Premature Yeast Flocculation—Still a Challenge!

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Premature Yeast Flocculation (PYF) was first reported by Kirin Breweries in the 1950s by Kudo (Kudo, 1958) and is it is a simple concept. In essence, PYF causing malt does exactly what it says—it causes the yeast to drop out of an active fermentation early as shown in figure below.

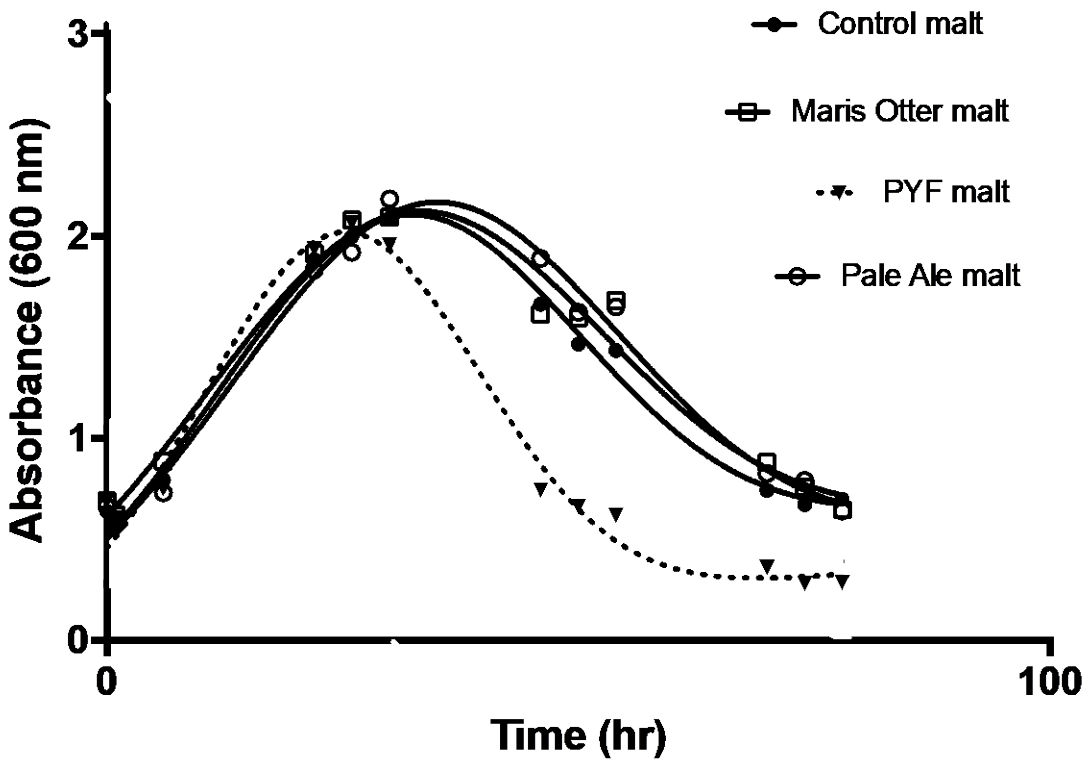

Fig. 1. An example of premature yeast flocculation

One of the issues with the PYF phenomenon is the confusing tendency to ascribe any problem in the fermentation process to PYF causing malt. For instance, a slow fermentation (for whatever reason—low pitching rate, poor yeast viability, low wort oxygenation on pitching, etc.) can result in poor CO_2 generation thus resulting in poor yeast suspension. These factors can lead to poor attenuation but do not cause premature flocculation. PYF malt can be difficult to determine as brewers tend to blend their malts by mixing malt from different batches, crop years, and varieties.

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Over 50 years ago, PYF was identified in malt in Japan. It occurs sporadically, and in turn, it has been sporadically investigated. We know it is associated with malt made from barley harvested with wet growing seasons. Most researchers believe it is caused by fungal attack of the barley or malt. Canadian

researchers have shown that PYF can be created by barley exposed to fungal attack in the field. Another intriguing report has indicated that the PYF factor is related to low O_2 and high CO_2 levels in the malting process.

Detection of PYF malt is not straightforward. The ASBC has developed a method (ASBC Yeast-14) to clearly detect the method by fermentation (Figure 2). This method takes ~5 days—first to culture the pitching yeast and then to undertake the fermentation using 450 g of malt. Koizumi et al. at Kirin breweries identified and quantified the PYF flocculating factor. They noted that the PYF factor derived from PYF malt is "a highly substituted glucuronoarabinoxylan-associated arabinogalactan protein." Filtration of PYF wort with 100 kDa filter membrane reduces or eliminates the factor.

- Use 15 mL fermentations of Congress wort with 4% glucose added @ 21 °C
- Turbidity and extract measurements taken 10 times over 75 h
- Use entire dataset to model yeast on suspension
- A standard ASBC method

Fig. 2. ASBC Yeast-14. Mini Fermentation Assay

Along with the early removal of yeast in PYF fermentations there is often an observation of increased FAN levels. As well and not surprisingly, high diacetyl levels can also result as the diacetyl rest is less effective when less yeast in suspension present. PYF is generally associated with lager yeast and to certain degree seems dependent on the yeast strain used. While one might expect a higher final apparent extract in PYF fermentations (due to the lack of yeast later in the fermentation) this does not seem to always be the case. Thus, aside from using Yeast-14 to test the malt, careful examination of fermenter yeast in suspension should be undertaken.

PYF wort is also reported to reduce the negative surface charge on yeast and cause very strong binding of the flocculated yeast cells. For perhaps for this reason, it seems difficult to rouse or resuspend the PYF yeast to "restart the fermentation." One is just resuspending large PYF flocculated yeast flocs that settle quickly and thus do not further attemperate the wort nor reduce diacetyl levels.

From a process perspective, eliminating sporadic PYF behavior in the brewery can pose a difficult challenge to the brewer and the maltster. It also continues to perplex malting and brewing researchers!

Reference

Kudo, S. Yeast Flocculation: On a Yeast-Flocculating Agent from Spent Grains by Acid Hydrolysis. *Rep. Res. Lab. Kirin Brew. Co.*, 1958, 1, 47–51.