Chemistry & Biochemistry Laboratory,
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# Challenges and solutions for implementing IQC measures in *ad-hoc* or non-routine analysis in universities

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Laboratory was accredited to ISO/IEC 17025:2005
from Sep 2001 to Jan 2007

  

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## Overview

1. Background
2. Challenges for universities
   - How reliable are research data?
   - What's the problem for research labs?
   - ISO 17025 standard & best practices and university laboratories
3. Some suggested solutions
   - Lessons learned: ISO 17025 accreditation and courses
   - Practical examples & suggestions
   - UK Code of Practice for Research

## The Background

History of quality issues:

- Scientific fraud
- Incompetence
- Simple errors

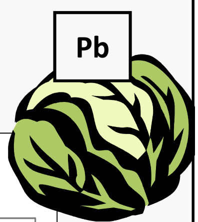
➢ Funding bodies, industry, the public need *valid data*

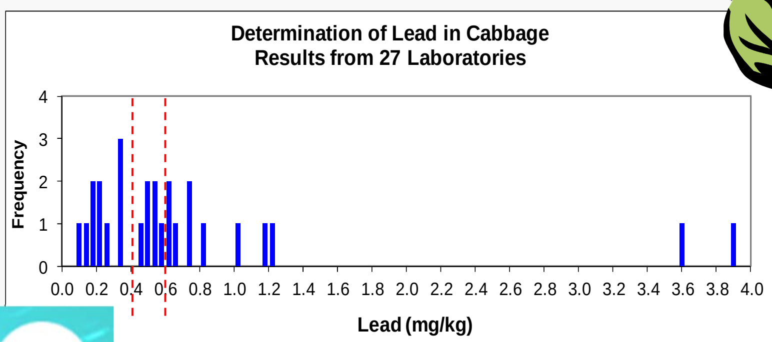

Midkiff 1984, *J. AOAC Internat. 67*, 851-860
Key et al 1996, J. AOAC Internat. 80, 895-899
Mueller-Harvey 2003, *J. Food Agric. Env. 1*, 9-11
Theron 2012, S. Afr. Inst. Phys., 57th Ann. Conf. 9-13 Jul 2012. Univ. Pretoria. S. Africa




## How reliable are research data?

- Acceptable range 0.23 - 0.41 mg/kg
- Only 4 laboratories within acceptable range





Sherlock et al. 1985, *Chem. Brit.* 21, 1019-1021
Beever et al 1996, *Anim. Feed Sci. 62*, 685-686
Mueller-Harvey 2003, *J. Food Agric. Env. 1*, 9-11

## What's the problem for research labs in universities?

Many published methods don't work in other labs

- Problem could stem from:
  - Scientific fraud
- Or may be due to:
  - Sampling, sample preparation
  - Inappropriate method
  - Interferences
  - Equipment malfunction
  - Incorrect calibration of equipment
  - Calculation/transcription errors
  - Human error

→Teach ethics

→Apply ISO 17025 principles



## The Challenges

## Challenge 1: the environment

Myths & beliefs:

- *'Analysis is routine, easy, not worth investing in'*
  - ➢ Analysis is never 'routine'
  - ➢ I prefer: 'systematic analysis'
- *'Accreditation hinders research'*
- *'Scientific research cannot be subject to quality management'*

But…

Peer review ensures quality for:

- Teaching
- Research grant applications
- Scientific papers

What about QC in analysis?

- Papers tend not to report QC results
  - ➢ QC receives little attention

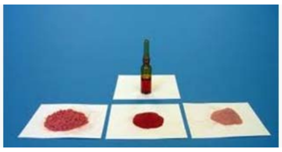
Gillespie et al 1999, *VAM Bulletin 21*, 6-10; Mueller-Harvey & Baker 2002, *VAM Bulletin 26*, 13-17; Mueller-Harvey 2007, *G.I.T. Laboratory Journal 5-6*, 48-49; Theron 2012, S. Afr. Inst. Phys., 57th Ann. Conf. 9-13 Jul 2012. Univ. Pretoria. S. Africa

## Challenge 2: Certified Reference Materials

Various IRMM standards

http://irmm.jrc.ec.europa.eu

NIST standard: *Vaccinium* berries

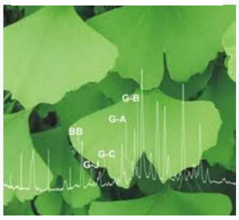


http://esciencenews.com

Urine samples

http://www.nist.gov/srm/

Gingko leaves



http://www.nist.gov/mml/analytical/organic/images/ginkgo-with-chromatogram_3.jpg

Research funds are difficult to obtain.

Up to $550 per CRM bottle:

- ➢ too expensive
- ➢ not suitable for regular use in universities

## Challenge 3:
## ISO language is difficult to understand

Text is

- 'legalese' and abstract
- bland
- pretty meaningless

Standard appears

- not appropriate for university labs

Many academics are not familiar with ISO 17025 standard

- ➢ Cannot teach it
- ➢ Students don't learn it



## Challenge 4:
## Students have difficulty implementing course material

Our 3-day course:

"ISO 17025 – How to Accredit your Laboratory: Practical Aspects of Gaining Accreditation"

- Occasionally my PhD students attend
- What have they learned?

## Challenge 4 (cont.):

- "I thought the balance check was only done on this particular balance"

  *Note*: during the course the balance check was only demonstrated on one balance

  - Is there really no need to check other balances?
  - What about the logbook next to each balance?

  ➢ Why do students find it difficult to translate theory/demonstrations into their lab practice?

## Some Solutions

See also:
D. Holcombe 1998: *Quality Assurance for Research and Development and Non-Routine Analysis* (Eurachem/CITAC Guide)

http://www.eurachem.org/index.php/publications/guides/qard

## Teaching of Ethics

A Code of Ethics needs to be part of the lab culture

- Awareness building is crucial
- People need to be educated to take their own responsibility
- Ethics needs to be taught within students' own disciplines
- Trained students could recognise ethical issues that consultants had overlooked.

➢ Training in Ethics Awareness =
Training in Health & Safety Awareness



## Helping students to understand ISO language and best practices (1)

- translate the legalese ISO language
- bring life into the abstract standard
- make it meaningful

➢ demonstrate how QC can be applied in the real world and in their own research

## Helping students to understand ISO language and best practices (2)

Students need:

- to learn how to question own and other's assumptions
- not to trust numbers from instruments or computers
- to see good practice in everyday activities
- to experience quality measures embedded in the laboratory culture

→ then students will "learn by doing"

## Traceability: a key component of QC

Applies to:

- Documents
- QC-samples & research samples
- Instruments
- Results

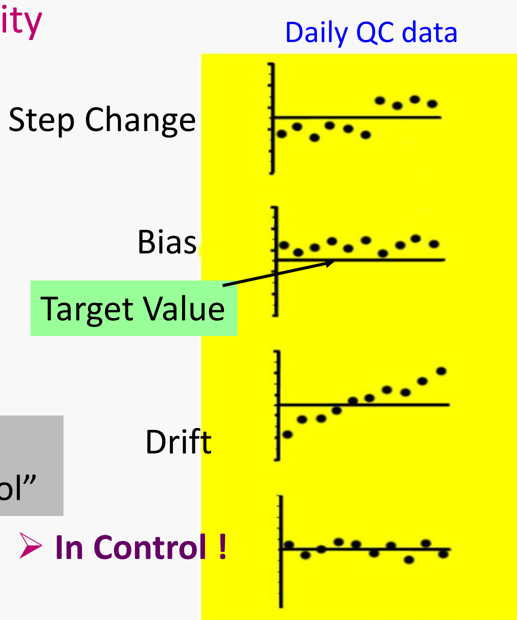
Teaching of Traceability

✓ The lab needs to demonstrate each point with examples

✓ Students need to apply procedures to their own work

Jorhem 2000. *Accred. Qual. Assur.* 5, 449-450

## Teaching of traceability with QC sample

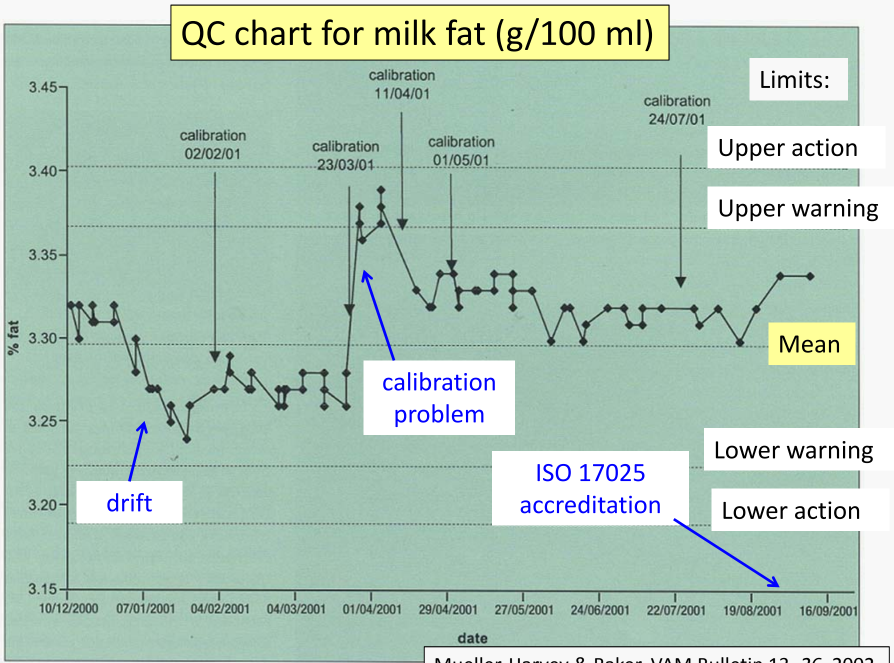



QC chart demonstrates that analysis is "in control"

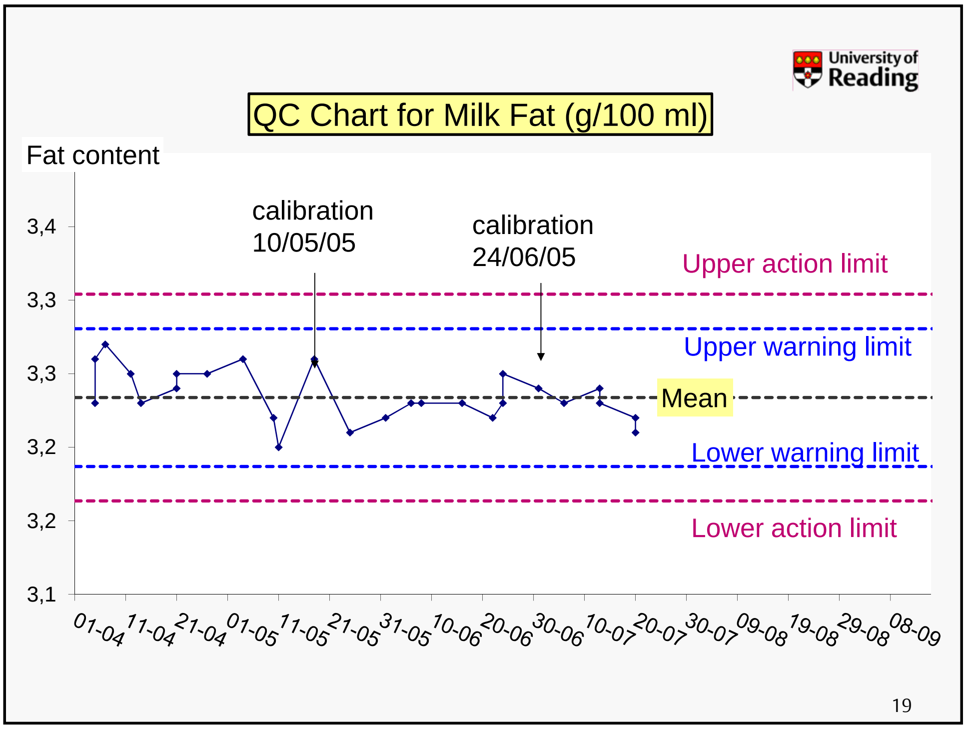
➢ **In Control !**



## QC chart for milk fat (g/100 ml)




Mueller-Harvey & Baker, VAM Bulletin 13, *26*, 2002



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QC Chart for Milk Fat (g/100 ml)
Fat content
calibration 10/05/05
calibration 24/06/05
Upper action limit
Upper warning limit
Mean
Lower warning limit
Lower action limit
3,4
3,3
3,3
3,2
3,2
3,1
01-04
11-04
21-04
01-05
11-05
21-05
31-05
10-06
20-06
30-06
10-07
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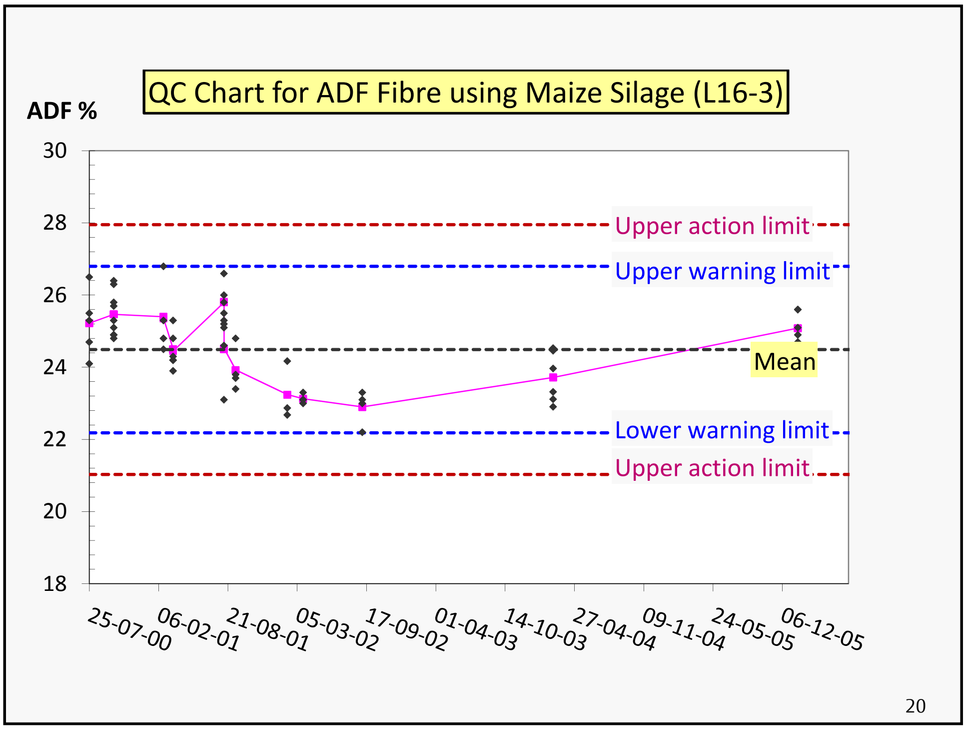
30-07
09-08
19-08
29-08
08-09



QC Chart for ADF Fibre using Maize Silage (L16-3)
ADF %
30
28
26
24
22
20
18
Upper action limit
Upper warning limit
Mean
Lower warning limit
Upper action limit
25-07-00
06-02-01
21-08-01
05-03-02
17-09-02
01-04-03
14-10-03
27-04-04
09-11-04
24-05-05
06-12-05

## Simple measures for universities

- Lab books: Need to be understandable by others;
  Ensure traceability of samples, results
  Methods, if under development, which version?
- Lab register: Unique numbers for plant samples
- Extracts/processed samples:
  Each researcher has unique ID numbers in fridges/freezers



## Simple measures (cont.)

- Freezers, fridges, incubators, ovens, muffle ovens:
  Annual checks using a flexible wire.
  Keep thermometer in fridge.
- Deionised water system:
  Logbook records when cartridge exchanged.
- Instruments: Internal or external service (how often?).
  Calibration (how often?).
  Performance tests: leak tests for gases, liquids; pressure readings; test clock.
  - Have annual service stickers on instruments
  - Have logbooks next to each instrument
  - Makes it easy to complete QC paperwork

# Simple measures (cont.)

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- Glass pipettes: All checked when donated to lab.
- Auto Pipettes: Checked before use; occasional service.
- Balances: Annual service; check before each use with IRM check weights;
  record each check in log books

- Thermometers: Calibrate one – then check all others against this master
  Keep all thermometers in 1 drawer & compare.



# CRMs *versus* In-house Reference Materials

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http://museum.nist.gov

→ find your own!


http://www.polygonblog.com/japanese-3d-zen-stones/

http://www.fleaglass.com


http://www.connect2group.com.au/wp-content/uploads/2010/03/Stepping-Stones.jpg

## Table used for check weights

Our balance logbooks contain acceptable ranges

- Makes it easy to decide whether:
  - re-calibration necessary
  - balance is ok

**Reading of check weights following Eastleigh Instrument service & calibration on 16/07/2007**
Balance BAL 2 Sartorius AC 210 S S.N. 20402794
Calibrated range 0 – 200 g
Acceptable limits for weights of SET 2
(checked on 3/08/07)

| Nominal weight | Weight found after calibration | Acceptance range |
|---|---|---|
| 50.0000 | 49.9984 | 49.9979 – 49.9989 |
| 20.0000 | 20.0006 | 20.0001 – 20.0011 |
| 10.0000 | 10.0003 | 10.0001 – 10.0005 |
| 5.0000 | 4.9984 | 4.9982 – 4.9986 |
| 2.0000 | 1.9998 | 1.9996 – 2.0000 |
| 1.0000 | 0.9999 | 0.9997 – 1.0001 |

## What else do we do?

- Lab network: Contains SOPs, current/agreed methods, QC charts, information on acceptable SD-values.
- Use duplicates/triplicates: Depends on method.
- Technician *versus* young researchers: Compare results on real samples.
- Use QC sample: For training to demonstrate proficiency.
- Choose appropriate QC sample: Make our own IRM.

# In-house Reference Materials (IRM)

http://www.chuckkruger.net/reek.jpg

http://sainfoin.eu

We make all our own IRM!

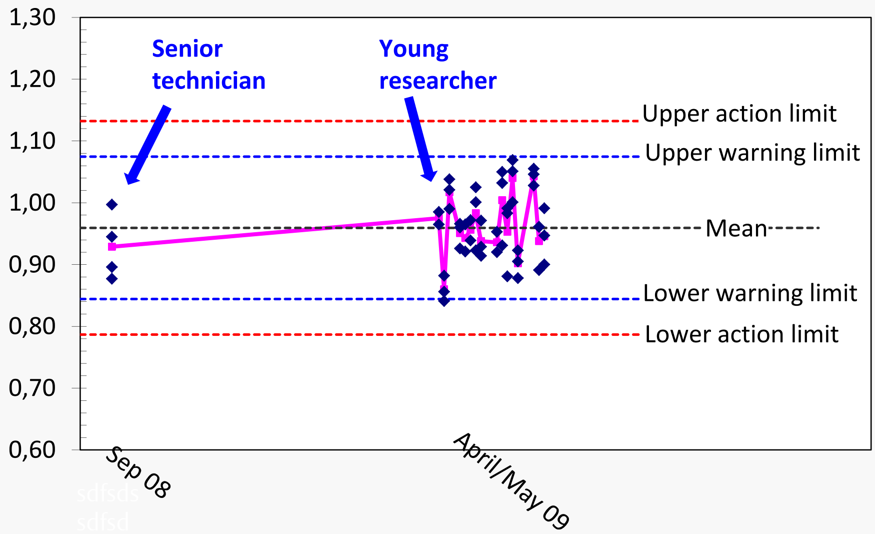
- Costs time
- But generates enough material

Walker & Brookman 1998. Guidelines for the in-house production of reference materials.
http://www.nmschembio.org.uk/



## *Ad hoc* QC chart for condensed tannins (HCl-butanol method)

Abs.
at 550 nm



## Code of Practice for Research

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- for research grants funded
- by
- UK research councils
- and
- government ministries
- (e.g. Agriculture, Environment, Food Standards Agency)

http://www.bbsrc.ac.uk



## Code of Practice for Research

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| | |
|---|---|
| 1. Responsibilities: ISO Ref 4.1, 5.2 | 1. Organisation structure showing line management |
| 2. Project planning: ISO Ref 4.2, 4.3, 4.4, 5.4, 5.6, 5.8 | 2a. Up-to-date study plans with milestones<br>2b. Statistical validation of experimental plan & procedures for data analysis<br>2c. Approved procedures for sampling<br>2d. Ethical approval documentation and licences |
| 3. Staff competence: ISO Ref 4.1.5 | 3a. CV's<br>3b. Training records |
| 4. Health & Safety: | 4a. Safety policy<br>4b. Documentation (e.g. pathogenic organisms, toxic chemicals) |
| 5. Facilities & equipment: ISO Ref 5.4, 5.6 | 5. Maintenance and calibration records of equipment used in research project |

## Code of Practice for Research

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| | |
|---|---|
| 6. Documentation of procedures & methods: ISO Ref 4.2, 4.3, 4.4, 5.4 | 6a. Approved Standard Operating Procedures<br>6b. Document control procedures |
| 7. Research or work records: ISO Ref 4.12 | 7a. Signed laboratory notebooks or indexed computer data files<br>7b. Archiving schedules & retrieval processes |
| 8. Handling of samples & materials: ISO Ref 5.8 | 8a. Procedures for receiving, labelling and tracking samples<br>8b. Storage log-books, sample register or LIMS system |
| 9. Quality Control: ISO Ref 4,13, 4,14, 5.4, 5.6, 5.9, 5.10 | 9a. Internal project reviews and auditing procedures for the research<br>9b. Approved publication policy with authorisation procedures |



## Summary

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**Code of Practice for Research**

- 'Has no teeth'
- Is limited in scope and rigour
- Irregular and infrequent inspections
- Standards tend to lapse after initial efforts…

**)utside inspections:**

)o have teeth', e.g.

- UK teaching assessments
- UK research assessments
- Health & Safety legislation
- ISO 17025 accreditation

What can we do now?

- Embed ethics & IQC into the lab culture
- Implement simple measures/processes

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## Conclusions

IQC including the 'Code of Practice for Research' need to be

- Taught in university laboratories
- Formalised, implemented and embedded
- Subjected to regular inspections



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## Thank you

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UKAP UK Analytical Partnership

- B. Woodget

Hefce Improve Project