United States production of craft beer in the twenty-first century has increased significantly, and the US craft beer continues to increase in volume and market share. The majority of American craft beers are unpasteurized and are susceptible to microbial contamination and spoilage. Wild yeasts (e.g. Saccharomyces cerevisiae var. diastaticus) and lactic acid bacteria (e.g. Lactobacillus acidotolerans) are responsible for several major recalls, the US craft beer in the recent history of causing serious economic consequences for producers.

Microbiological stability of U.S. craft beer is of great importance because the majority of the products are unpasteurized\(^2\). Furthermore, Food Safety and Quality (FSQ) providers in the U.S. more focus to prevent contamination and it can be difficult to control inventory and storage conditions of packaged product. A major threat to the U.S. craft beer market is product degradation due to microbial contamination.\(^4\) The microbial stability of beer, including Saccharomyces cerevisiae var. diastaticus was likely the causative organism in at least three major recalls of super attenuated beer\(^1\) and Lactobacillus acidotolerans contamination resulted in a national recall of a prominent barrel aged imperial stout due to undesirable off flavors\(^2\).

In contrast to traditional top-fermenting brewing yeast, Saccharomyces cerevisiae var. diastaticus secretes an extracellular glucosylamylase that can increase the overall fermentable sugars in beer leading to over attenuation. It is capable of growth at temperatures as high as 45 °C, but can remain viable at refrigeration temperatures. This is particularly dangerous to consumers if beer contaminated with S. cerevisiae var. diastaticus is packaged because it can cause package failure and explosion. In addition, the increased fermentation can lead to alcohol labeling non-compliance.

Selecting media including YM + CuSO₄ and lysine agar may be used in conjunction with 37 °C aerobic incubation to detect diastaticus in top-fermented beer, but some strains of diastaticus are inhibited. Detection of S. cerevisiae contamination including diastaticus in lager yeast can be achieved without the use of molecular diagnostics\(^6\). Detection of wild yeast and spoilage bacteria can be challenging for U.S. craft breweries because the use of advanced microbiological detection methods are not commonly adopted. This could be a result of a large focus on detecting contamination in lager beer in scientific literature. After all, larger beer production has dominated the U.S. beer market, but for many craft breweries, they are gaining a foothold in the sector\(^1\). The American Society of Brewing Chemists (ASBC) recommends molecular diagnostic equipment for microbiological screening only for breweries that produce over 10,000 barrels (25,000hl), and traditional microbiology is recommended for breweries that produce at least 15,000 barrels (35,000hl).\(^7\) Molecular diagnostics techniques including real-time PCR (qPCR) are currently the most widely accepted methods to detect and identify the aforementioned spoilage organisms with confidence\(^5\). Several commercially available molecular diagnostic kits are available to detect the spoilage organisms.

Additionally, reactive testing of packages can measure increased carbonation and alcohol content in beers that are suspected to be contaminated with diastaticus.

The U.S. Food and Drug Administration’s (FDA) Food Safety Modernization Act (FSMA) of 2011 marked a major change in U.S. craft beer safety. Food safety and quality (FSQ) providers need to prevent contamination to prevent recalls, spoilage, and ensuring beer safety. Businesses are required to have FSQ to protect consumers from foodborne illness and to maintain a competitive advantage. In accordance with the FDA, craft beer producers are required to have a food safety plan that includes a HACCP plan to ensure that production processing is conducted in a manner that prevents or significantly reduces the occurrence of hazards and controls that are reasonably likely to cause the product to become hazardous.

<table>
<thead>
<tr>
<th>Date</th>
<th>Brewery</th>
<th>Style</th>
<th>ABV</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/30/2014</td>
<td>10 Barrel Brewing</td>
<td>Fruit Beer</td>
<td>4.50</td>
<td>wild yeast; Body S. var. diastaticus</td>
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<tr>
<td>8/2/2014</td>
<td>Angry Orchard</td>
<td>cider</td>
<td>5.00</td>
<td>wild yeast; Body S. var. diastaticus</td>
</tr>
<tr>
<td>1/18/2016</td>
<td>Goose Island</td>
<td>Imperial Stout</td>
<td>14.20</td>
<td>Lactobacillus acidotolerans</td>
</tr>
<tr>
<td>5/1/2016</td>
<td>Left Hand Brewing</td>
<td>Sweet Stout</td>
<td>6.00</td>
<td>wild yeast; Body S. var. diastaticus</td>
</tr>
<tr>
<td>12/17/2016</td>
<td>Revolution Brewing</td>
<td>IPA, Porter</td>
<td>5.00-10.00</td>
<td>wild yeast; Body S. var. diastaticus</td>
</tr>
</tbody>
</table>

References

13. Whetter, S. N. (2005). Culture Media and Handbook of Brewing Biology. Numeris, Germany: Fachverlag Heel Car. The United States craft beer market continues to grow in size and complexity\(^1\), and microbiological spoilage is a major threat\(^3\). Widespread distribution of mostly unpasteurized products with rudimentary or nonexistent microbiological quality control and quality assurance poses risks to the consumer and manufacturer alike. Super attenuating yeast (e.g. Saccharomyces cerevisiae var. diastaticus) and spoilage bacteria such as Lactobacillus acidotolerans have caused major recalls in recent times\(^11\). As craft beer continues to mature and government oversight becomes more comprehensive, focus on preventing microbiological contamination must persevere in order to preserve the integrity of the industry\(^15\). Innovative diagnostic techniques like real-time PCR can provide reliable ways to detect and identify bacterial and fungal beer spoilers.\(^12\)

About Founders Brewing Company

Founders Brewing Company is located in Grand Rapids, Michigan, USA. The company was founded in 1997 by Mike Stevens and Dave Engbers, and it is celebrating its 20th anniversary. Founders follows the philosophy of producing high quality beer with complex, bold flavors and aromatics. Founders is one of the highest recognized breweries in the U.S. and it is consistently ranked as a top brewery by organizations such as the Ratebeer.com and BeerAdvocate.com. Mahou San Miguel (Spain) partnered with Founders and purchased a majority share in 2013. In December 2014, Founders beer is distributed in 46 States in the U.S. and 26 countries including Slovenia.

Figure 2 – Google search interest for “beer recall” and “craft beer” google search trend

Conclusions

The rapid growth of the U.S. craft beer segment has led to business partnerships with foreign entities and even complete buyouts. The rapid growth of the U.S. craft beer segment has led to business partnerships with foreign entities and even complete buyouts.