

# Drying characteristics of VIP faecal sludge

Blessing Makununika  
(BSc Chem Eng)

## Supervisors

Pr. Buckley  
Dr. Velkushanova  
Dr. Septien



UNIVERSITY OF  
KWAZULU-NATAL  
INYUVESI  
YAKWAZULU-NATALI



**PRG**  
pollution research group

# Summary

1. Overview
2. Objectives
3. Material and methods
4. Experimental Results
5. Conclusion
6. Further work



# Overview

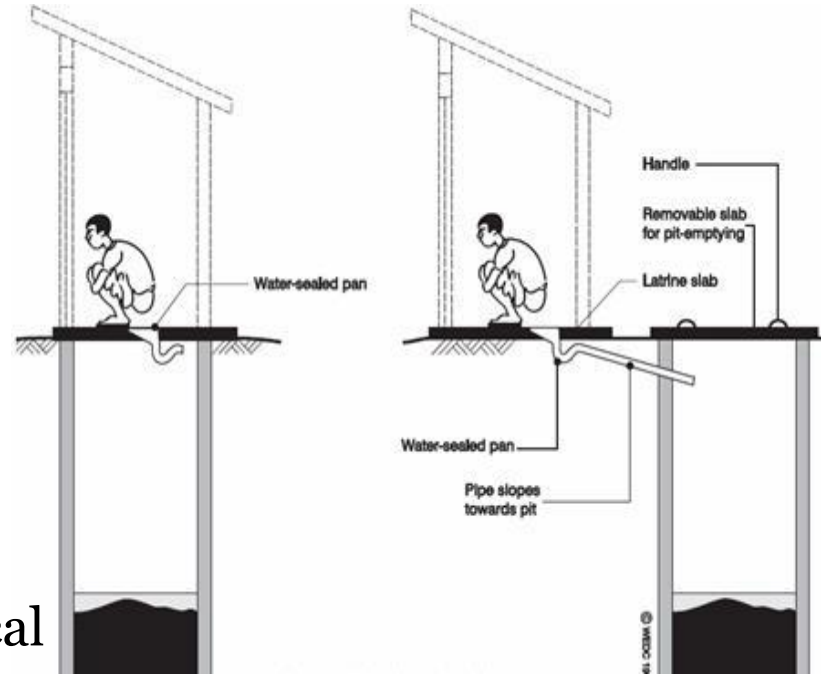
- Bill and Melinda Gates Foundation (BMGF)  
Grantee
- BMGF vision – enhance global healthcare and reduce poverty
- Reinvent The Toilet Challenge (RTTC)

The logo for the Bill & Melinda Gates Foundation is displayed on a dark red rectangular background. The text is white and arranged in three lines: "BILL & MELINDA" in a serif font, "GATES" in a larger serif font, and "foundation" in a smaller, lowercase sans-serif font.

BILL & MELINDA  
GATES *foundation*

# Sanitation challenges

- 2.5 billion don't have access to basic sanitation
- Most rely on onsite sanitation
- Emptying of pits and the disposal of the contents pose a major problem to the local municipalities



# Common disposal route

Estimated excretion of nutrients per capita in different countries based on diet

- Agriculture 

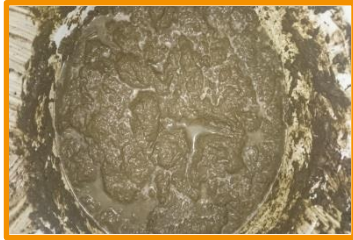
Country	Nitrogen [kg/cap.yr]	Phosphorus [kg/cap.yr]	Potassium [kg/cap.yr]
China	0.5	0.2	0.5
Haiti	0.3	0.1	0.3
India	0.3	0.1	0.3
South Africa	0.4	0.2	0.4
Uganda	0.3	0.1	0.4

- Landfill
- Waste water work

# Research on possible processes of Faecal sludge

- Gasification
- Combustion
- Pyrolysis
- Drying
- Hydrothermal carbonization
- Anaerobic digestion
- Composting

# Advantages of drying



**Drying**



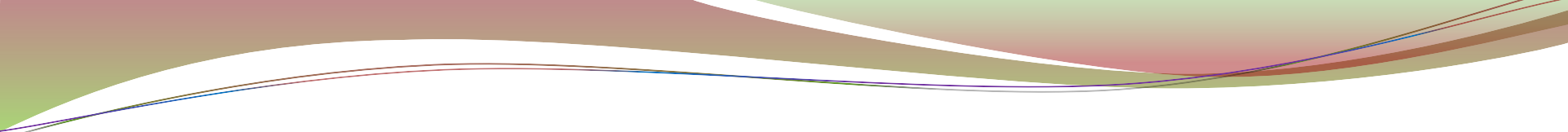
- Volume reduction
  - Mass reduction
- } Lower transport costs
- Pathogen free product → safer handling
  - Increase of calorific value → increase of combustion efficiency

# Objectives

Investigating effect of the drying air temperature, air flow rate and air relative humidity on :

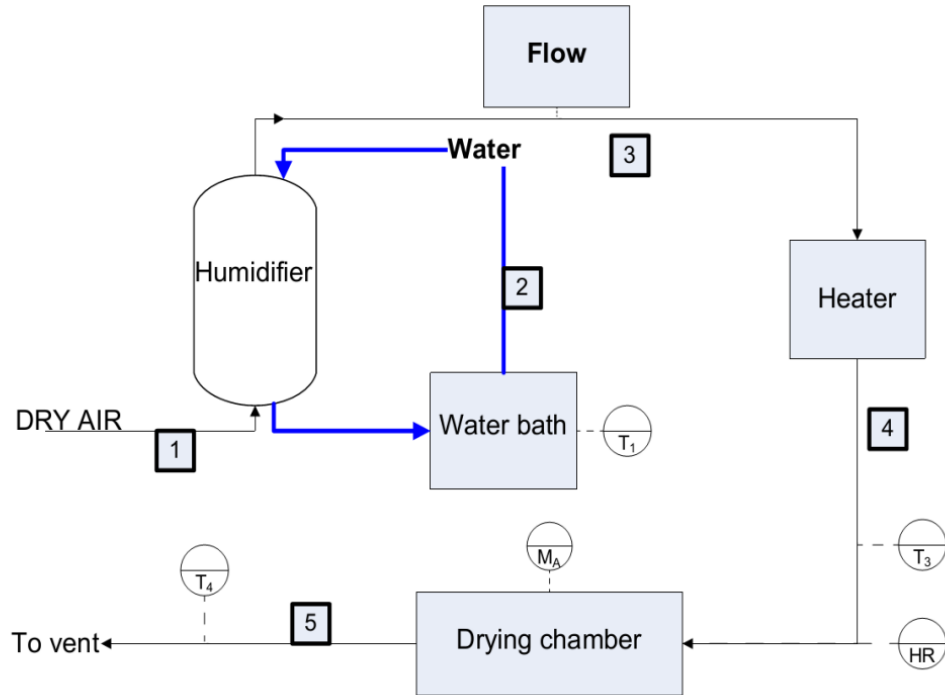
- Drying characteristics – Drying curves
- Thermal characteristics – Calorific value
- Inorganic nutrient analysis –  $\text{NO}_3^-$  , P , K



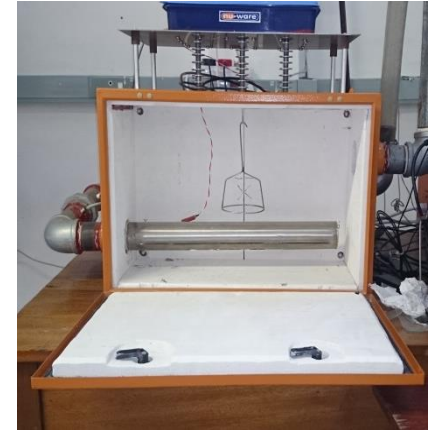


# Materials and methods

# Material and methods



Humidifier



Drying chamber

# Thermal and chemical analysis



Bomb calorimeter

Caloric value



Spectroquant

Nutrient concentration

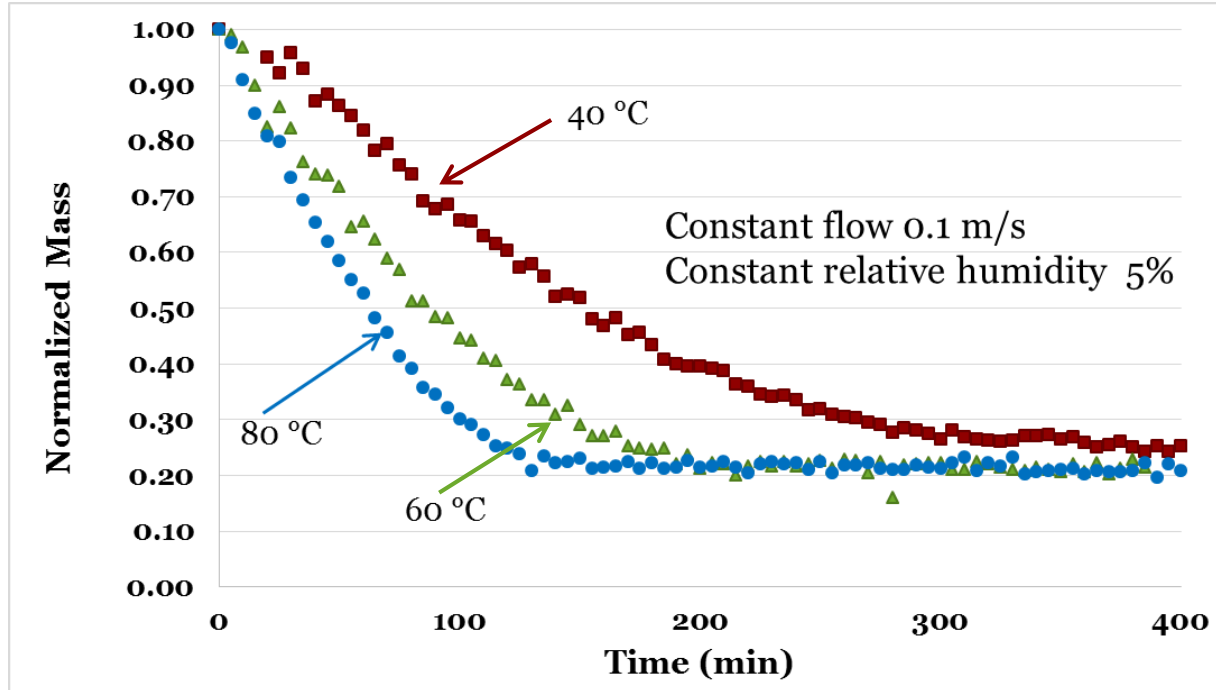


# Experimental Results

# Important terminology

- Equilibrium moisture content,  $M_e$
- Moisture ratio,  $MR = \frac{M - M_e}{M_0 - M_e}$
- Constant rate drying period
- Falling rate drying period

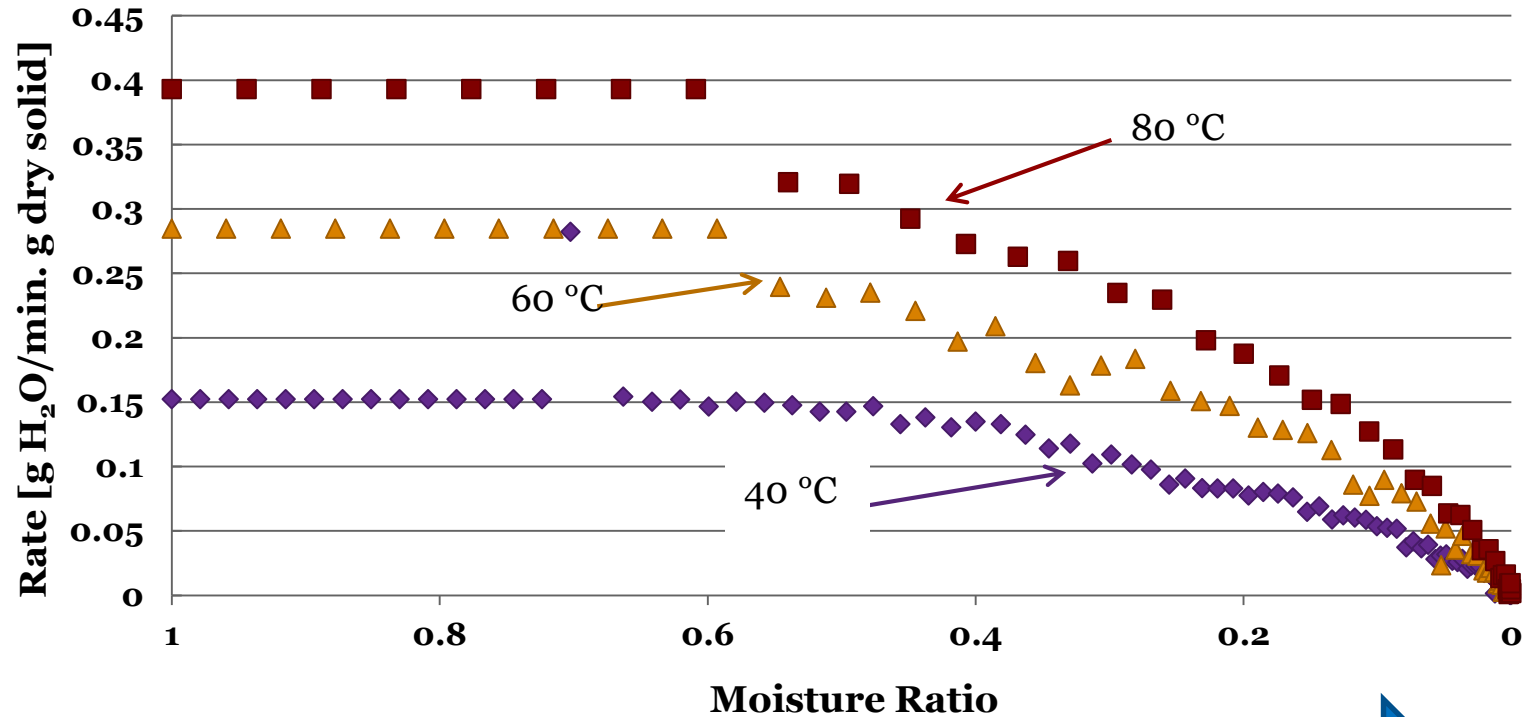
# Effect of air temperature



## Drying times

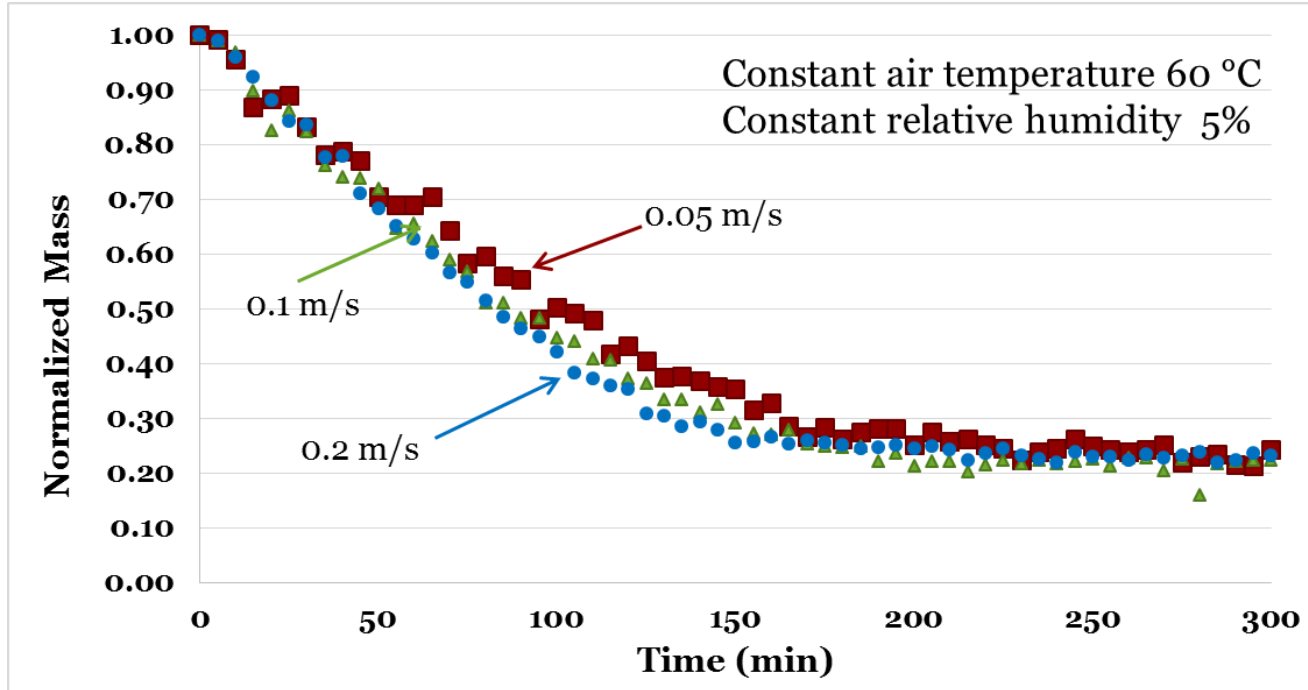
- 40°C – 5 hrs
- 60°C – 3 hrs
- 80°C – 2.5 hrs

# Effect of air temperature on rate curves



Increasing temperature increases drying rate

# Effect of air flow

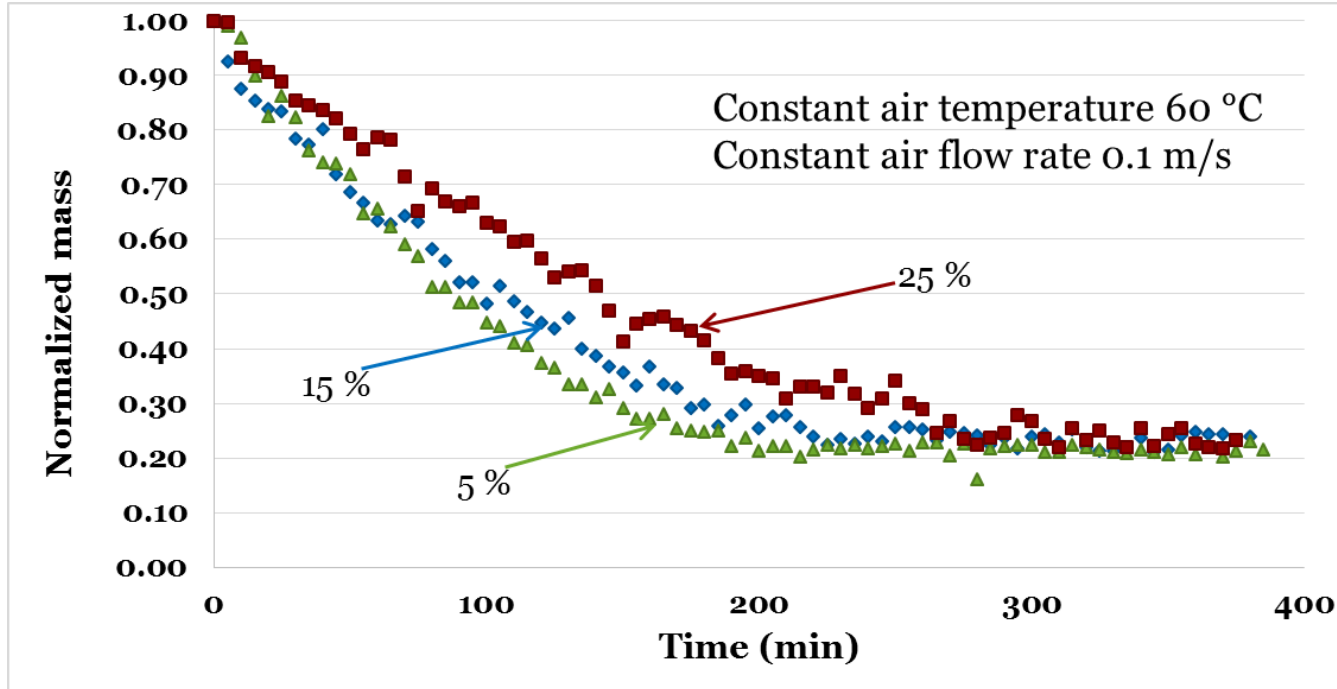


## Drying time

- 60°C – 3 hrs



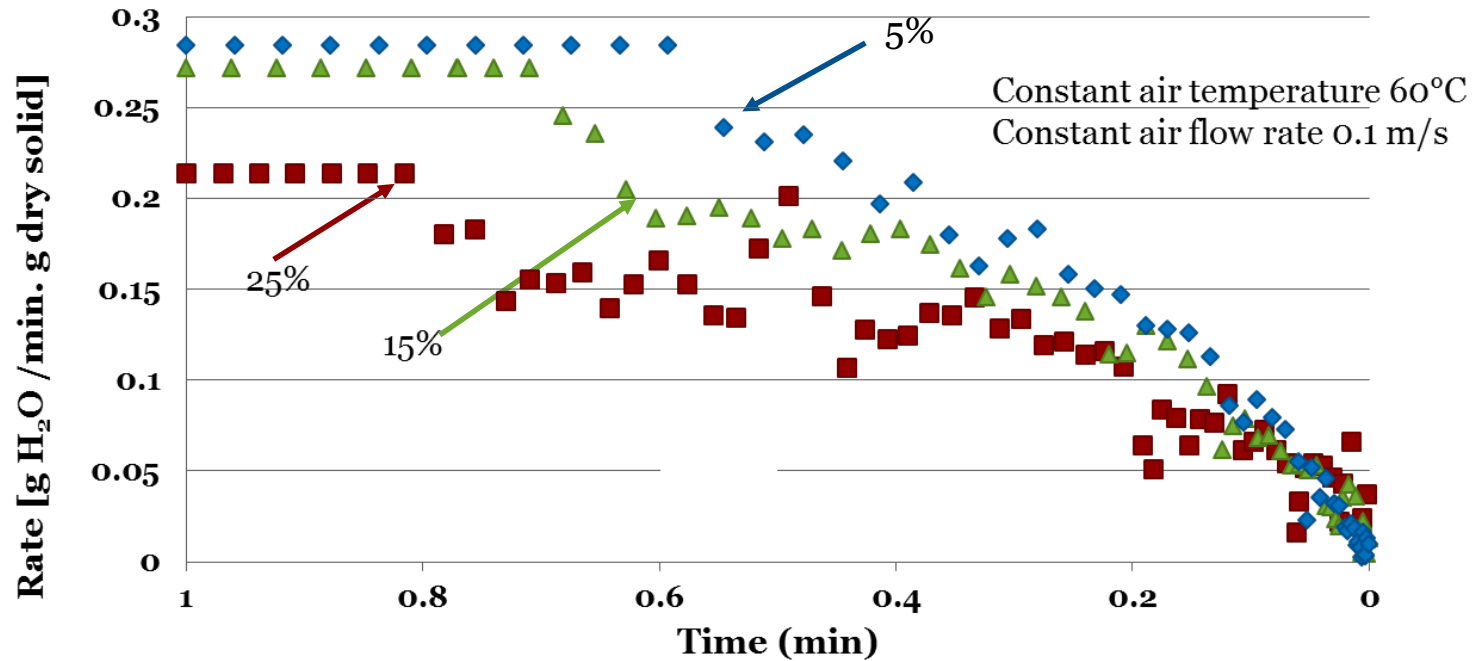
# Effect of air humidity



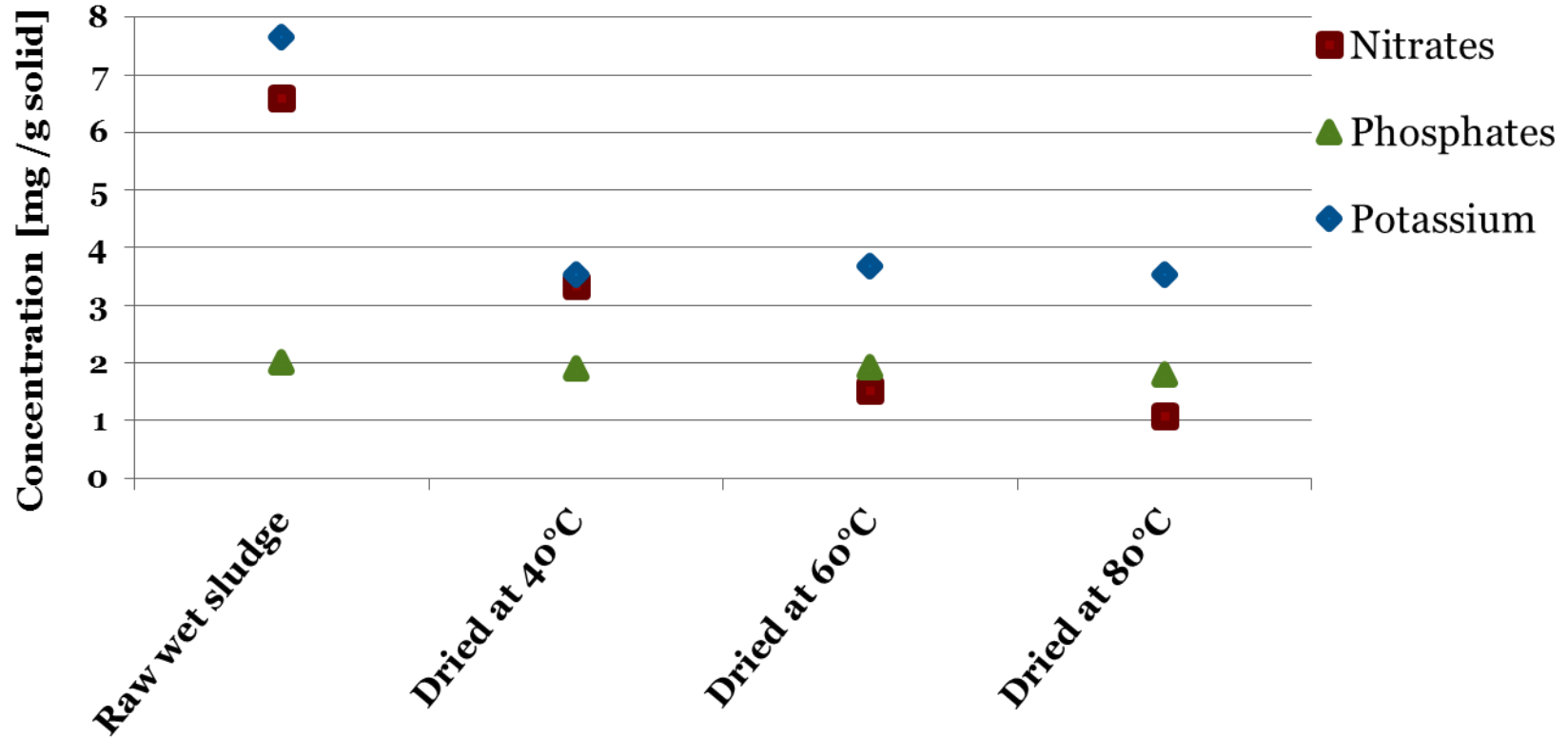
## Drying times

- 5% – 3 hrs
- 15% – 4 hrs
- 25% – 5 hrs

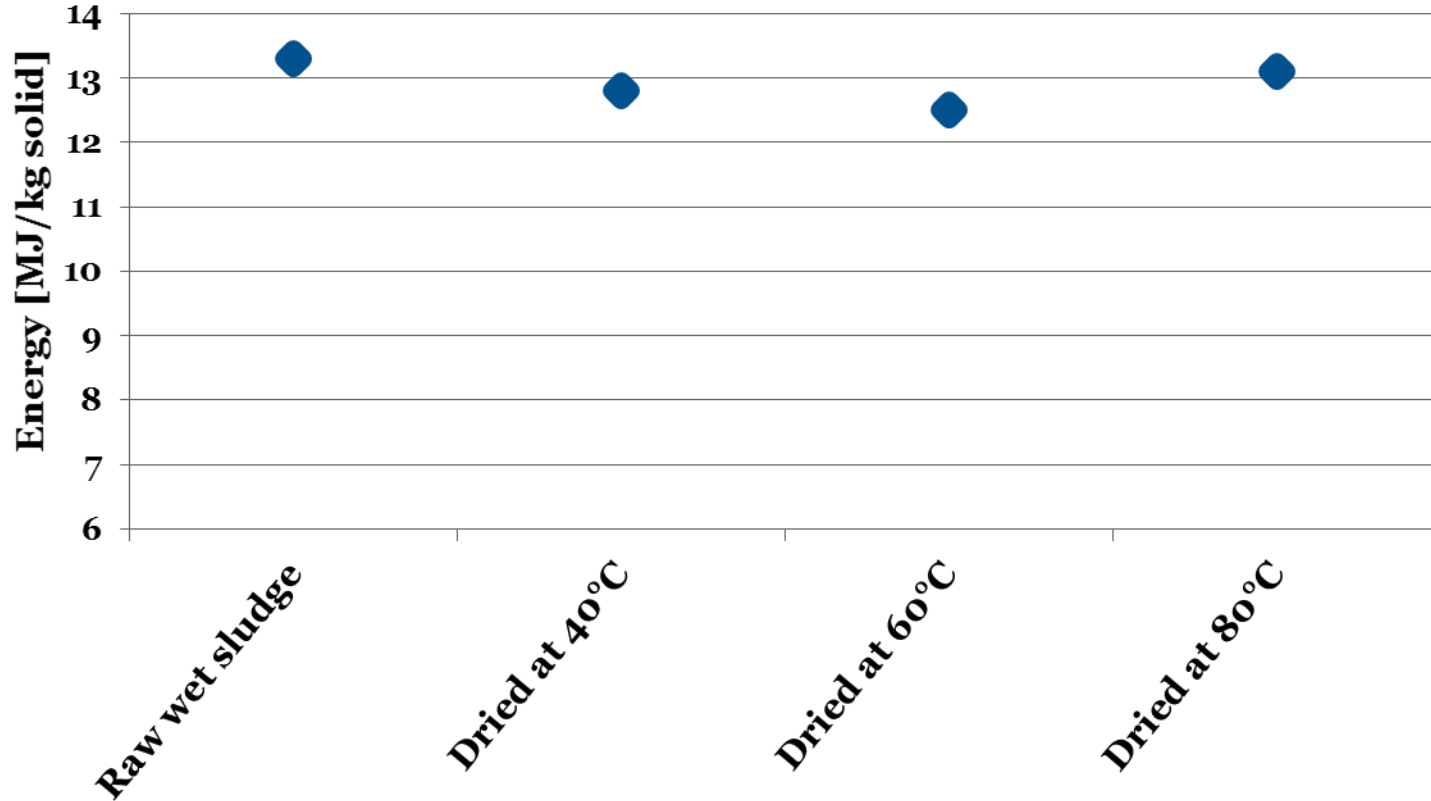
# Effect of relative humidity on rate curves



# Variation of nutrients with temperature



# Effect of temperature on calorific value





# Conclusions

## Conclusions

- Air temperature and relative humidity have a significant effect on drying rate unlike air flow rate
- Nitrates and potassium concentrations decrease with increase in temperature
- The drying condition have not a significant effect on the phosphates concentration and caloric value

## Work to be done

- Effect of initial moisture content
- Particle geometry and size
- Model and determine the variation of moisture effective diffusivity in the porous solid

A photograph of a male scientist in a white lab coat standing in a laboratory. He is wearing white gloves and has his right hand resting on a wooden lab bench. The lab coat has the name 'BUCKLEY' and 'UKZN' visible on the chest. The background shows various laboratory equipment, including a blue cabinet, a microscope, and a wooden table. The text 'Thank you' is overlaid in a large, orange, serif font across the center of the image.

# Thank you

## Contact details

Tel : 031 260 3375

Email : [209506872@stu.ukzn.ac.za](mailto:209506872@stu.ukzn.ac.za)

Supervisor: [buckley@ukzn.ac.za](mailto:buckley@ukzn.ac.za)