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The Core Elements of a Strong Laboratory Management System

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The core elements of a strong laboratory management system

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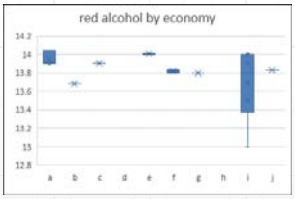
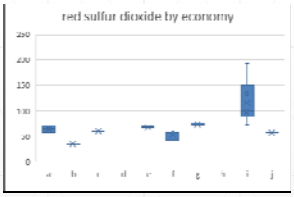
Wine analysis, still required.

- Efforts are continuing to reduce the level of regulation for the movement of wine between markets
- The amount of some wine components, however, still does feature in some regulatory structures for the import and sale of wine in some economies.
- Because of this analytical testing of wine is still a component of moving wine between some economies.
- For this reason it is important that there is confidence that the results between laboratories in different economies provide equivalent and comparable results.
- This is critical to ensure that product meets the various regulatory requirements before it is shipped to the end market.
- Also to avoid disputes once a product is in market

The unfortunate reality

Analyte	units	N	Mean	StDev	Min	Median	Max
Alcohol	% V/V	17	13.81	0.25	13	13.9	14.04
Sulfur Dioxide (total)	mg/L	18	79.20	36.61	36	69.72	194
Titratable acidity (endpoint 8.2)	g/L (tartaric acid equivalents)	14	6.59	0.41	5.95	6.475	7.72
Titratable acidity (endpoint 7.0)	g/L (tartaric acid equivalents)	13	5.87	0.32	5.25	5.84	6.7
Reducing Sugars	g/L	11	4.51	1.39	1.83	4.8	6.8
Glucose + Fructose	g/L	10	2.24	0.53	1.65	2.155	3.5
Copper	mg/L	14	0.31	0.10	0.073	0.346	0.4
Iron	mg/L	11	1.47	0.35	0.58	1.56	2
Manganese	mg/L	10	1.77	0.38	1.092	1.685	2.61
Methanol	mg/L	8	224.40	40.90	177	213.1	300





EW1

Achieving good and consistent results

- To reduce the impact of individual laboratories variations
- And to ensure that individual laboratories are producing meaningful results which are fit for purpose
- Requires adherence to a relatively simple set of principles and ensuring a proper understanding of the impact of specific matrices such as wine.
- In the following slides we will discuss 12 elements of these principles with specific reference to the requirements in wine testing.

Slide 4

EW1 Eric Wilkes, 11/05/2017

1. Sample management

- Wine samples will change over time in relation to many of the analytical parameters use in regulatory environments.

All wine analysis should be done on freshly opened samples less than 6 hours after opening.

- Wine in all storage vessels will change analytically over time.

Wines which are stored long term (months to years) in their original packaging can be expected be expected to have changes in SO_2, colour and organic acids.

- Once opened sample degradation can be relatively swift (minutes to hours).
- SO_2, dissolved CO_2 and O_2 and alcohol can be impacted by having open samples.

A1

Wine samples should be stored in sealed non-ullaged containers.

1. Sample management

- Refrigeration can also impact a number of key analytes, particularly organics acids, pH, titratable acidity, colour and metals.

Wines should only be stored refrigerated or frozen when absolutely necessary and after appropriate validation.

- Most wine analysis is temperature dependent and should be done at 20ºC.

Wine sample should be allowed to equilibrate to 20ºC before opening and analysis unless the method specifically requires.

- Samples for analysis of CO_2 need to be stored refrigerated for at least 24 hours before analysis to allow equilibrium of the dissolved gas.

Slide 5

A1 I don't know what "unalleged" means. Recommend deleting or replacing this word.
Author, 06/05/2017

2. Appropriate methods

- Wine is very complex mixture of different components.
- Methods must be appropriate both for analyte being tested and for product that contains it.
- A classic example is the testing of wine sugars.
- The general Codex method for sugars relies on the ability of the many sugars to reduce aqueous copper solutions in an alkaline environment.
- Wine contains significant amounts of other non sugar component which also share this characteristic, meaning that such methods will give an unrealistically high value.
- Another sugar sometimes found in wine (sucrose) does not reduce sugars and so is not detected by this method.

Methods used for wine analysis should, where possible, minimise the interference from other wine components.

3. Matrix dependency

- Even when the method is considered appropriate, different wines (red, white or sparkling) can lead to different outcomes for the same test.
- For example measuring SO_2 using an iodic titration method (Ripper) works relatively well for white wines, however the colour components in reds interfere significantly and must be decolourised.
- In titratable acidity there is a degassing step which work well for still wine, but is not appropriate for sparkling and must be modified.

Analytical methods for wines must take into account the impact of matrix effects of the individual product type, red/white, still/sparkling, sweet/dry

- Methods also need to account for interference by potential additives such as A2 ascorbic acid.

Slide 8

A2 would be useful to say which analytes ascorbic acid would interfere with using what technique

Author, 06/05/2017

4. Method validation

- It cannot be assumed that an analytical method as generalised in a reference or text will work with all matrixes or with the individual equipment or environment available in a given laboratory.

When testing wine it is imperative that methods developed for other food or beverage types are specifically and formally validated for all the wine matrices to be tested.

- At the very least this should involve:
  - Duplicate samples done on different days.
  - Comparison of results from other laboratories,
  - Spiked samples and known reference samples,
  - Studies to understand the impact of different wine types/matrices,
  - Linearity of response across the known range of the analyte,
  - Development of the limit of detection

5. Analytical limits

- A common issue with much wine analysis is the range of values that can be found for a given analyte.
- SO_2 measurements can range over 2 orders of magnitude (5 to 350 mg/L).
- Similarly, sugar can range from 0.5 to 300 g/L.
- Very few analytical methods are linear for these kinds of ranges and procedures must be in place to ensure sample pre-treatment for samples that fall outside the linear range of the method.

Analytical methods must have suitable procedures to ensure that the samples fall within the validated scope of the method.

- In the case of wines this can often be managed by having a knowledge of the wine type and identifying pre-treatment or different procedures based upon this.

6. Understanding your limits, Uncertainty of Measurement

- It is a well established fact that even using the same procedures, results will vary between laboratories.
- This comes about because of small differences in equipment, environment and the influence of the analyst.
- For this reason, during the validation process it is important that a Uncertainty of Measurement (UoM) be developed for the method.

All analytical results should be accompanied by an uncertainty of measurement.

- This data allows the results to be understood in context of the sample.
- If the analysis is being done regularly it is often simplest to regularly test the same wine (check sample). Analysis of the variation in results for this sample can give a well defined UoM.

7. Quality control / assurance samples

- Many laboratories run samples in duplicate as a form of QA.
- However while useful it will not necessarily identify issue with equipment or procedures.
  - If something is wrong for the original it can also be wrong in the repeat.
- In wine analysis a more reliable procedure is to run a regular known wine sample.

All wine analysis should be performed with regular check samples of a known wine.

- A good level of check is every 10^{th} sample or at the beginning and end of each run if doing less than 10 samples.
- Control limits can then be set to decide if results should be accepted.
- A calibration standard should **never** be used as a check sample.
- Cask wines often work as suitable standards.

8. Control charting

- Identifying progressive changes or failures in a method is very important.
- The most important tool in this process is the use of control charts.

All analytical procedures should have a control chart showing the variation in results for known samples.

- The obvious result to chart is the check sample discussed in the previous slide.
- It can be physically or electronically graphed each time it is done.
- Statistical limits can be set as triggers for out of specification procedures.
- The control chart can also be used to generate rigorous UoMs for a given procedure.
- If regularly doing different matrices having check sample of each is considered good practice.
- Even if a procedure is not regularly done in a laboratory, the check sample should be run on a regular basis and charted.

9. Proficiency programs

- While internal checks and validations are powerful tools, they do not necessarily identify lab bias.
- This is a bias that may be present because of an unidentified issue with the procedure or its application to a specific matrix.

For this reason it is vitally important that laboratories participate in proficiency testing programs where they compare their results to other laboratories on the same sample.

- These programs provide assurance that the results obtained fall within the expected range for that sample.
- They also give a good indication of the realistic levels of accuracy that is achieved throughout the participants.
- Statistical limits can be placed on the results to trigger investigations into compliance.
- There are major wine based PTPs available with APEC sponsoring participation for participating economies.

10. Staff qualification / training

- No analysis is truly totally automated.
- To a greater or lesser extent it always relies on physical input or supervision by staff.

All staff who participate in the provision of analysis should be suitably trained and regularly qualified against written procedures.

- Training should always be done by other qualified staff.
- All staff should regularly requalify with a method to ensure that they are aware of any changes and maintain there skills.
- A very good system is that all staff regularly get together and run a check sample to ensure that the procedure is being carried out consistently.
- In wine it is also important that training include an understanding of the different wine types and matrices that may be encountered and the provision that needs to be made for each.

11. Internal auditing

- Once procedures have been developed it is important that they be continually monitored, this is the role of internal auditing.

All analytical procedures must be regularly audited to ensure that they are consistently carried out against written procedures.

- The audit can be done simply by another staff member monitoring the test being done by an analyst to determine if it is being done as it is written in the procedure.
- Each procedure should be audited at least on a yearly basis.
- If deviations from procedures are found, then corrective action must be taken.
- If the corrective action shows that the deviations improve the procedure (and is supported by validation), then the procedure should be changed.

12. A single quality management system

- To use a very old adage: if it is not written, then it is not done.

All aspects of analysis should be documented in a single quality manual which is regularly reviewed.

- This manual at the very least should document;
  - Actual analytical and sampling procedures
  - The scope of samples that they are validated for
  - Quality control and assurance procedures
  - Corrective action procedure
  - Training procedures

- It is important that the quality manual apply to all testing in the laboratory and not just special cases.

Internationally recognised accreditation

- The ultimate step in developing a laboratory quality system is to seek accreditation to an internationally accepted standard.
- The relevant one for wine testing is ISO17025
- Accredited laboratories must have demonstrated their ability to meet the requirements as set out in the standard.
- Results form such laboratories do carry a high level of confidence that they meet the levels of accuracy and precision as set out in the associated UoM.

Next Steps

- To help laboratories implement the principles discussed above we will be holding a number of virtual workshops for APEC wine testing laboratories.
- They will be focussed on
  - The practical aspects of wine testing.
  - Implementation of specific wine testing methods
  - Best forms of QA/QC
  - Results from the APEC ring testing program
  - Standardisation of wine test methodologies
- The first virtual workshop will be held in June of this year.