3. Results

The results are dealt with in several sections as they relate to:

- Wine Quality - statistically significant.
- Incidental to Wine Quality – statistically significant.

In this report, sulphur dioxide, dissolved oxygen and titratable acidity are abbreviated as SO_2, DO_2 and TA respectively.

WINE QUALITY - STATISTICAL SIGNIFICANT RESULTS

Free and Total Sulphur Dioxide (SO2)

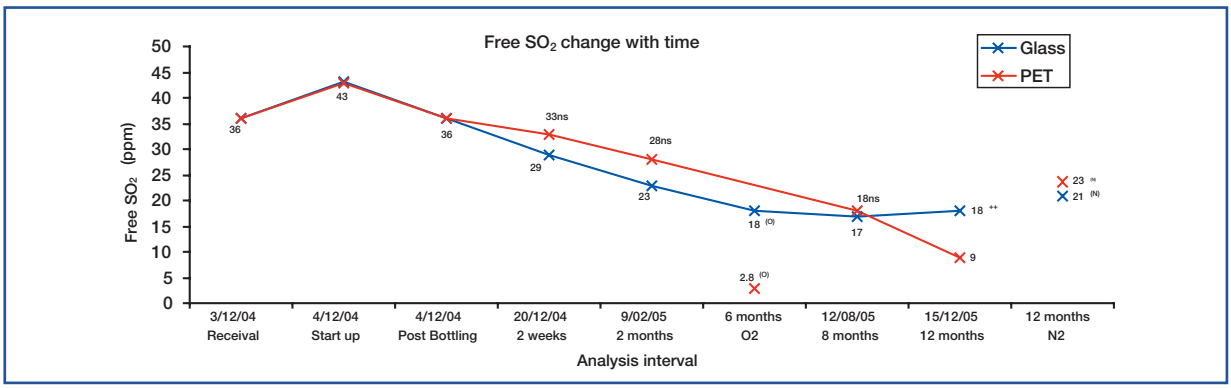

Figure 1: The change with time of Free SO_2 concentration of wine stored in glass and PET bottles. ++Statistically significant to 99% Confidence. (N) and (O) indicate that the measurements were taken on wine after the filled bottles were stored in either a nitrogen or oxygen enriched environment (≈100%).

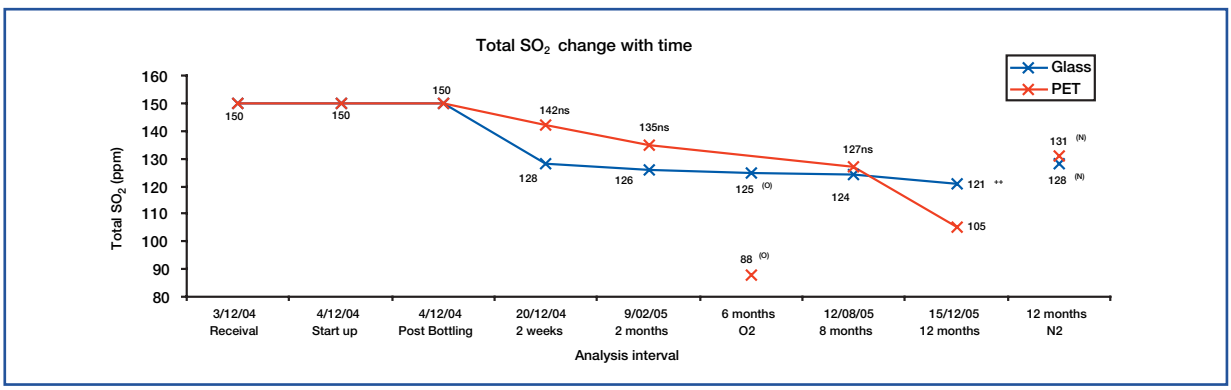

Figure 2: The change with time of Total SO_2 concentration of wine stored in glass and PET bottles. ++Statistically significant to 99% confidence. (N) and (O) indicate that the measurements were taken on wine after the filled bottles were stored in either a nitrogen or oxygen enriched environment (≈100%).

Ambient Conditions The free SO_2 and total SO_2 data for the trial is shown in figures 1 and 2, respectively. Initially, the concentration of free and total SO_2 is identical in both containers. As the trial progressed the drop in the concentration of free and total sulphur dioxide was more pronounced with wine in the glass bottles, than the PET, until 8 months. After that time, both the SO_2 levels in the PET bottles declined rapidly to a level lower than that of wine in glass.

Nitrogen Atmosphere The trends in the data at 12 months show that free and total SO_2 levels were highest in PET (N2) and lowest in Glass (air). The relevance of this observation is discussed in terms of the presence of Amfresh™ and seal of the screw cap.

Oxygen Atmosphere Wine in PET bottles which were kept in a 100% oxygen atmosphere declined to <5ppm by the 6 month sample interval. Levels of free SO_2 as low as 5ppm are not considered adequate for the preservation of wine. These wines were described in sensory terms as brown and tired (data not shown). In contrast, the level of free and total SO_2 of wine in glass bottles were similar, or marginally lower, when compared with the glass treatment under ambient conditions. This is discussed in terms of the hermetic quality of the screw cap – glass seal.

Dissolved Oxygen (DO_2)

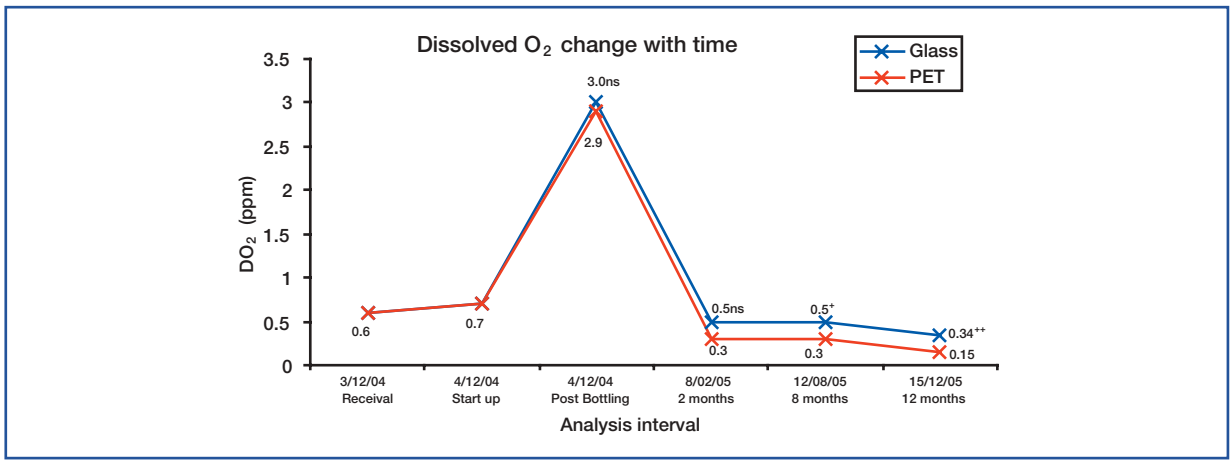

Figure 3: The change with time of Dissolved Oxygen (DO_2) concentration of wine stored in glass and PET bottles. +Statistically significant to 95% confidence. ++Statistically significant to 99% confidence.

The dissolved oxygen (DO_2) data for the trial is shown in figure 3. Initially, the concentration of dissolved oxygen in wine is identical in both container types. During bottling the concentration of DO_2 in both treatments peaked at about 3.0 ppm; a level considered high by industry standards. In some respects it was serendipitous that both treatments commenced the trial with, effectively, the same level of DO_2. As the trial progressed, a drop in the concentration of dissolved oxygen occurred in both treatments. The drop was always more pronounced in wine in the PET bottles compared with glass such that at 12 months the confidence level for this result was 99%. The lower level of DO_2 in wine in PET bottles compared to glass is discussed with the behaviour of SO_2 and the role of Amfresh™ (the oxygen scavenger) in the PET bottle.

Organoleptic changes to wine based on container type

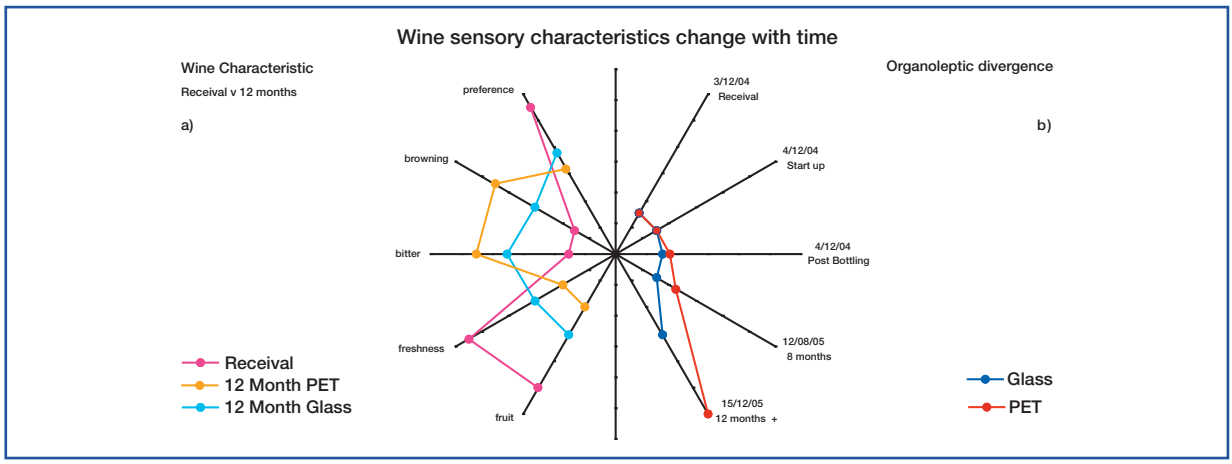

Figure 4: a) The change in Wine Characteristics of wine at receival compared with wine stored for 12 months in glass and PET. b) The organoleptic divergence of wine stored in glass and PET bottles with time. +Statistically significant to 95% confidence.

DATA PRESENTATION

It can be difficult to graphically present subjective results such as wine flavour and other wine attributes.

Figure 4 is an attempt to pictorially present such data and the way to read it is as follows:

- black lines (spokes) of the 'wagon wheel' or 'flavour wheel' are the wine attribute examined.
- a value on the black line close to the centre of the diagram is a 'low' result and a value furthest away from the centre is a 'high' result.
- example, Figure 4a Wine Characteristics (LHS) BROWNING receival sample was least brown and 12 month PET was most brown with glass showing some browning.
- example, Figure 4b Organoleptic Divergence (RHS) 8 MONTHS wine in PET was trending to be more divergent from that packed in glass, although the result was not statistically significant. In other words some tasters could begin to detect differences in the taste of the wine but it was not significant (+) until 12 months from bottling.

INTERPRETATION

The change over 12 months in taste of the wine in glass and PET is presented as Organoleptic divergence in Figure 4b. Organoleptic divergence of wine in each treatment was similar at post bottling. There was evidence of a trend at 8 months that PET was different from glass, however only some experienced tasters could consistently detect a difference – the majority of tasters were unable to reliably detect differences between the treatments at 8 months from bottling. At 12 month sample interval, wine in PET and glass were readily identifiable by most tasters as determined by triangle testing (significance of 95%). Despite that level of significance, there was no consensus with the tasters as to the preference for wine in PET or glass.

The change over 12 months in certain wine attributes of the wine stored in glass and PET is presented as Wine Characteristics in Figure 4a.

Very small, if any, differences in wine characteristics existed between treatments at 8 months (data not shown; sample size was too small for significant results). In contrast, at 12 months, wine in PET was showing more age or development because it was less full and fresh and more bitter and brown, compared to wine in glass. Both treatments exhibited aged characteristics compared to the wine when received. Also demonstrated in this figure is an indication of the number of people who preferred each treatment. It is interesting to observe that wine in PET and glass containers have almost equal numbers liking each, with only 56% of tasters preferring the Glass container (Figure 4a, 'preference').

INCIDENTAL to WINE QUALITY – STATISTICALLY SIGNIFICANT RESULTS

Attributes of opening torque, alcohol concentration, titratable acidity and turbidity are considered.

Torque

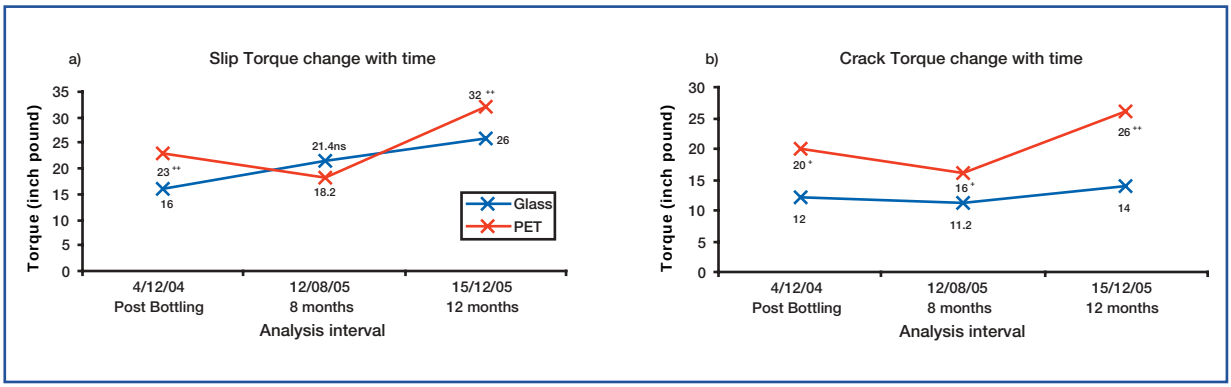

Figure 5: Changes with time of a) slip (seal) opening torque and b) crack (pilfer proof) opening torque of glass and PET bottles filled with wine. + Statistically significant to 95% confidence. --++ Statistically significant to 99% confidence.

As observed in figure 5, torques related to opening the bottle (slip) and breaking the pilfer-proof bridge (crack) are significantly higher with the PET bottles, than glass, at all sample intervals with the exception of seal torque at 8 months. This observation was considered incidental to the any effects on wine quality since all torques were adequate and within specification of each of the manufacturers (Amcor PET bottle; Auscap screw cap). Thus no influence was expected from torque characteristics. One reason for why the PET torque might be higher than for screw caps on glass is that the anti-scuff coating on glass ensures a more slippery surface on which the screw cap can work during opening.

The results of analysis of % alcohol, titratable acidity and turbidity for the trial are presented in figures 6, 7 and 8 respectively below:

Alcohol

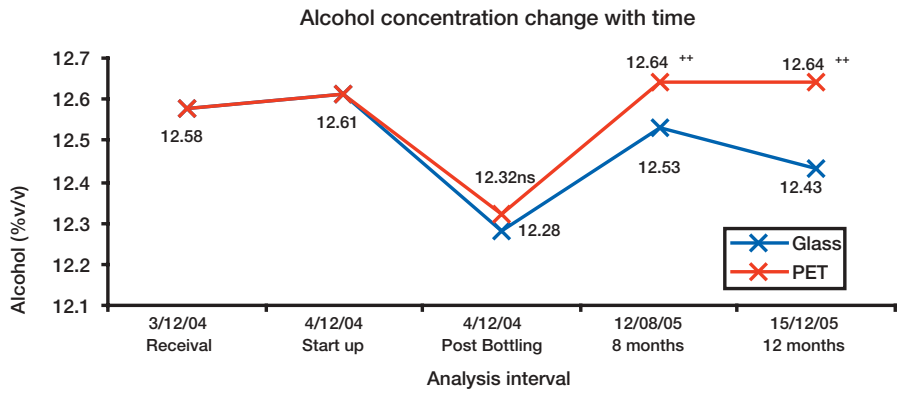

Figure 6: The change with time of Alcohol (%v/v) concentration of wine stored in glass and PET. ++ Statistically significant to 99% confidence.

Titratable Acidity

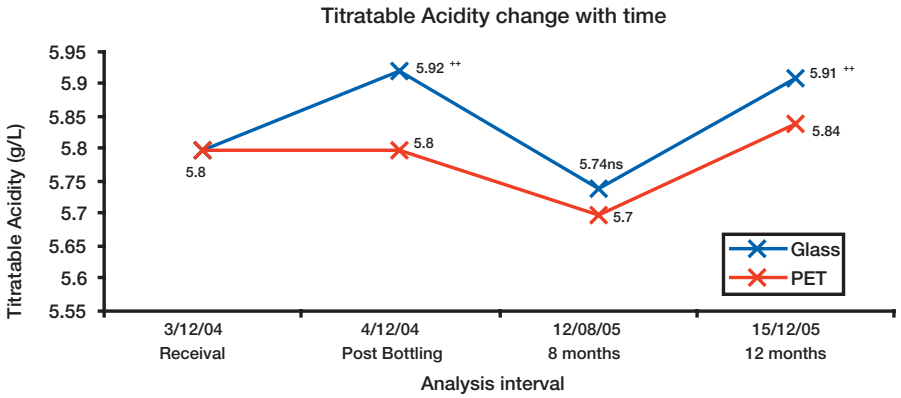

Figure 7: The change with time of Titratable Acidity (TA) of wine stored in glass and PET. ++ Statistically significant to 99% confidence.

Turbidity

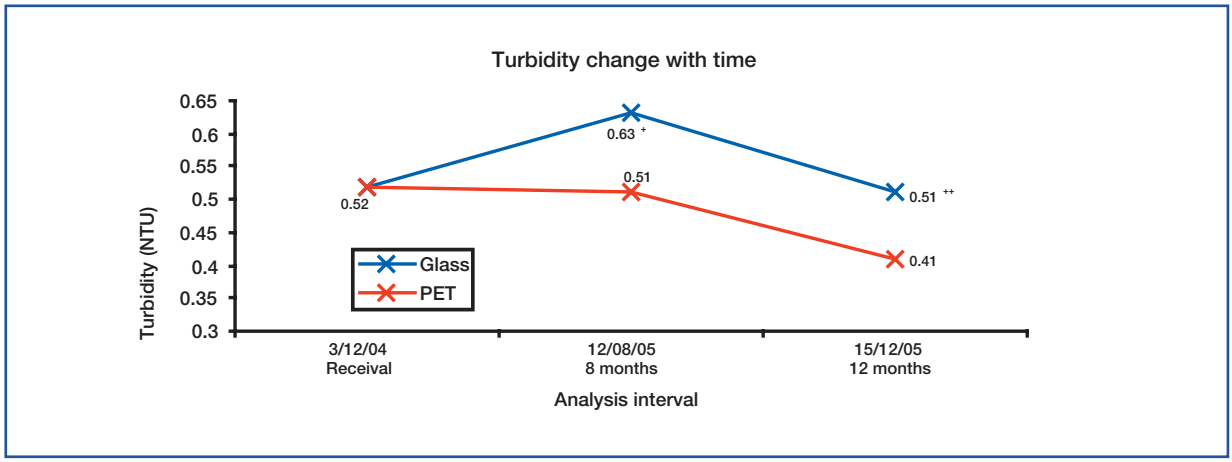

Figure 8: The change with time of Turbidity (NTU) of wine stored in glass and PET. + Statistically significant to 95% confidence. ++ Statistically significant to 99% confidence.

It was interesting to note that, from post bottling analysis and for the duration of the trial, alcohol concentration was higher, and levels of titratable acidity and turbidity were less in wine in PET compared to glass. These observations were statistically significant to 99% confidence at the 12 month sample interval. The most likely explanation for alcohol% to be less in the glass treatment was that it was the only bottle which could be handled into the rinser and it is residual rinse water which diluted slightly but significantly the wine in that treatment. Whether this fact had any bearing on the titratable acidity and turbidity is unclear.

The pH was measured at all sample intervals throughout the trial. The results, however, indicate that there was no significant difference between the two treatments (Data not shown).

The vacuity of the Amcor PET 187mL bottle was found to be approx 200mL at the same fill height (ullage) of the ACI glass187mL bottle. The PET bottles were supplied by Amcor who have taken steps since the beginning of the trial to remove volume and redesign the claret bottle to 187mL fill volume.