also helps the brewer understand the malt's contribution to fermentable extract, pH, color, viscosity, and nitrogen content[2]. A wort sample with low turbidity is required to support later photometric testing. Gravity filtration using an appropriate filter paper supports all of these objectives.

CO_2 removal prior to further testing

During fermentation, CO_2 is produced and dissolves into the solution. When a QC lab prepares a sample of this solution for analysis, this dissolved CO_2 may lead to inaccurate results in tests such as total acid determination. Therefore, the CO_2 content needs to be minimized prior to testing. One method for achieving this is to pass the beer sample through an appropriate paper filter using gravity filtration.

Removal of yeast cells after fermentation

Measuring the total acidity of the final brewed product requires that the remaining yeast cells are removed. This simple separation of particulate matter from liquid sample can be achieved through gravity filtration.

Methods

In this study Whatman Grades 2V, 597½, and 2555½ from GE Healthcare's Life Sciences business were evaluated for their suitability in the three tests described below. All filters were 320 mm in diameter and prepleated with 16 pleats (Fig 1).

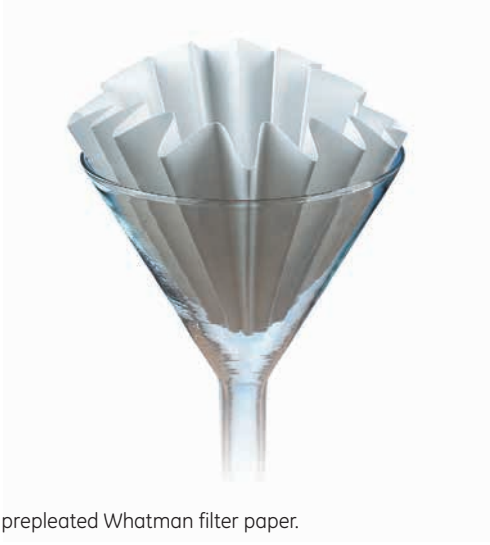

Fig 1. A prepleated Whatman filter paper.

All tests were performed according to the ASBC methods presented in Table 2. All testing was performed by the Biotechnology School at Jiangnan University, No 1800 Lihu Avenue, Wuxi, Jiangsu, 214122, China.

Table 2. Study design

Whatman filter	Product code	Lot number	Tests (ASBC Method)
Grade 2V	1202-320	G8605164	Wort filtration (Malt-4)
Grade 597½	10311853	G7471143	CO_2 removal (Beer-1,D)
Grade 2555½	10313953	G5137158	Yeast cell removal (Beer-8)

Removal of turbidity from wort

Two batches of malt were prepared to support testing of the filtration step for method ASBC Malt-4. The malt was prefiltered prior to further testing in order to isolate the wort. Spent grain was removed by prefiltering the malt using a coarse filter bag. The wort in the filtrate was adjusted to a turbidity level of 10 prior to measuring the base turbidity. A 150 ml sample of wort was filtered using gravity through Whatman filter paper Grade 2V, 597½, or 2555½. The turbidity pre- and post-filtration was measured and the percent reduction calculated. This process was repeated for a total of three samples. The filtration times were also recorded.

CO_2 removal from bottled beer

The amount of CO_2 in beer is expressed as mg/ml and is derived from the following formula:

$$\frac{C \times (V-V_0) \times 44}{10} \times \frac{V_1 + 1}{V_1}$$

Where:

C = concentration (M) of HCl standard

V_0 = volume of HCl (ml) required to adjust pH in a water blank to 3.9

V_1 = sample volume (ml)

V = volume of HCl (ml) required to adjust pH of the sample to 3.9

Per ASBC method Beer-1,D a 4 ml sample of beer chilled to 4°C was filtered using gravity through Whatman Grade 2V, 597½, or 2555½ and transferred to a conical flask. NaOH (1 ml of a 10 M stock) was added to the beer and mixed thoroughly. A 10 ml sample of this mixture was transferred to a fresh beaker and 20 ml of distilled water added. The mixture was then titrated against 0.5 M HCl, with the volume required to reduce the pH to 3.9 recorded. The measurement was repeated with 50 ml of unfiltered beer and then with 50 ml of water (as a blank control).

The amount of CO_2 in unfiltered and filtered beer samples was measured, and the amount and percentage of CO_2 removed was calculated. This process was repeated for a total of three samples.

Removal of yeast cells after fermentation

A typical fermentation broth containing yeast cells suspended in solution was prepared. In order to test such a broth for acidity per ASBC method Beer-8 such a broth would first have yeast cell content removed. The initial number of suspended yeast cells was estimated using a cell counting chamber. Aliquots of 150 ml of this suspension were then filtered by gravity through one of the three filter paper grades. The filtrate was subjected to serial dilution. The resulting samples were plated on YPD agar plates to determine the number of viable yeast cells not retained by the filter. The difference between the two counts was used to determine the efficiency of filtration. This process was repeated for a total of three samples.