146

WORLD BREWING CONGRESS 2016

Specialty Malt Acidity

Jordon Geurts, Briess Malt & Ingredients

World Brewing Congress
August 13-17, 2016
Sheraton Downtown Denver
Denver, CO 80202, U.S.A.

Abstract

Mash pH is a factor that influences enzyme activity, yeast health, solubility of compounds, clarity, and the flavor of finished beer. Historically, in certain beer styles, mash pH was sometimes manipulated by adjusting the grain bill with specialty malts of varying colors and acidities to achieve a desired target pH. We investigated numerous factors affecting the pH and titratable acidity of specialty malts including: production method, resulting malt color, barley variety, and malting location. Our study evaluated the relative importance of these factors and their relationship to mash pH for a variety of samples with the aim of giving brewers a better quantitative feel for the effect specific malt types can have on mash pH. A strong relationship between mash pH and measured malt color was found. Barley variety and malting location showed a smaller and more variable effect.

Methods

Malt samples were chosen to represent a range of production methods, colors, barley varieties, and production facilities. To measure the deionized water (DI) mash pH and complete the titrations, 25g samples were placed in a beaker on a preheated stirring hotplate. 100mL of 70°C deionized water was added to samples, which were then mashed for 5 minutes at 70°C. To assess the shift in pH from 70°C to room temperature (20-25°C), the DI mash pH was taken after the 5 minute mash, then the samples were cooled to room temperature in an ice bath as rapidly as possible and the pH was recorded again. Samples were titrated using 0.1N NaOH, or 0.1N HCl depending on the initial DI mash pH in relation to the target pH of 5.2. We generated a 3rd order polynomial curve using Microsoft Excel from the data points collected. The resulting equation from the line of best fit was used to determine our titratable acidity to our target pH of 5.2.

Results

A relationship between malt color and DI mash pH was found with a resulting R^2 value of 0.844. The strongest relationship by production method was found in roasted caramel malts (R^2=0.897), followed by kilned base malts (R^2=0.485), and dark roasted malts (R^2=0.342) (Fig. 1). A relationship between color and titratable acidity was also found, but only for malts produced with the same method. Roasted caramel malts showed the strongest relationship (R^2=0.775), followed by dark roasted malts (R^2=0.656). Kilned malts showed almost no relationship in this case (R^2=0.150)(Fig. 2). When looking at differences in barley variety and differences in malting location our results showed a more variable and smaller effect. A roaster on the other hand, produces highly uniform malt, but has wildly different heating conditions than a kiln. The result from roasting is color formation through the Maillard reaction and caramelization. Dark roasted products are similarly uniform, but are roasted at temperatures high enough to utilize the Maillard reaction, caramelization, and pyrolysis. The reactions involved in each pathway will affect pH and titratable acidity in different ways because of the different reaction products produced.

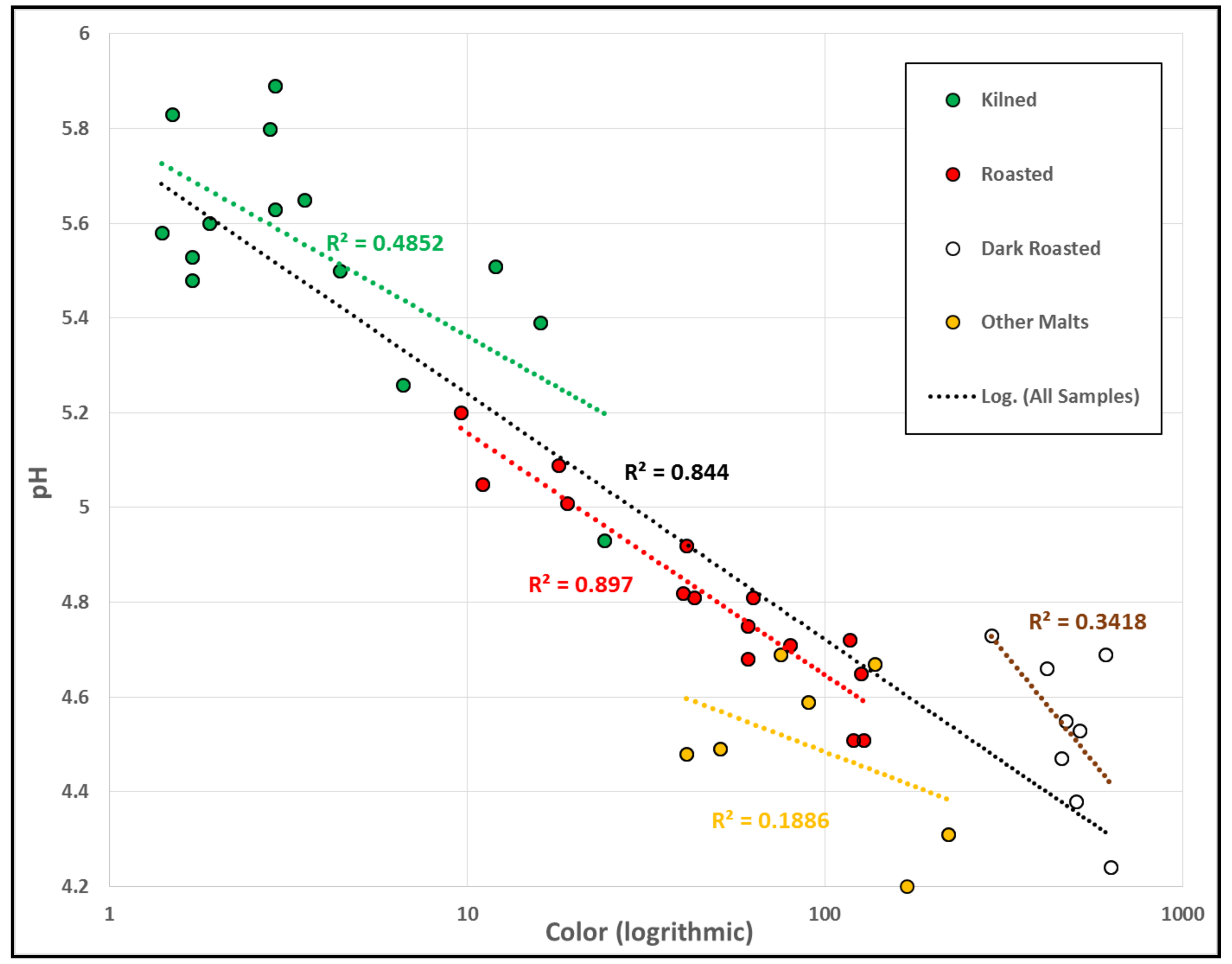

Figure 1 - Relationship between mash pH and malt color classified by production method, showing a strong relationship overall, and strongest among roasted malts

Discussion

The relationship between malt color, pH, and titratable acidity was highly variable due in large part to the production method used to create the malt. This is not surprising due to the different and unique conditions utilized to create the variety and depth of colors found in specialty malts. Our assessment of pH and titratable acidity was designed to measure pH early in a mash, after the grist was fully hydrated and enzymes would be active. It was also designed to be rapid, so that the feasibility of lot analysis for inclusion on a certificate of analysis could be determined. Because pH is a factor that can have a large impact on the brewing process, it is important to measure and know general tendencies that are associated with it. We observed a trend of decreasing pH with increasing color (Fig. 1). This trend was stronger and more predictable in roasted malts than with other production methods.

Titratable acidity tended to increase with color, but the rate of increase was highly dependent on the production method (Fig. 2). For both pH and titratable acidity, malts of a similar color can respond differently during a titration. These differences are most likely a result of the specific compounds that are generated in each unique production process.

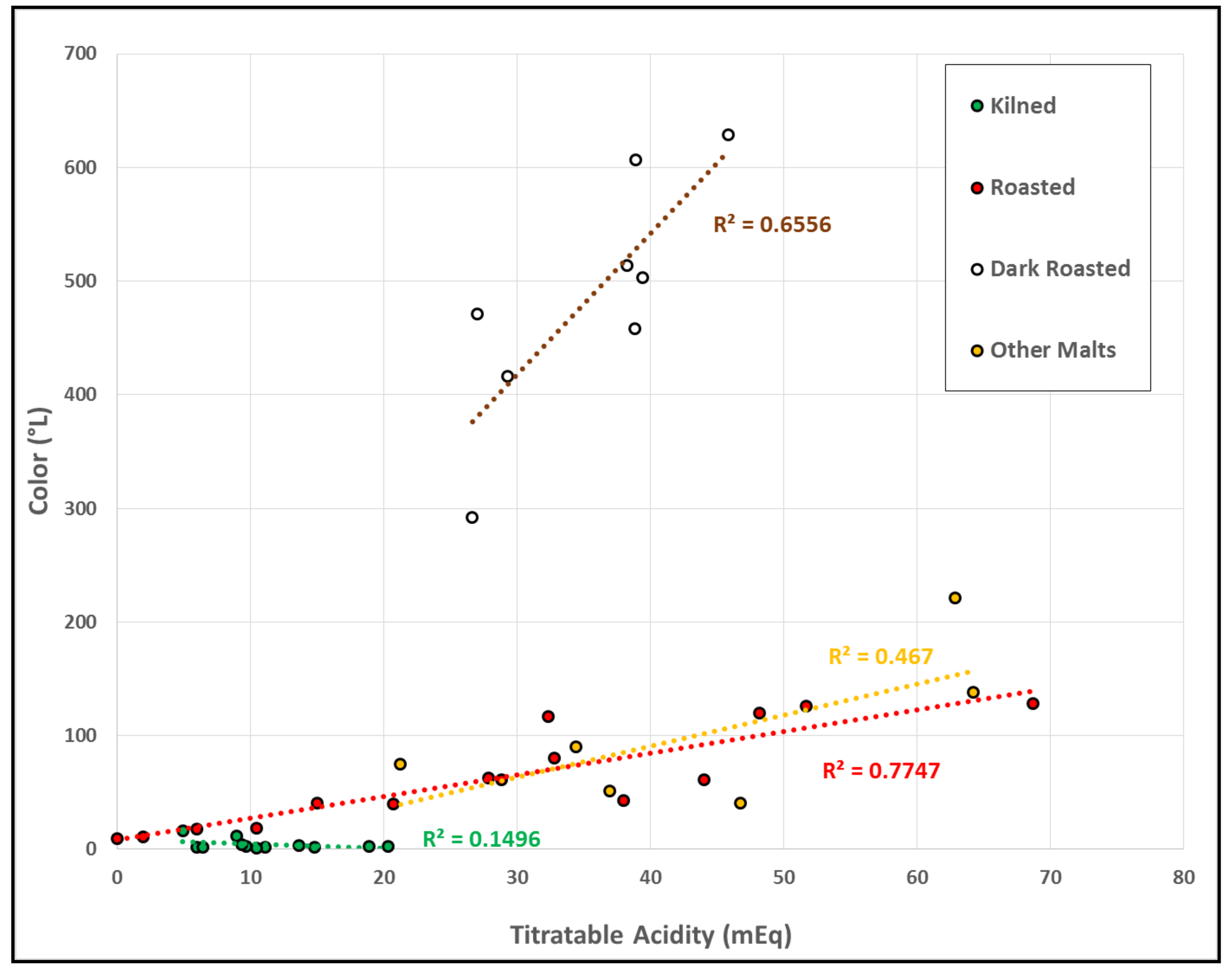

Figure 2 – Relationship between titratable acidity and malt color classified by production method, showing a stronger relationship for roasted and dark roasted malts than kilned malts.

When malt is produced on a kiln, it is not produced uniformly. The grain bed is exposed to different heating conditions at the top and bottom. Heating conditions dictate color formation, which in the case of kilned malts, is primarily through the Maillard reaction

When analyzing finished products made from different barley varieties our selection of samples was limited to caramel malts. It was further limited by the practice of utilizing barley varieties to produce specific products. Due to distinctive varietal attributes, each variety of barley will best lend itself to a particular finished product. This means. that while we are looking at different varieties, in this case they may share many similar attributes. When comparing caramel malts, Conrad barley showed slightly lower pH and slightly higher titratable acidity than Conlon and Copeland varieties (Fig. 3). With differences being so slight, it is difficult to attribute them to variety alone.

Different malting facilities may have different equipment, conditions, or water sources. We wanted to analyze how different conditions at separate facilities may affect the pH and titratable acidity. Our selection of samples was again limited to caramel malt samples. In this case we chose those of the same variety, produced

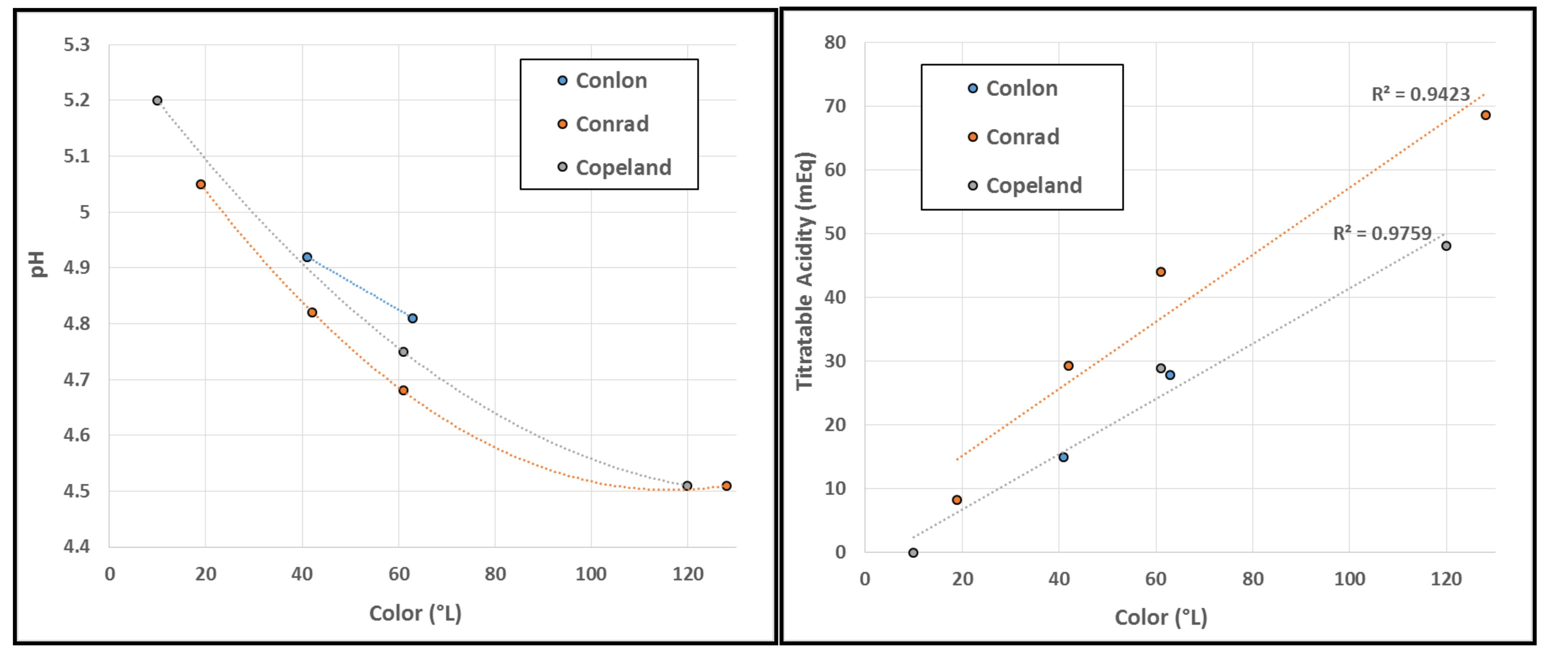

Figure 3 – Relationships between mash pH and malt color (left) and titratable acidity and malt color (right) in three different barley varieties showing only slight differences as malt color increases

at multiple locations. While there are some differences between the malting locations, the initial processes remain the same, which in this case results in finished malt that is very similar. The pH values are nearly identical at similar colors (Fig. 4), and the titratable acidity is only slightly different for malts produced at these locations.

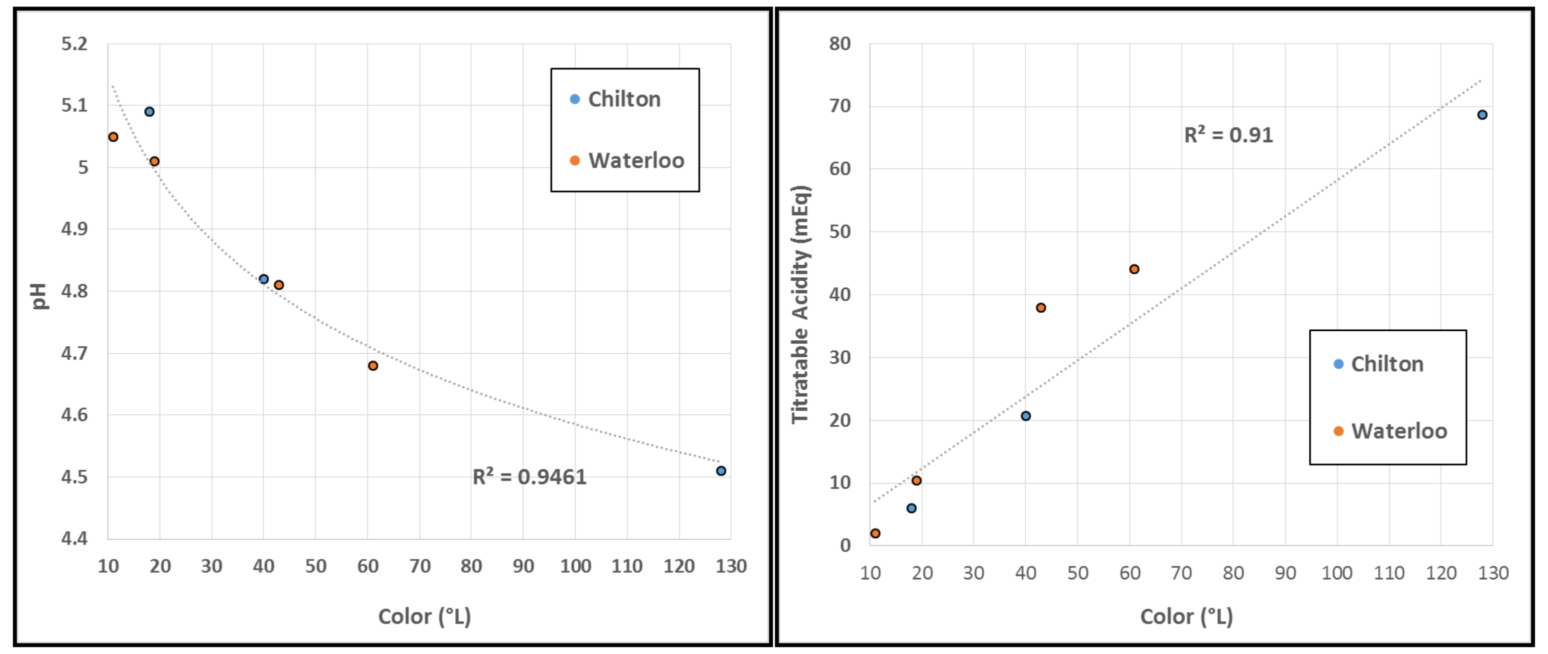

Figure 4 – Relationship between mash pH and malt color (left) and titratable acidity and malt color (right) at two malting facilities showing no significant differences between locations

Conclusion

As color increases, pH decreases. As color increases, titratable acidity increases at different rates specific to the production method. Production method has the greatest effect on pH and titratable acidity, whereas barley variety and production location have a minor, more variable effects.