ENZYMATIC ANALYSIS KIT FOR THE DETERMINATION OF GLUCOSE AND FRUCTOSE IN GRAPE JUICE AND WINE

PRODUCT
Product no. 4A140, for 30 tests, for in vitro use only.

PRINCIPLE OF MEASUREMENT
Glucose and fructose are the main sugars found in grape juice and wine and are determined enzymatically according to the following equations:

\[
\begin{align*}
\text{HK} & : \\
\text{Glucose} + \text{ATP} & \leftrightarrow \text{Glucose-6-phosphate} + \text{ADP} \\
\text{Fructose} + \text{ATP} & \leftrightarrow \text{Fructose-6-phosphate} + \text{ADP}
\end{align*}
\]

Glucose and fructose react with adenosine triphosphate (ATP) in the presence of the enzyme hexokinase (HK) to form glucose-6-phosphate (G6P) and fructose-6-phosphate (F6P).

\[
\begin{align*}
\text{G6PDH} & : \\
\text{G6P} + \text{NADP}^+ & \leftrightarrow \text{Gluconate-6-phosphate} + \text{NADPH} + \text{H}^+
\end{align*}
\]

G6P is oxidised by nicotinamide adenine dinucleotide phosphate (NADP) to gluconate 6-phosphate using glucose-6-phosphate dehydrogenase (G6PDH) enzyme as a catalyst. The amount of NADPH formed is measured at 340 nm and is stoichiometrically related to the amount of glucose consumed.

\[
\begin{align*}
\text{PGI} & : \\
\text{Fructose-6-phosphate} & \leftrightarrow \text{Glucose-6-phosphate}
\end{align*}
\]

Next, the enzyme phosphoglucose isomerase (PGI) is added to convert the F6P to G6P. The G6P now formed reacts with NADP and the NADPH determined is stoichiometrically related to the amount of fructose in the sample.

CONTENTS
The kit includes the following reagents:

<table>
<thead>
<tr>
<th>Reagent No.</th>
<th>Reagent</th>
<th>Preparation</th>
<th>Quantity</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Buffer</td>
<td>Add contents of Reagent No.2, Coenzymes, mix to</td>
<td>33 mL</td>
<td>18 months at 4°C</td>
</tr>
<tr>
<td></td>
<td></td>
<td>dissolve</td>
<td></td>
<td>6 months once combined</td>
</tr>
<tr>
<td>2</td>
<td>Coenzymes</td>
<td>Nil</td>
<td>0.2 g</td>
<td>18 months at 4°C</td>
</tr>
<tr>
<td></td>
<td>(ATP/NADP)</td>
<td>0.7 mL</td>
<td>18 months at 4°C</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>G6PDH/HK</td>
<td>Nil</td>
<td>0.7 mL</td>
<td>18 months at 4°C</td>
</tr>
<tr>
<td>4</td>
<td>PGI</td>
<td>Nil</td>
<td>0.7 mL</td>
<td>18 months at 4°C</td>
</tr>
<tr>
<td>5</td>
<td>Standard</td>
<td>Nil</td>
<td>3.3 mL</td>
<td>18 months at 4°C</td>
</tr>
</tbody>
</table>

The shelf life of Reagent 1 & 2 can be extended by placing aliquots in a freezer.
Do not freeze enzyme reagents 3 & 4.
Failure to store reagents at the recommended temperature will reduce their shelf life.
For concentration of Standard, refer to label on bottle.

SAFETY
- Wear safety glasses
- Do not ingest Buffer or Standard as they contain sodium azide as a stabilizer

PROCEDURE
Operating Parameters
- Wavelength: 340 nm
- Cuvettes: 1cm, quartz, silica, methacrylate or polystyrene
- Temperature: 20 – 25°C
- Final volume in cuvette: 3.04 mL
- Zero: against air without cuvette in light path
SAMPLE PREPARATION
Samples should be diluted with distilled water to ensure concentration in the assay solution is no more than 1.0 g/L. For the majority of dry wine samples, a 1 in 10 dilution is satisfactory. Semi-sweet wines may require a 1 in 20 or 1 in 50 dilution, while fortified and dessert wines may require a 1 in 100 dilution or greater.

As a general guide, further dilution is required if the absorbance reading is greater than 1 absorbance unit. Samples may be used directly without decolourisation. Filter turbid samples through Whatman No. 1 filter paper.

SAMPLE ANALYSIS
a. Pipette the following volumes of reagents into the cuvettes:

<table>
<thead>
<tr>
<th>Reagent</th>
<th>Blank</th>
<th>Standard</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffer</td>
<td>1.00 mL (1000 µL)</td>
<td>1.00 mL (1000 µL)</td>
<td>1.00 mL (1000 µL)</td>
</tr>
<tr>
<td>Distilled water</td>
<td>2.00 mL (2000 µL)</td>
<td>1.90 mL (1900 µL)</td>
<td>1.90 mL (1900 µL)</td>
</tr>
<tr>
<td>Sample/Standard</td>
<td>0.10 mL (100 µL)</td>
<td>0.10 mL (100 µL)</td>
<td>0.10 mL (100 µL)</td>
</tr>
</tbody>
</table>

b. Mix well and read absorbances, $A_1$, after 3 minutes.
c. Pipette the following reagent into the cuvettes:

| 3. G6PDH/HK | 0.02 mL (20µL) | 0.02 mL (20µL) | 0.02 mL (20µL) |

d. Mix well and read absorbances, $A_2$, after 10 minutes.
e. Pipette the following reagent into the cuvettes:

| 4. PGI | 0.02 mL (20µL) | 0.02 mL (20µL) | 0.02 mL (20µL) |
f. Mix well and read absorbances, $A_3$, after 10 minutes.

CALCULATIONS*
1. Calculate the Absorbance for the Sample for Glucose:

   Glucose Absorbance, $A_G = (A_2 - A_1) - (\text{Blank}A_2 - \text{Blank}A_1)$

2. Calculate the Glucose concentration as follows;

   Glucose Concentration (g/L) = $A_G \times 0.8637 \times \text{Dilution Factor}$

3. Do the same for the Standard by substituting the Standard absorbances in place of the Sample absorbances.

4. Calculate the Absorbance for the Sample for Fructose:

   Fructose Absorbance, $A_F = (A_3 - A_2) - (\text{Blank}A_3 - \text{Blank}A_2)$

5. Calculate the Fructose concentration as follows:

   Fructose Concentration (g/L) = $A_F \times 0.8694 \times \text{Dilution Factor}$

6. Add the Glucose and Fructose results to get the total sugar concentration

7. Precision (where $x$ is the glucose concentration in the sample in g/l):

   Repeatability $r = 0.056x$
   Reproducibility $R = 0.12 + 0.076x$

*A calculation spreadsheet is available for download at:

REFERENCES

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