

# Sensory Evaluation Report for the one-way PET keg

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Discrimination tests are commonly used in sensory evaluation to determine any perceptible differences between two types of products. In a triangle test three samples are presented, two being the same and the latter being different. The task is to choose the sample that is most different out of the three.

An extra pale ale was conditioned and stored in two different kegs. Sample A represents beer in the one-way PET keg and Sample B is beer in the stainless steel keg. Sensory evaluation in the form of a triangle test was conducted with the Keg King staff as participants. The aim was to determine if there is a significance difference in taste between the two kegs.



It is in the company's interest to prove that the two kegs provide the same beer-tasting experience. The statistical results in this report strongly support one-way PET kegs as a viable replacement for stainless steel kegs in the commercial beverage industry.

Both kegs were stored at 4°C for 2 months. The one-way PET keg was sanitised in 70% ethanol and the stainless steel keg in 0.2% phosphoric acid. A panel of 13 tasters evaluated the two beers. Each taster was presented six sets of three samples of the combinations ABB, BAB, BBA, AAB, ABA, BAA. From each set, the taster has a 33% of choosing the correct sample.

In choosing the correct sample, the most different beer, a confidence level of 95% is generally desirable for a result to be statistically significant. For instance, out of a total of 78 responses, a minimum of 34 correct responses is required to show that beers A and B are significantly different. In other words, there would be a 95% probability that beer A is different to beer B for the average consumer.

Test type	Triangle						
Number of tasters	13						
Use	Multi-purpose						
Samples	<p>Three test samples of the same beer type. Two samples are drawn from the same keg, and the latter drawn from the other keg.</p> <p>Sample A is beer drawn from a one-way PET keg. Sample B is beer drawn from a stainless steel keg.</p>						
Basic Method	<p>Tasters assess three beer samples and choose the odd one out.</p> <p>Each taster is served the following combinations. From each set, there is a 33% chance of choosing the correct sample.</p> <table><tr><td>Set 1: ABB</td><td>Set 2: BAB</td><td>Set 3: BBA</td></tr><tr><td>Set 4: AAB</td><td>Set 5: ABA</td><td>Set 6: BAA</td></tr></table>	Set 1: ABB	Set 2: BAB	Set 3: BBA	Set 4: AAB	Set 5: ABA	Set 6: BAA
Set 1: ABB	Set 2: BAB	Set 3: BBA					
Set 4: AAB	Set 5: ABA	Set 6: BAA					

Results for the triangle test are shown in the table below. Values for the minimum number of correct responses required for statistical significance were derived from Lawless and Heymann's 'Sensory Evaluation for Food'.

	six-set data	two-set data
Correct responses	28	8
Total responses	78	26
Minimum number of correct responses required to determine a significant difference with 95% confidence	34	14
Significant difference?	no	no

Out of a total of 78 responses, 28 were correct in identifying the odd sample. At a 95% confidence level, a minimum of 34 correct responses is needed to show a significant difference. Since 28 is less than 34, the data shows that statistically there is no significant difference between samples A and B.

During the tastings, several of the tasters were caught with fatigue upon the repetitive nature of the experiment. This was particularly noticeable after going through the first two sets. To circumvent this, data from Sets 1 and 2 was used to construct an arguably more accurate set of results. This time, 8 out of 26 responses were correct. A minimum of 14 correct responses was required for this data pool to establish a significant difference. Therefore, beer A is still not significantly different from beer B.

To further investigate the matter, an additional Chi-square distribution was conducted using data from the triangle test. This is another discrimination test to determine statistical difference between two products. The assumption here is all tasters had to make a choice regardless of whether they knew the correct answer or not.

The null hypothesis states that there is no distinguishable difference between samples A and B.

$H_0$  = Null hypothesis (A and B taste the same)

$H_0$ : A = B

The alternative hypothesis would be the contrary; beers A and B are distinguishable enough to be significantly different.

$H_A$  = Alternative hypothesis (A and B taste different)

$H_A$ : A  $\neq$  B

The Chi-square statistic ( $\chi^2$ ) compares observed data with expected data. In our case, the observed number of responses (both correct and incorrect) is compared against the expected number of responses (both correct and incorrect). This value is then compared against critical values in a Chi-square distribution curve to determine if there is a significant difference between the two samples. For a two-sided test, the risk of a Type 1 error is 5% (or 95% confidence).

$$\chi^2 = \sum \left[ \frac{(\text{Observed responses} - \text{Expected responses})^2}{\text{Expected responses}} \right]$$

If the Chi-square statistic is greater than the upper-tail critical value or less than the lower-tail critical value, then we reject the null hypothesis and accept the alternative hypothesis; that samples A and B are significantly different.

	six set data	two set data
$\chi^2$	0.231	0.0769
Upper-tail critical value	3.841	
Lower-tail critical value	0.004	

As shown in the table above, this is not the case.

From the six-set data:  $\begin{cases} \chi^2 = 0.231 < 3.841 \\ \chi^2 = 0.231 > 0.004 \end{cases}$       From the two-set data:  $\begin{cases} \chi^2 = 0.0769 < 3.841 \\ \chi^2 = 0.0769 > 0.004 \end{cases}$

We do not reject the null hypothesis, concluding that there is no significant difference between samples A and B. In other words, beer stored in a one-way PET keg tastes no different to beer in a stainless steel keg.

Based on our statistical findings from this experiment, we are confident in our one-way PET kegs replacing standard stainless steel kegs without compromising on beer flavour. However, more sensory tests will be necessary in the future as there is always room for improvement. There are numerous factors to work on next time, including:

- More participants: having a larger pool of data to work with in statistics can lead to more reliable results.
- More neutral beer: a lager would work better than a pale ale for a triangle test. Being neither pro-malt nor pro-hop, this makes it easier for tasters to point out distinctions between the two samples.
- Phosphoric acid sanitiser only: ethanol was used to sanitise the PET keg for technical reasons. For the sake of consistency, it would make sense to sanitise both kegs with the same chemicals; this being phosphoric acid as it has a much larger taste threshold and is less likely to affect beer flavour.
- Longer storage period: it would be worth looking into storing the kegs longer than 2 months, perhaps up to 6 months. This is especially relevant for the PET keg as it would be good to know how well the oxygen-barrier properties can hold up over an extended period.

At least two of the points should be considered for the next sensory evaluation. The findings in this report are merely a small step towards a potentially game-changing application.