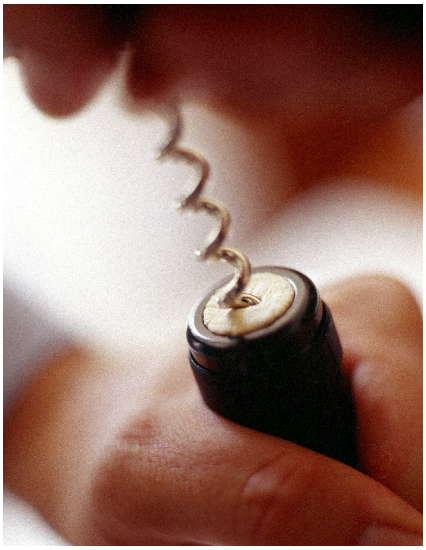
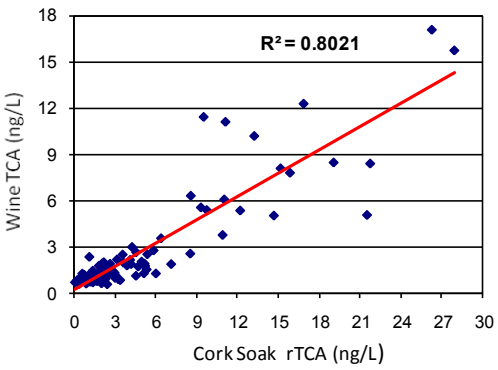
Group Cork Soaks Predict Tainted Wines



In the 2000 study sponsored by the CQC and conducted by ETS Laboratories, wine bottles were sealed with corks that had been individually tested for releasable TCA (RTCA). Subsequent analysis of the bottled wine displayed a high correlation between RTCA in the cork and TCA in the bottled wine. After 14 months the average bottle contained 51% of the RTCA value found in the cork. The correlation was good, with an R^2 value of 80%.

Correlation of TCA from individual corks and bottled wine after 14 months.



This data was used to justify the validity of using group soaks as a screening tool that accurately indicated the potential ability for a cork population to introduce TCA into bottled wine. The tool has since been widely used by both the cork industry and wineries.

In 2006 the American Vineyard Foundation sponsored a research project conducted by ETS Laboratories to verify the validity of using group cork soaks as a predictive tool. Their report "Evaluation of a Quality Control Tool for Predicting the Distribution of 2,4,6-Trichloroanisole in Bottled Wines" supports the use of group soaks as a quality control tool.

The report concludes, "This study demonstrates clearly that cork's RTCA is a good predictor of TCA transfer to bottled wine, at least within several months. It also shows that RTCA tests from group cork soaks, if applied in large scale QC programs, can reduce dramatically the occurrence of both "muted" and "corked" bottles in the marketplace."

In the AVF study, cork bales were screened using 50-cork group soaks in a similar manner to the CQC protocol. Bales were classified by the average TCA value determined from 10 fifty-cork group soaks. The study included a range of corks that ran from an average of <1.0ppt to over 7.0ppt. There were a total of 10 bales selected for the study, but only three of bales had TCA scores within the acceptable range of CQC requirements.

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Screening Standards

At the end of 2008 CQC members adopted new acceptance standards for their cork screening protocol. These standards call for any group cork soak with RTCA concentrations of 1.5ppt to be flagged as "non-conforming". The CQC protocol is based on the ISO-2859 sampling model that accepts or rejects a group of items based on the number of non-conforming individual samples taken from the group.

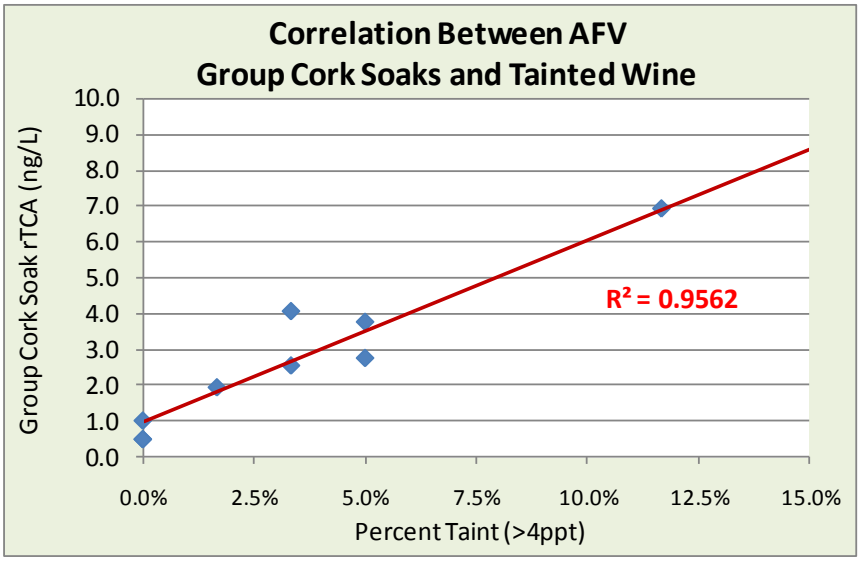
In the case of CQC cork soaks, the inspection group is a cork "lot" – defined as a single grade of cork, from the same supplier batch, shipped on the same container. For a typical cork lot of 100,000 corks there are 20 bales of 5,000 corks. Many CQC members utilize expanded sampling plans, but the CQC minimum is Level 2 – the second highest inspection level outlined. For 20 cork bales, Level 2 inspection requires 5 samples. CQC members will create 50-cork group soaks from each bale sampled.

Lot acceptance is based on the number of non-conforming samples. CQC members use the AQL (Assured Quality Level) of .04. In general terms this means that there is a 96% probability that an accepted lot will have mean RTCA concentration below the flag level of 1.5ppt. For lots with up to 8 samples – there can be no flags for acceptance. For lots requiring between 8 and 20 samples – one flag is permitted.

The CQC Sampling Protocol has undergone multiple changes since its inception. In each instance, standards have been tightened and improvements have been manifest.

Group Cork Soaks Predict Tainted Wines

Bottled wines were segregated by cork bale and tested for TCA at intervals ending at twenty months. The results after twenty months showed a distinct correlation between the RTCA measured in group cork soaks and TCA found in the bottle. With an R^2 value of over 95% the predictive value of group cork soaks was well established.



From a practical standpoint, three of the ten bales tested in the AVF Study would have been accepted under current CQC protocol (A, B & C). Sixty bottles from each lot were tested at 14 months. Of the total 180 bottles in the three acceptable lots, 179 contained no reportable TCA. The only bottle that had a reportable concentration showed TCA concentration at 1.6 part per trillion.

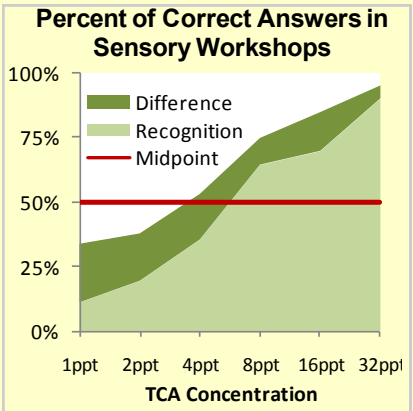
Of the seven sample lots that would have been rejected by CQC Protocol, three are displayed below. They had an average RTCA score of 4.33ppt in group soaks and generated 12 bottles with TCA over 4ppt — for a 6.6% taint rate.

Bale	Releasable TCA from Group Soak	TCA Detected In Bottled Wine				
		<1.0ppt	1-2ppt	2-4ppt	4-8ppt	>8ppt
A	<1ppt	100%	0%	0%	0%	0%
B	<1ppt	100%	0%	0%	0%	0%
C	1.02	98%	2%	0%	0%	0%
Total Corks from Bales Passing CQC		**179**	**1**	**0**	**0**	**0**
		99.4%	**0.6%**	**0.0%**	**0.0%**	**0.0%**
E	2.56	88%	5%	3%	3%	0%
G	3.78	88%	5%	2%	3%	2%
I	6.95	83%	5%	0%	3%	8%
Total Corks from Bales Failing CQC		**156**	**9**	**3**	**6**	**6**
		86.7%	**5.0%**	**1.7%**	**3.3%**	**3.3%**

Sensory Detection of TCA in Wine & Soaks

TCA (2,3,6-trichloroanisole) is a highly volatile substance with sensory threshold levels commonly measured in the range of parts per trillion (ppt). Though individual sensitivity varies considerably, it appears that a range from 2ppt to 20ppt will include most anyone.

The CQC has conducted several studies to identify sensitivity to TCA in a variety of wines and cork soaks. Results consistently show that 50% of panelists can recognize TCA at a concentration of approximately 6ppt.



CQC studies were conducted with panelists drawn from the wine and cork industries. Studies focused on consumers indicate a higher threshold. Analysis of wines "sent back" at the restaurant maintained by the Culinary Institute of America revealed that its customers did not return wines unless TCA levels exceeded 10ppt.

Authors of the American Vineyard Foundation study have described four sensory levels based on the chemical concentration of TCA in wine. Wines with TCA at levels of 8ppt or higher were termed "corked", between 4-8ppt were "moderately tainted", between 2-4ppt "muted", between 1-2ppt were termed "possibly muted".

Test Results Should be Viewed in Context

Releasable TCA from group cork soaks represent the average RTCA of individual corks. But at the reduced RTCA levels seen in today's soaks, group scores are more valuable as an indicator of the number of outliers in an otherwise "clean" sample.

A 50-cork group soak with releasable TCA of 2.5ppt is more likely to represent a sample that has several high RTCA corks than represent a sample with 50 corks all with a TCA level of 2.5ppt.

After examining the data from over 150,000 group samples, CQC members have seen that there is generally a good correlation between individual bales within a single lot. We also see the occasional presence of a high RTCA bale score in an otherwise clean lot. When repeated testing is performed, we rarely see the high score duplicated except in lots where there are multiple flags.

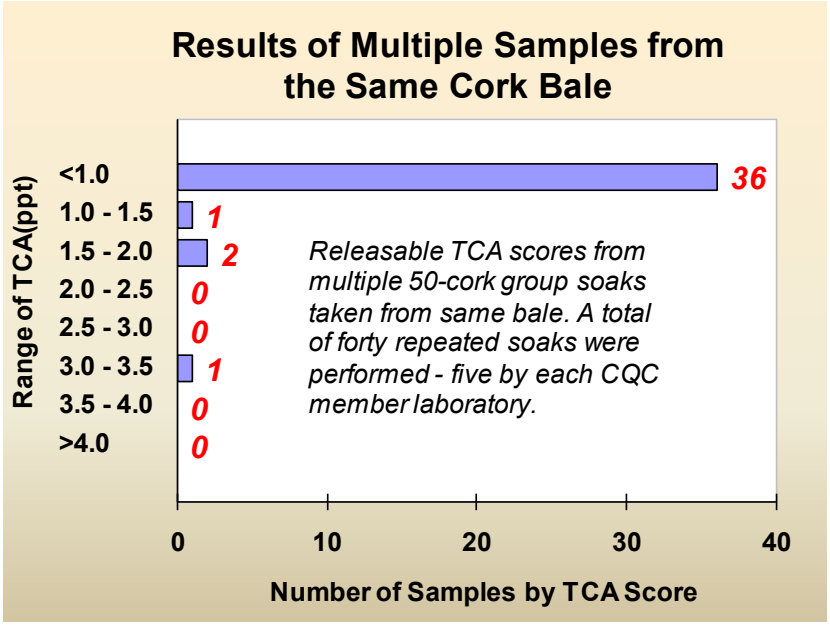
Today's determination of a faulty cork lot is marked by a high number of outlying individual corks. These outliers are unpredictable and can significantly alter the average of a 50-cork sample. That is why CQC members stress comparing multiple samples from the same lot.

The CQC screening protocol includes a flag level of 1.5ppt for 24-hour soaks. In a lot sampled with up to eight 50-cork soaks, a single flag will prevent the entire lot from acceptance. In lots with samples up to 20 soaks – one flag is permitted.

CQC members regularly conduct collaborative testing of soak procedures. The methodology calls for each CQC laboratory to conduct five 50-cork group soaks from the same bale. There are eight CQC members, so each collaborative test shows the results of 40 repetitive samples from the same bale. Over the last ten collaborative tests we consistently see a coefficient of variance of 25-35% among these 40 repetitive samples.

Causes of the variation are partially explained by analytical variance – demonstrating a CV of 10% and by simple population statistics. The 50 cork sample size is sufficient as a screening tool, but it is not large enough to provide a high-confidence average for a given cork bale.

That is why CQC members look at RTCA levels from individual soaks in the context of the entire lot. Taken as a single statistic – the difference between a RTCA value of 1.0ppt and 1.5ppt is not very revealing. In context, a lot with three scores over 1.5 ppt is a much more telling story.



Example Application

When reviewing sample scores, some wineries are tempted to go down the list of RTCA scores – accepting the low numbers and rejecting the others. This practice can lead to a false sense of security and unsatisfactory results.

Leaving aside the false positive, where wineries reject an individual bale due to differences in RTCA values within the normal range of variation, there is a great opportunity for false negatives.

It is quite common for an unacceptable lot to have numerous bales that do not display RTCA. If a winery accepts all of the low bales without viewing the performance of the entire lot, it is easy to purchase corks with an unsatisfactory level of outliers.

In this example, both Lot A & B show 15 bales — 12 of which have RTCA below 1.0ppt.

Lot A	
Bale	TCA from Group Soak
1	<1
2	<1
3	<1
4	1.2
5	<1
6	<1
7	2.1
8	<1
9	<1
10	<1
11	<1
12	1.1
13	<1
14	<1
15	<1
Lot **Accepted** under CQC Screening Protocol	

Lot B	
Bale	TCA from Group Soak
1	<1
2	2.4
3	<1
4	<1
5	<1
6	<1
7	<1
8	<1
9	2.3
10	<1
11	<1
12	<1
13	1.4
14	<1
15	<1
Lot **Rejected** under CQC Screening Protocol	

Lot A has one "flagged" score above 1.5ppt. It would be accepted under the CQC protocol. Lot B has two flags and would be rejected.

We expect that if this lot were retested there would be similar results — but with the flags appearing on different bales. The <1ppt bales from Lot A are assumed to be of higher quality than the <1ppt bales from Lot B.

Wineries should ensure that they purchase corks from a company that has conducted extensive testing at the lot level. Individual bale scores should be reviewed in the context of the entire lot.

The CQC Screening Protocol has been Adopted Around the World

The CQC screening protocol, developed by ETS Laboratories, marked a turning point in the fight against TCA in corks.

Previous detection methods were based on sensory perception. They were time consuming, inconsistent and non-quantified. Cork samples were evaluated as pass or no-pass. There was no way to recognize good suppliers, since clean corks were undifferentiated from corks having TCA just below the sensory limit.

With the advent of the chemical screening method, cork suppliers are able to precisely evaluate TCA to concentrations of 1ng/L (ppt).

This detection method is now employed by cork organizations in South Africa, Australia and South America. In Europe, the method is specified by the OIV, and there are dozens of GC/MS machines installed on behalf of cork producers.

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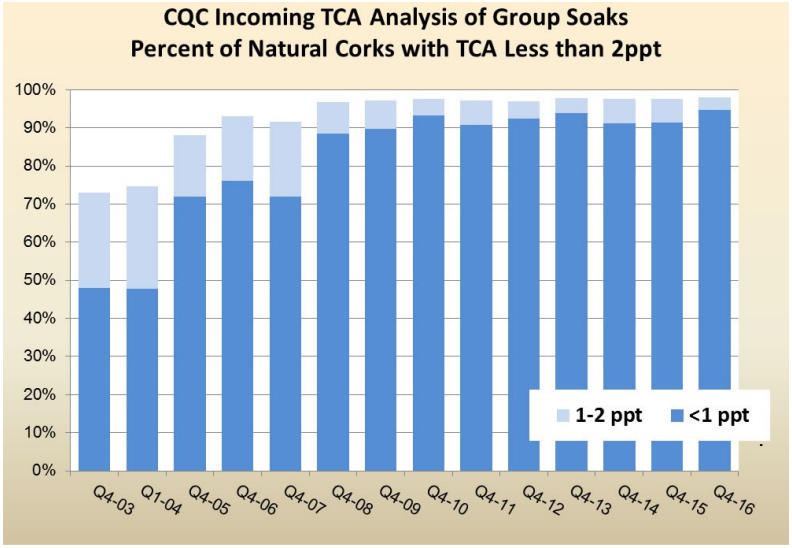
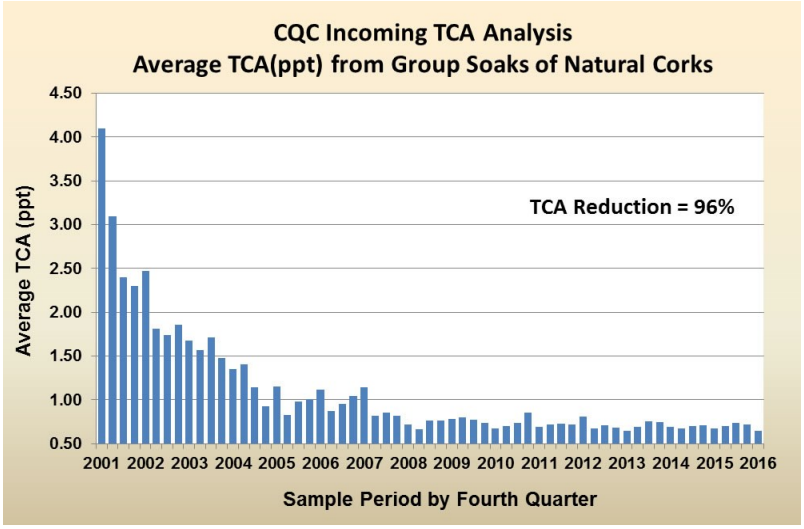
Historic Results

Since the Cork Quality Council adopted a program for chemical testing incoming shipments in 2001, it has tracked the RTCA scores from over 300,000 cork soaks. This rich source of data clearly demonstrates the reduction in TCA levels and quality improvements seen in cork shipments to CQC member companies.



Q4 test results with less than 1ppt RTCA accounted for 95% of a all incoming natural cork shipments in 2016 This is triple the percentage from 2002. The total of samples less than 2ppt was 98% in 2015. Current CQC screening guidelines flag any sample that scores over 1.5ppt.



2016 results from screening incoming cork shipments have shown an 96% reduction in RTCA since 2001. Please note that these figures include scores of all prospective shipments and include scores from cork lots that have been rejected. For statistical purposes, scores of <1ppt are tracked as 0.5ppt.