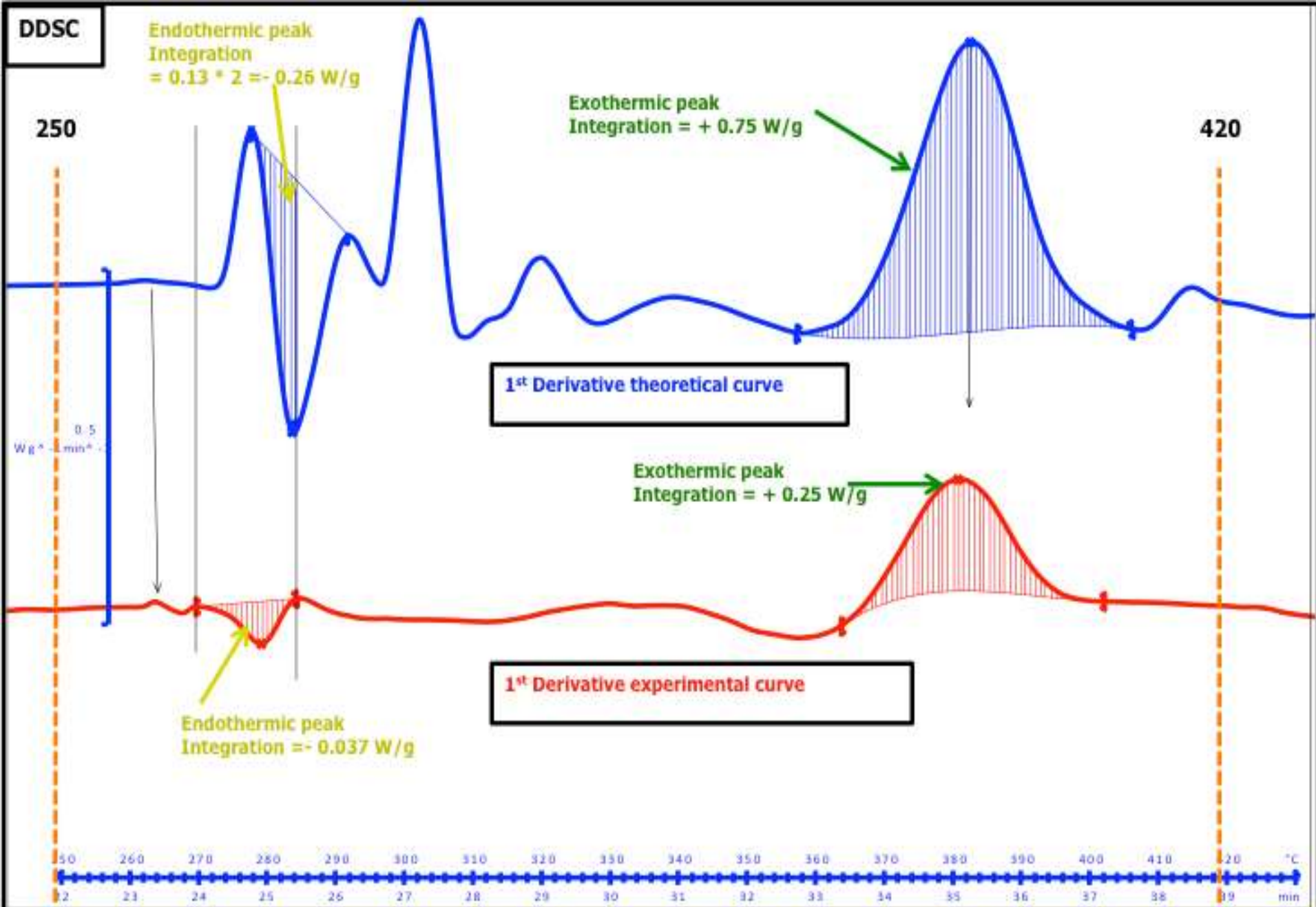


**TGA Analyses showing an interaction between starch and wood**

# RESULTS

- TGA
- **DSC**
- Bench cone calorimeter

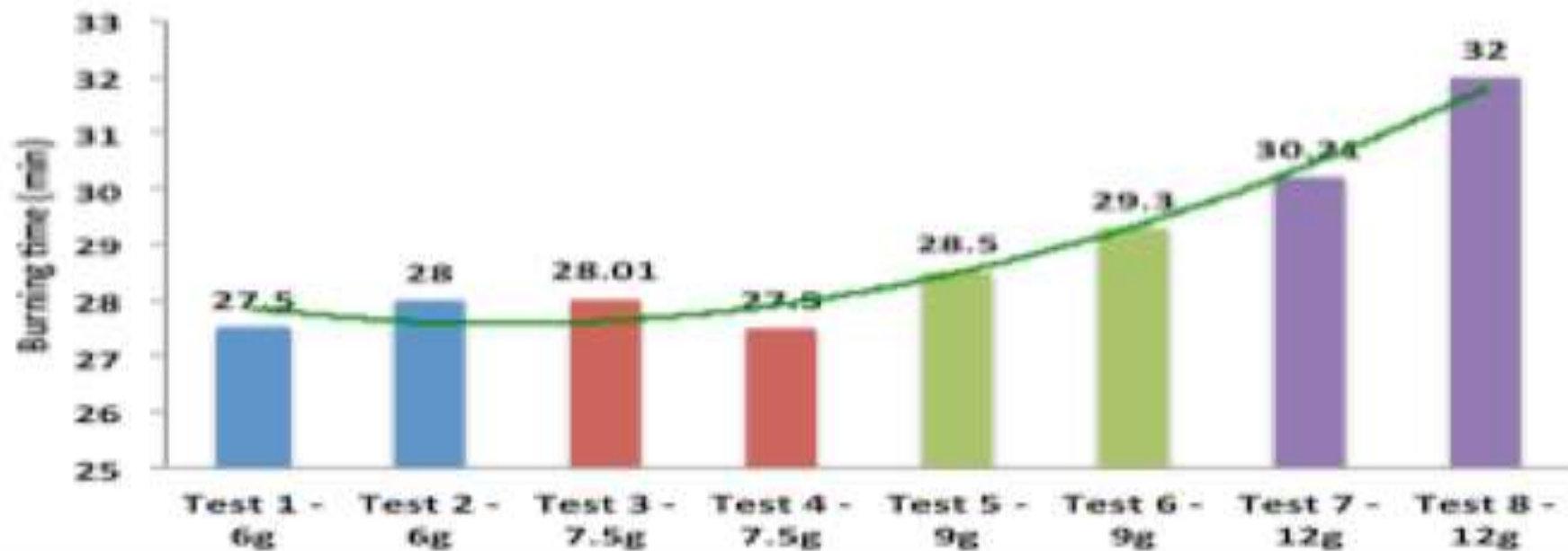
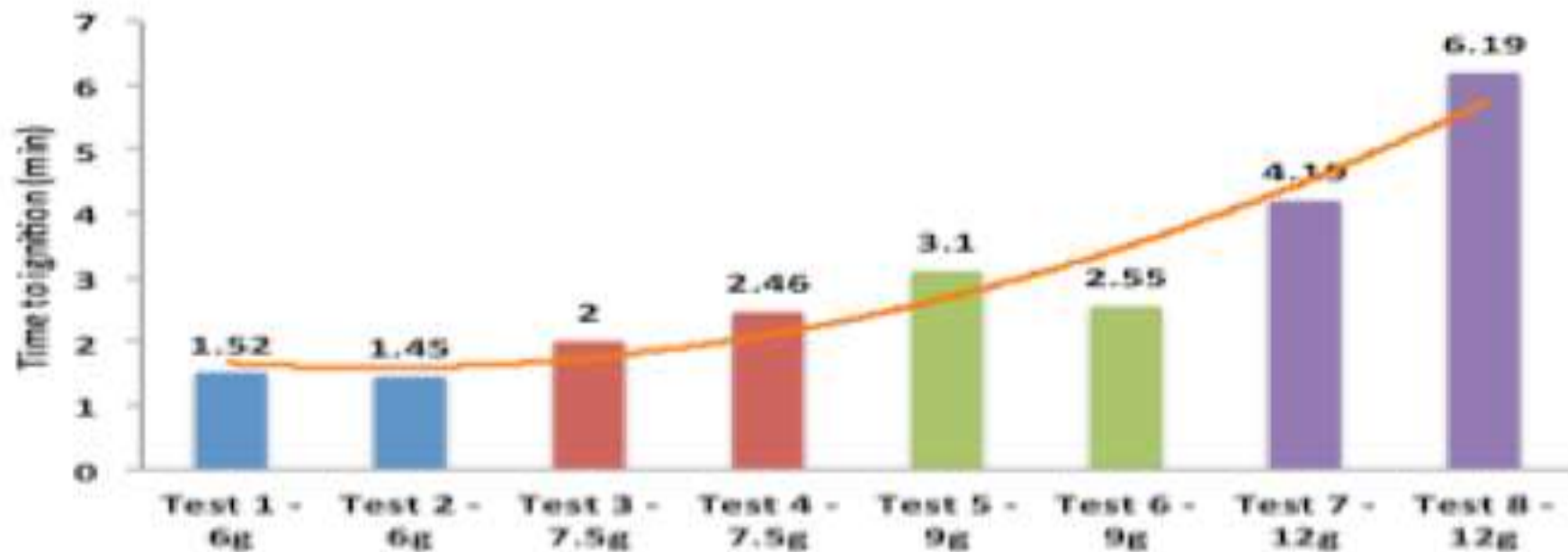


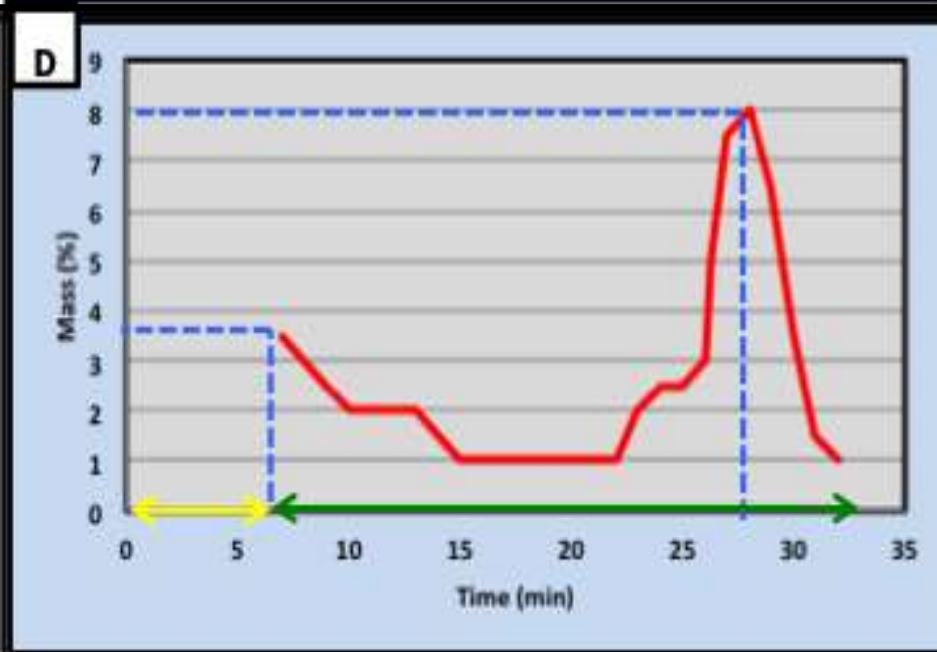
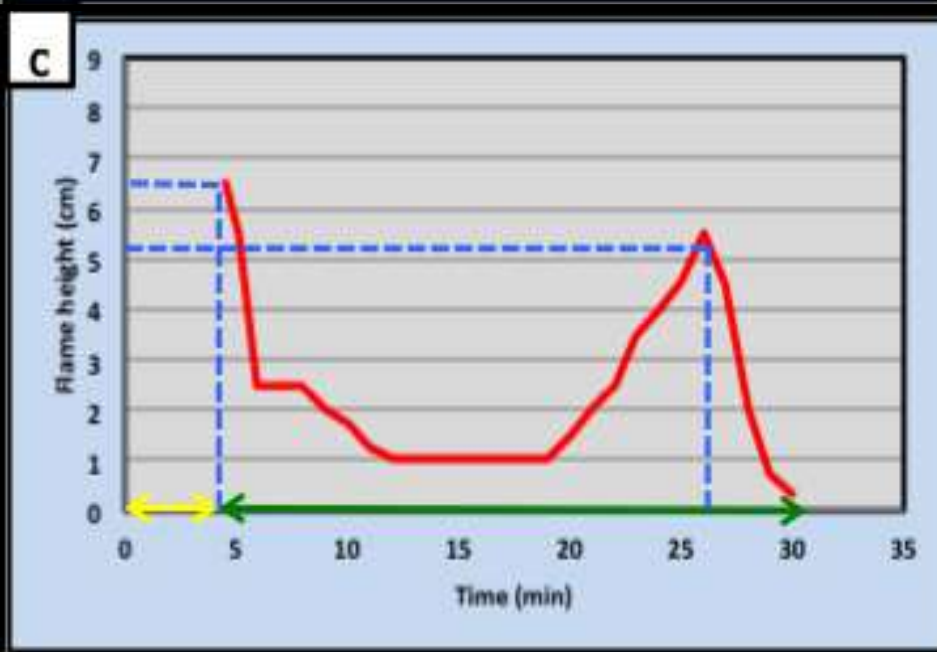
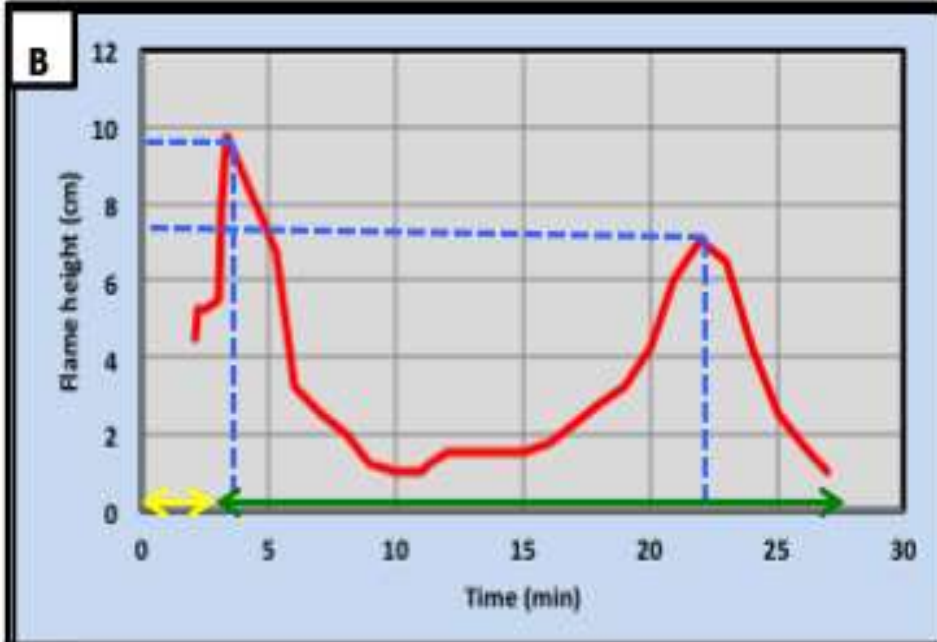
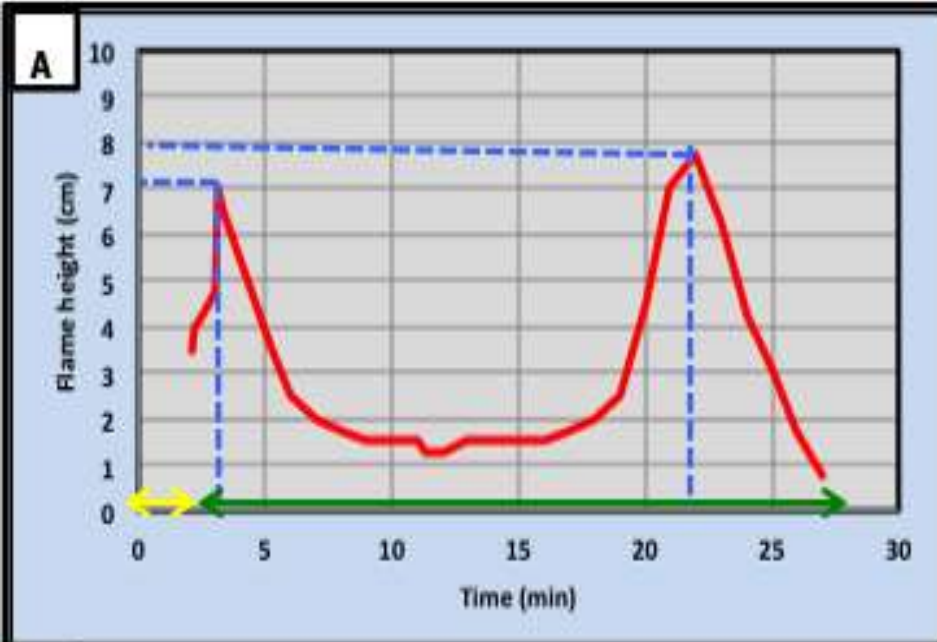


DSC analyses showing an interaction between starch and wood

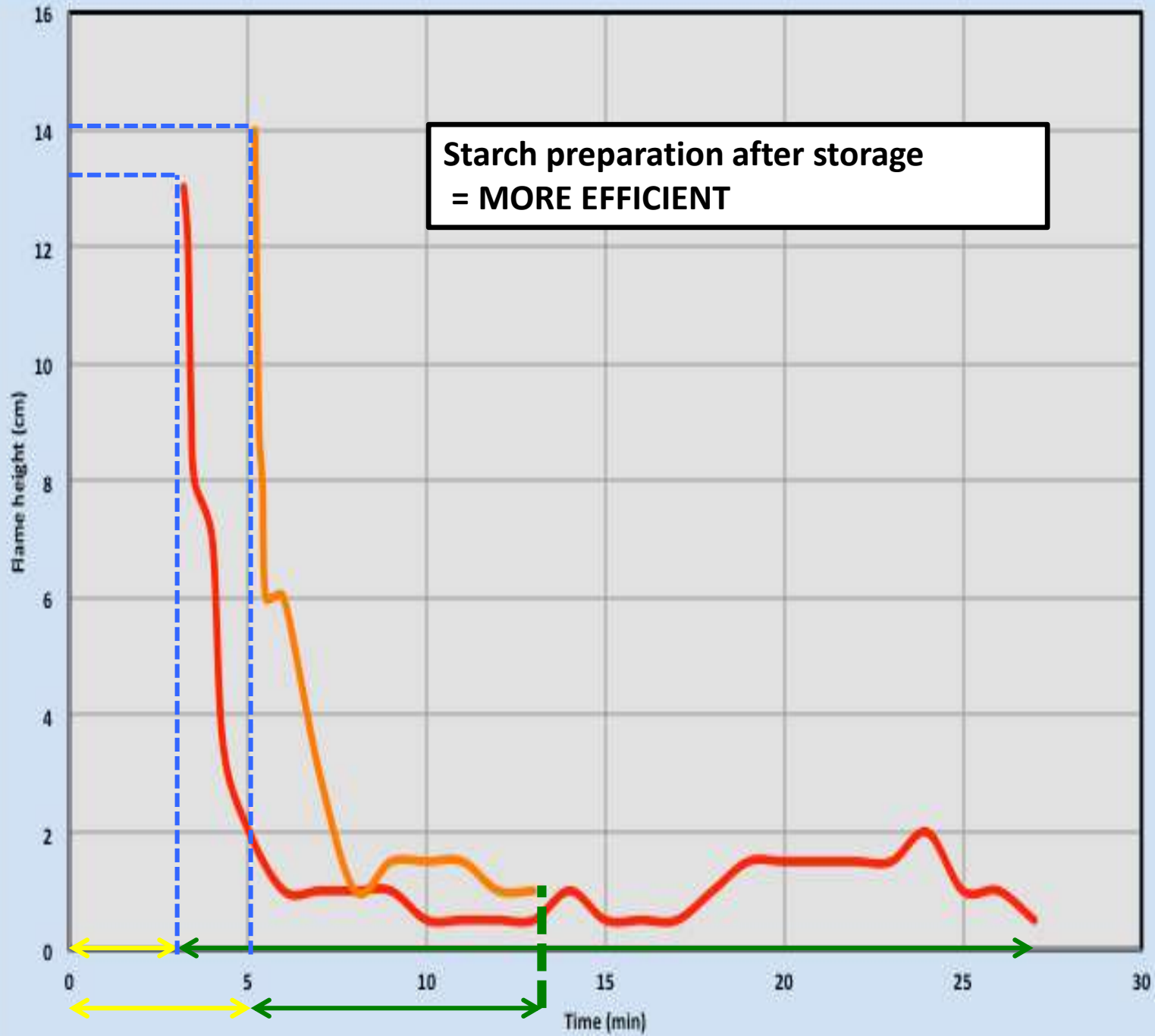
# RESULTS

- TGA
- DSC
- **Bench-cone calorimeter**





Effect on flame height as a function of the quantity of starch: 6 g (A, B) and 12 g (C, D)



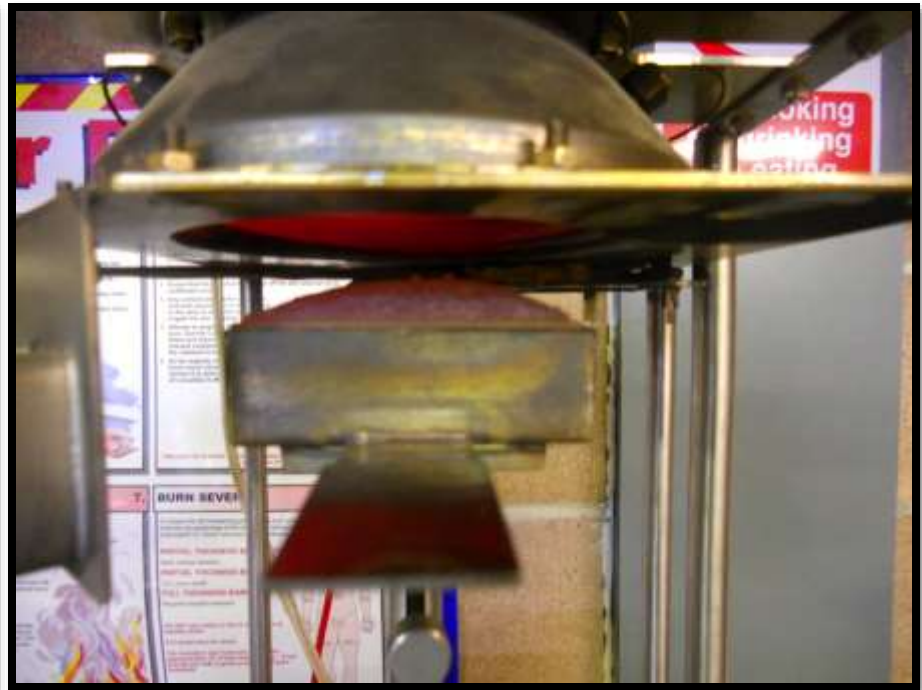
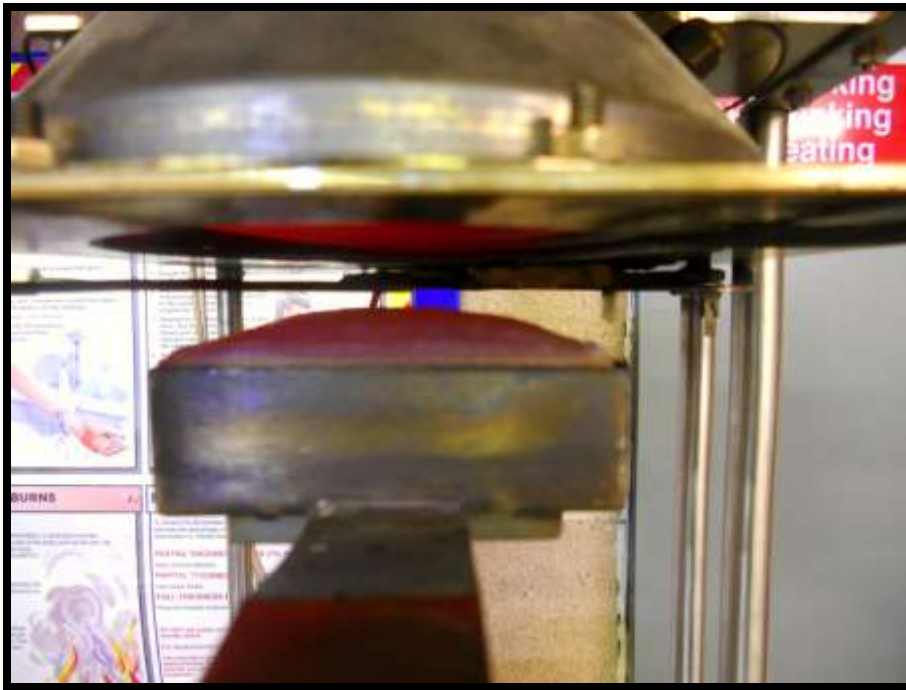
- Starch solution rested - 6 g
- Starch solution rested - 9 g

# DISCUSSION



# Discussion

**When exposed to heat, starch forms an intumescent layer that consists of a thermal protection.**



# CONCLUSION





# Conclusion

- ◆ Both TGA and DSC curves shows 'co-operativity' between starch and wood
- ◆ Bench-cone test parameters (time to ignition, flame heights..) reveal potential passive fire protection capabilities of starch
- ◆ Surfaces of burnt samples show 'intumescent' characteristics
- ◆ Noticeable differences between the 'type's of formulations (i.e. powder, colloidal, maturity, etc.)

# Work in progress/future directions

- ◆ **Bench-cone calorimetry with ‘Gel Feu’**
- ◆ **Bomb calorimetry**
- ◆ **Hyphenated techniques (TGA/FT-IR; TGA/GC-MS)**
- ◆ **Oxygen consumption cone calorimetry (heat release and its rates!)**
- ◆ **Active protection- some laboratory scale tests**

**Thank you for your attention**

