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Specialty Malt Contributions to Wort and Beer

Cassandra Liscomb, Daniel Bies, and Robert Hansen
Briess Malt & Ingredients Co., Chilton, WI, U.S.A.

ABSTRACT

Specialty malts are those malts that by definition provide something different or "special" to wort and beer. Information on specialty malts is often presented around how they are made or specific styles they are used in. As brewers in the United States and worldwide become more creative and the ever-increasing number of beer styles expands and blurs, it is important to revisit the discussion around impacts of specialty malts and define their features and benefits outside of stylistic references. This article summarizes available information for many specialty malt types and their contributions to wort and beer.

How are specialty malts defined? One must not lose sight of the "specialness" of any malt. In truth each batch and each kernel of malt is unique and therefore special. The maltster's and brewer's art is not lost on those malts or beers that are most commonly sold. Volumes of papers and research have been expended and are available to describe the common brewer's base malt and proper production of pilsner. Much time has been spent in an effort to artistically produce these malts to be of the utmost fitness in providing efficient conversion, separation, and extract yield, all while simultaneously offering consistency and uniformity.

Specialty malts are best defined by their intent to be different. Not superior, but different. Maltsters and brewers today are calling for malts with specific regional origin, nontraditional grain types, and other marketable and valuable distinguishing production designations such as organic, low food miles, and locally produced. Although the influence of variety, growing region, and malting process cannot be denied, in general this does not limit what characteristics the malt can offer.

What the brewer ultimately desires from the malts are the influences they have upon the finished beer. They are looking for differentiating characteristics, features, and benefits. Some benefits to beer from specialty malts are also influenced strongly by other ingredients. Foam, body, and mouthfeel in particular are influenced by malt, but also by other factors such as hop acids, apparent extract, and real extract. The features and benefits we will focus on for this paper, then, are those that are primarily or solely provided by specialty malts. These are color, malt-derived flavors, and acidity.

Color from Malt

The primary consideration for formulating specialty malts in most beer styles is flavor, not color. Malt flavors are used to bring balance to beer and are the source of limitless variation and differentiation. An example is the use of dark roasted grains in porters and stouts, which are used to impart a signature roastiness reminiscent of coffee or chocolate. Along with this flavor comes the brown or black color that we expect from the style. Similarly, the consequence of achieving a caramelly sweet balance in an IPA is the beer taking on an amber color. It is also true that in some instances malt is used for its color-altering properties, not just the amount of color but also the type. The goal of this section will be to describe and demystify malt color. This will be accomplished by describing some of the color dogma, defining the concepts we need to understand the nature of malt color, and finally showing the range of achievable colors from malt.

The Dogma

As brewers we have all heard the following:

1. Munich malt contributes "deep golden to orange hues," while caramel malt contributes "deep golden to red hues."
2. A small amount of roasted barley will impart a reddish hue in a pale beer.
3. Light caramel malt will impart a different hue than medium or dark caramel malt.

While each of these statements may have a bit of truth in practice, they are painting an unnecessarily complex and misleading portrait of what malt color is. In fact, the differences in hue between most malt types are simply caused by the practical usage rate at which they can be applied. That is, a traditional 10°P 15 SRM (standard reference method) beer made with 25% caramel 60 Lovibond malt would have the same color as a 30°P 15 SRM beer made with 4 Lovibond pale malt, if a 30°P beer could be brewed from the pale malt alone.

Definition of Terms

Color. The aspect of the appearance of objects and light sources that may be described in terms of hue, lightness, and saturation for objects and hue, brightness, and saturation for light sources (12).

Hue. The attribute of a color by virtue of which it is discernible as red, green, and so on, and which is dependent on its dominant wavelength and independent of intensity or lightness (15). An example of a common unit to represent hue is the Linner hue index.

SRM. An arbitrary unit that measures the ability of a liquid sample to absorb light of a specific wavelength within the blue region of the visible spectrum of electromagnetic radiation. That is, how much blue light is taken up by the liquid? Put another way, SRM is not a measure of color or hue but truly a measure of the absence of blue light.

E-mail: Cassie.Liscomb@briess.com

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% Transmittance. The percentage of visible light that passes through a liquid at a distinct wavelength.

Malt Color

There have been many attempts to better classify the perceived color of beer based on stylistic patterns (4) or employing more sophisticated color space measurements (5,16) such as tristimulus measurement. Wort and beer color also can be described by two simple attributes: hue and SRM. A description of hue will supply us with necessary information such as how distinct colors in the visible spectrum (red, orange, blue, etc.) behave in relation to each other, and SRM color (simply referred to as SRM from here on) will give us the intensity of color at one distinct point along the visible spectrum. With these two attributes we have all the tools we need to predict how all wavelengths of visible light will behave as they pass through a glass of beer. These assumptions will not hold true for cloudy or turbid beer, because turbidity adds another dimension of complexity to perception.

Color-causing compounds are generated in the thermal processing of malt. These compounds cause color owing to their ability to absorb electromagnetic radiation (i.e., light). Depending on the amount and type of compounds produced, these compounds can have the effect of imparting differing intensities and hues of color when white light passes through beer. The remaining light transmits to our eyes and is perceived as color. Research shows that one type of hue (color type) is produced in the processing of the majority of malts (1), namely, kilned pale and Munich-style malts and almost all caramel malts. These malts are said to impart colors such as golden orange up to deep red depending on the concentration of the colored components (mainly melanoidins) (8). For the sake of simplicity, these malts will be referred to as red-type malts. The second class of hue is imparted by dark roasted malts, such as the dark chocolate and black malts, which are said to impart colors such as deep golden to brown to black depending on the concentration of the colored components. For the sake of simplicity these malts will be referred to as black-type malts.

All red-type malts provide the reddest hue that can be produced through traditional malting processes, and all black-type malts provide the blackest hue that can be produced through traditional malting processes. The reason that specific red-type malts may be said to contribute a different color is because the concentration of the coloring compounds differs among malts in this category. That is, each malt provides differing intensities of the same color type. The same holds true for black-type malts: all will display the same hue, and the perceived color will vary based only on their intensity.

Now that we have described the two major color types it is time to discuss brown-type hues. These hues are imparted by all those malts that fall somewhere between the red and black types. Brown-type hues result when malt is dry roasted short of achieving its maximum color. The shift from red color to brown shows up when roasted caramel malts are pushed to colors in excess of 120 Lovibond, or when kilned malts are dry

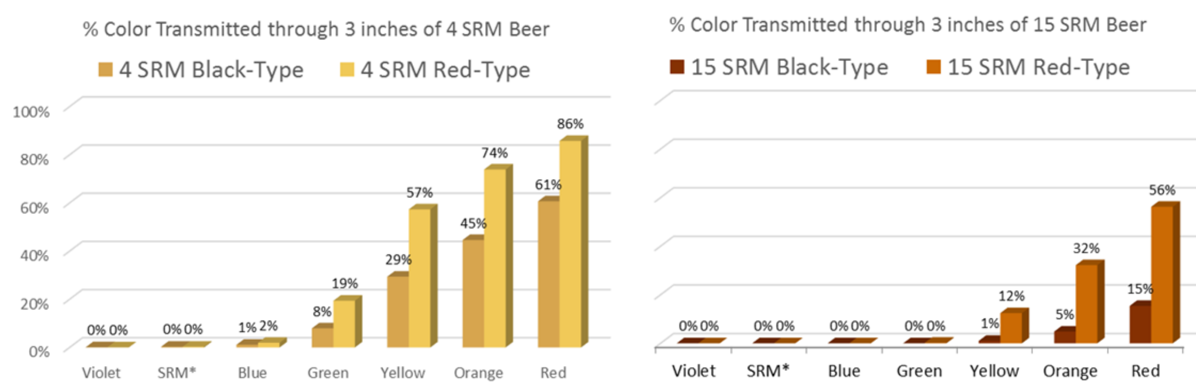

Figure 1. Approximate percentage of distinct colors that are transmitted through beer. Left: two malt color types at 4 SRM. Right: two malt color types at 15 SRM.

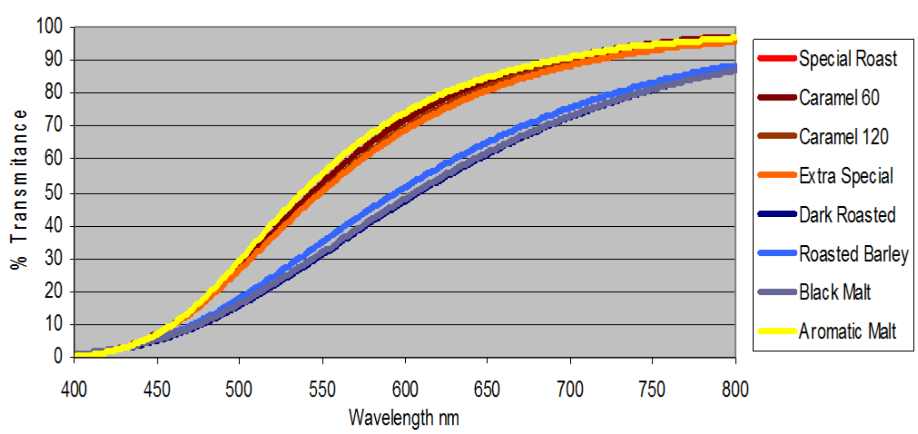

Figure 2. Spectrophotometric wavelength scans of worts made from a variety of specialty malts diluted to 20 SRM.

roasted to make traditional brown malt. Here the compounds that cause black color are being created while, simultaneously, the compounds causing red color are being destroyed. Depending on the amount of heat applied, these malts will progress from red-type hue toward black-type hue. We can view the red- and black-type colors as the bookends and all intermediate colors that lie between as the pages that seamlessly progress from red to black. The brown-type malts do not possess any unique color opportunities that could not be obtained through combined usage of red and black types.

Although malt and beer analysis is performed on the basis of the amount of light that does not make it through a sample of beer (absorbance), we perceive the color of beer based on the amount and type of light that is transmitted. SRM is defined by the amount of light that is absorbed at a distinct wavelength of light that corresponds to the blue-violet color region. As a result, we can say that two beers brewed to the same SRM using two different color types will have the same effect on light in the blue-violet region. However, as we mentioned, the different color types (hues) will have different proportions of colors along the visible spectrum. Figure 1 displays how distinct color regions along the visible spectrum would be perceived in a pint glass for two malt types at the same SRM formulation. This work is possible because many modern spectrophotometers have the ability to measure at distinct 1 nm wavelengths in the 430–700 nm range. As a result, we are able to accurately differentiate more than 270 distinct points along the visible color spectrum.

The graphs in Figures 1 and 2 show that for the same SRM significantly more red, orange, and yellow light passes through the red malt sample than the black malt sample for the same amount of blue-violet light absorbed (430 nm). The result is that for the same SRM there is more red, orange, and yellow light, and thus more total light that passes to the eye for red-type beer. Simply put, the red-type beer will appear lighter and redder than the black-type beer. Formulating for color is possible and predictable because there are two distinct color contributing types (1). Thus, for a specific SRM and hue (color type) a color can be predicted because the weighted influence of each malt type can be known. This allows not only the ability to predict the color type of any beer formulation but also the ability to analyze a beer's color and determine the type of malts used (1) The hue and SRM data gathered through full color spectrum analysis can also be used to generate color simulations. One method to accomplish this would be to use the transmittance values of three distinct points along the spectral scan that correlate with red, green, and blue and represent them proportionally on a personal computer as RGB color (Figs. 3 and 4).

The fact that one beer can be perceived as significantly darker than another beer at the same SRM points out a flaw in the concept of using SRM to describe color intensity. Figure 5 shows both how the visible spectrum of light is transmitted thorough a 0.5 in. sample (ASBC specified) (14) of two different beers at 15 SRM and how when one of these beers is diluted to 8.4 SRM the two spectra cross at 540 nm. The total amount of light in the second example (different SRM) shows that the two samples transmit the same amount of light, and although the types of light differ, the total amount of light is similar, unlike in the first example (15 SRM). The result is that these two beers will have different hues and different SRM colors but will be perceived as having similar color intensity. This phenomenon demonstrates that a color measurement sys-

Figure 4. Computer simulation of two beer colors at the same SRM using an RGB color model developed by Briess Industries.

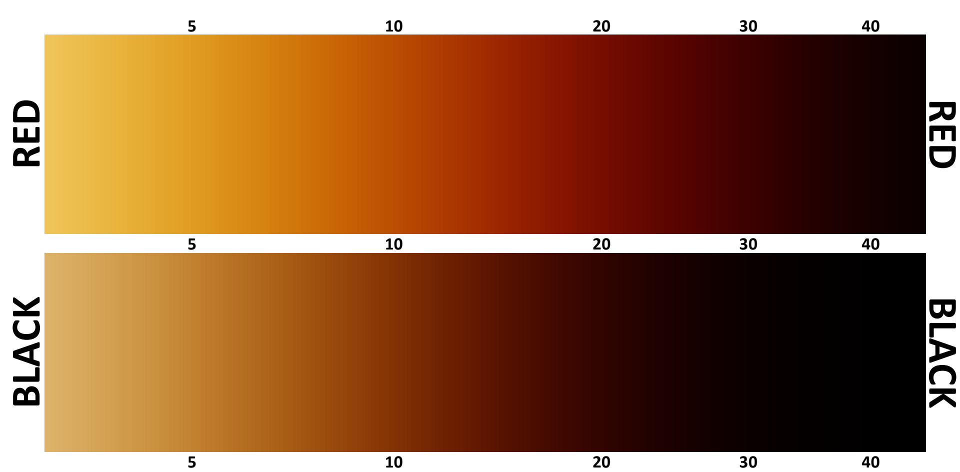

Figure 3. Computer simulation of two hue types over a broad spectrum of SRM values. Colors are intended to represent the perceived color of a pint of beer in a well-lighted room.

tem that utilizes the 540 nm wavelength would more accurately represent intensity than the SRM system, which utilizes the 430 nm wavelength.

Flavor from Malt

The American craft beer industry is focusing more than ever before on building new and diverse brands with unique flavors. This section explores the trends of flavors that are created through different malt processing methods and comments on the contributions that specialty malts make to wort and, ultimately, beer flavor. A brief overview of flavor terminology and the research of malt flavor compounds is provided.

Flavor Terminology

Many brewers are familiar with Morten Meilgaard's beer flavor wheel from 1979 (11) and the current beer flavor wheel (Fig. 6), which utilizes the original design of the wheel but offers more detailed terminology from industry experts. The current beer flavor wheel has gained industry-wide acceptance for the sensory evaluation of finished beer. In addition to the wheels shown, various designs of similar concept can be found online to describe the sensory perceptions of raw brewing materials, including malt and hops. However, the industry does not recognize a standard method or lexicon for the sensory evaluation of such materials at this time.

In response to growing concern from sensory professionals that flavor wheels are becoming too complex and confusing, hierarchical diagrams, such as the one shown in Figure 7, are gaining momentum as a tool for lexicon development. In any design, flavor terminology diagrams are meant to provide tasters with the proper language to most effectively communicate their sensory experiences.

Science of Malt Flavor Compounds

There are numerous volatile compounds found in malt, many of which have been identified and classified by their chemical structure and mode of formation. Not all flavor volatiles contribute significantly to the overall flavor of malt. It is generally accepted that Strecker aldehydes and intermediate Maillard reaction products have the most profound impact on malt sensory perception (3).

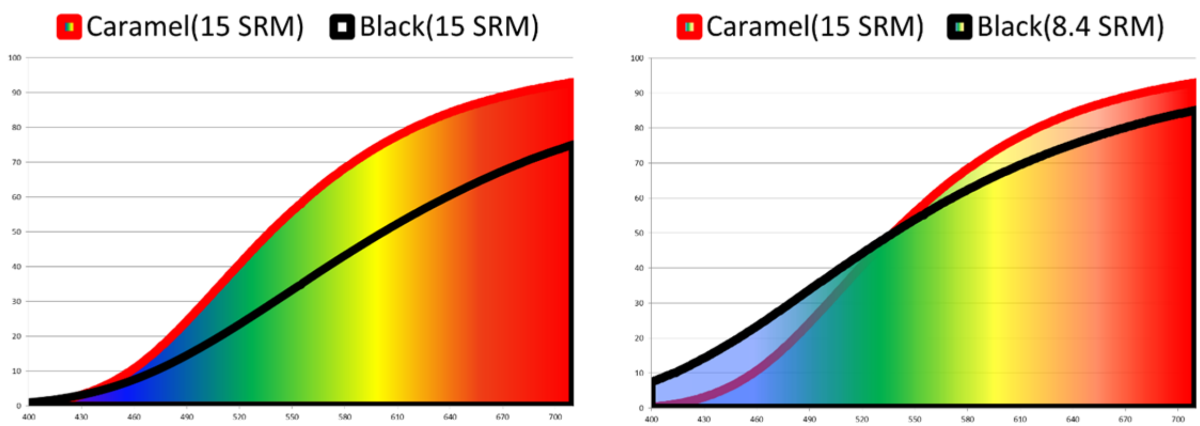

Figure 5. Full wavelength scans of two malt types. Left: two worts at the same SRM. Right: two worts at different SRM with similarly perceived intensities.

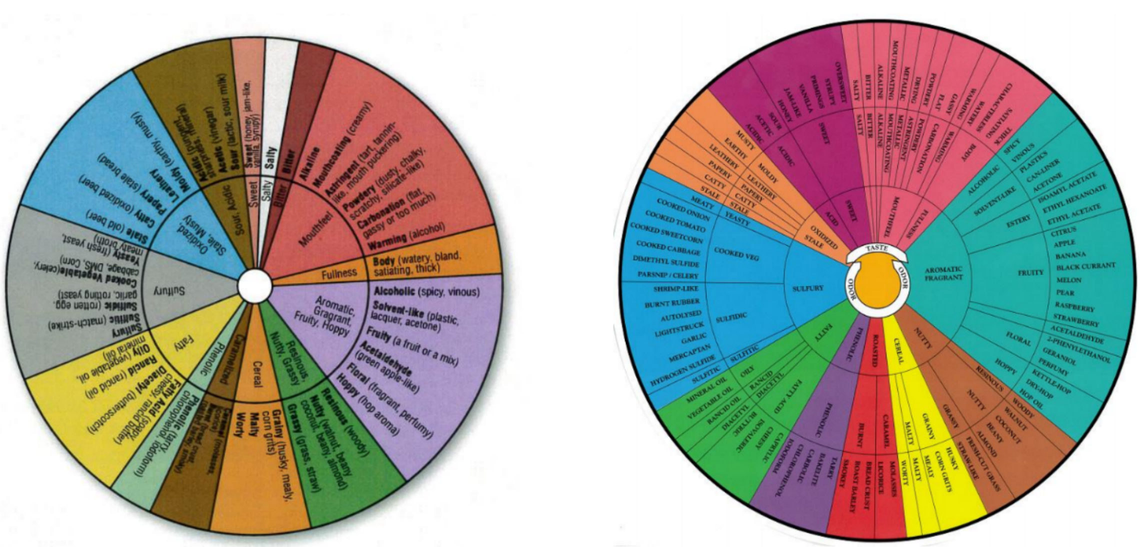

Figure 6. Left: Meilgaard's beer flavor wheel (11). Right: the beer flavor wheel developed by the American Society of Brewing Chemists (ASBC) in collaboration with the European Brewery Convention and the Master Brewers Association of the Americas. Reproduced by permission from ASBC.

The Maillard reaction is, in simple terms, the nonenzymatic browning that occurs when amino acids and reducing sugars react under heated conditions. In kilned and lower-color caramel malts, oxygen heterocyclic Maillard reaction components such as pyrenes, furans, and furanones dominate flavor. In roasted and higher-color caramel malts, nitrogen-containing heterocycles such as pyrazines, pyridines, and pyrroles are responsible for most of the overall flavor (3).

Each of these compound classes is associated with known flavors, which have been determined through the use of gas chromatography–mass spectrometry/olfactometry. For example, pyrazines contribute roasted, toasted, nutty, bready, and baked flavors, whereas furans and furanones contribute sweet, burnt, and caramel-like flavors (9,18). In summary, the flavors perceived in specialty malts are a result of the specific volatile compounds that are produced in thermal processing.

Malt Flavor Generation

The degree of thermal processing is the most influential variable in determining the level of volatile malt compounds (13), and thus, the specific flavors that are produced in specialty malts. Just like malt color, malt flavor does not develop linearly. Unique processes can be utilized to create unexpected flavor perceptions. This subsection will discuss general trends of flavors that are produced through different processing methods.

Kilned Malts

Kilned malts are created in a process in which raw barley kernels are steeped, germinated, and dried on a kiln at relatively low temperatures for several hours. The style of malt that is produced can be manipulated by adjusting time, temperature, and moisture targets. Kilned malts measure anywhere from 1 Lovibond to over 20 Lovibond. Owing to the relatively low temperatures they are exposed to in processing, kilned base malts (<10 Lovibond) retain all or most of their enzymatic power, allowing them to be used at any rate in a brew. At colors >10 Lovibond, kilned malts will generally lack the enzymes to be used as a true base malt.

Kilned malts with low levels of color development (1–2 Lovibond) tend to be sweet with dominant grainy or doughy flavors. These same flavors are maintained in the medium color range (3–10 Lovibond), but they are complemented by greater intensities of bready and graham cracker flavors. Kilned malts that are dried at higher temperatures, such as Munich-style malts (>10 Lovibond), have a bolder perception of biscuit, toast, malty, and bready flavors (Fig. 8).

Typical Usage Rates of Kilned Malts

Pale Ale Malt. Can be used as the sole base malt in just about any ale to promote a rich, full, malty flavor with hints of biscuit and subtle nut-like flavors. In lighter beer styles, 0.2 lb/gal will develop warm, malty, and toasty flavors.

Vienna Malt. Can be used as the sole base malt in full-flavored lagers and ales to impart a rich maltiness that is heavy in the biscuit notes. In lighter beer styles 0.2 lb/gal will develop warm, malty, and slightly biscuity notes.

Mild Malt. Use at a rate of 1 lb/gal for exaggerated maltiness with prominent biscuit character and a subtle toasty note. At 0.2–0.5 lb/gal, this malt will enhance malty flavors and aromas in any beer.

Munich 10 Lovibond. Use at 1 lb/gal to impart prominent sweet malty flavor, with suggestions of biscuit, toast, and graham cracker. A more restrained usage of 0.2–0.4 lb/gal will

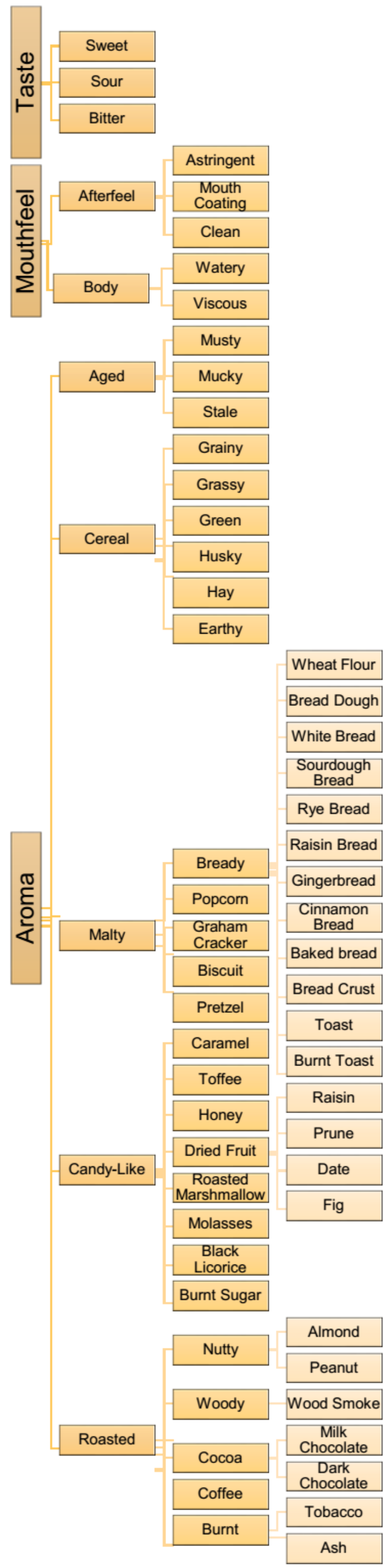

Figure 7. Hierarchical diagram of specialty malt sensory terminology developed by Briess Malt & Ingredients Co. (Chilton, WI, U.S.A., 2015).

impart a warming malt character with subtle notes of biscuit and toast.

Munich 20 Lovibond. Use at 1 lb/gal to impart intensely rich maltiness with flavors of biscuit, toast, and graham cracker. A restrained usage of 0.1–0.3 lb/gal will impart a rich malt character with notes of biscuit and toast.

Dry Roasted Malts

Specialty malts in this category are steeped, germinated, kilned, and roasted to create a broad range of colors and flavors. The exact style of malt produced is dependent on time, temperature, and moisture targets in the kiln and roasting drum. The roasting process eliminates the enzymatic power of the kernels, which means that malts in this category are not able to convert their own starches into sugars and must be accompanied by a base malt in any brew.

Dry roasted malts range from 25 to 550 Lovibond. On the lower end of color development (25–60 Lovibond), these types of malts are generally dominated by biscuit, bready, nutty, and toast flavors. Unique processing can introduce sourdough, tangy, pretzel, and woody flavors in the 30–50 Lovibond color range. On the higher end of color development (350–550 Lovibond), kilned and roasted malts are dominated intensely by coffee, cocoa, dark chocolate, burnt, and roasted flavors (Fig. 9). Maltsters also offer dehusked malts as an option to reduce the perception of bitterness and astringency in dark roasted products, but brewers are cautioned that overuse will defeat their intended purpose.

Typical Usage Rates of Dry Roasted Malts

Victory. For dark beer, use up to 0.5 lb/gal for pronounced toasty, biscuity, baking bread, and nutty flavors. At 0.1–0.2 lb/gal this malt will add a subtle nutty-toasty quality.

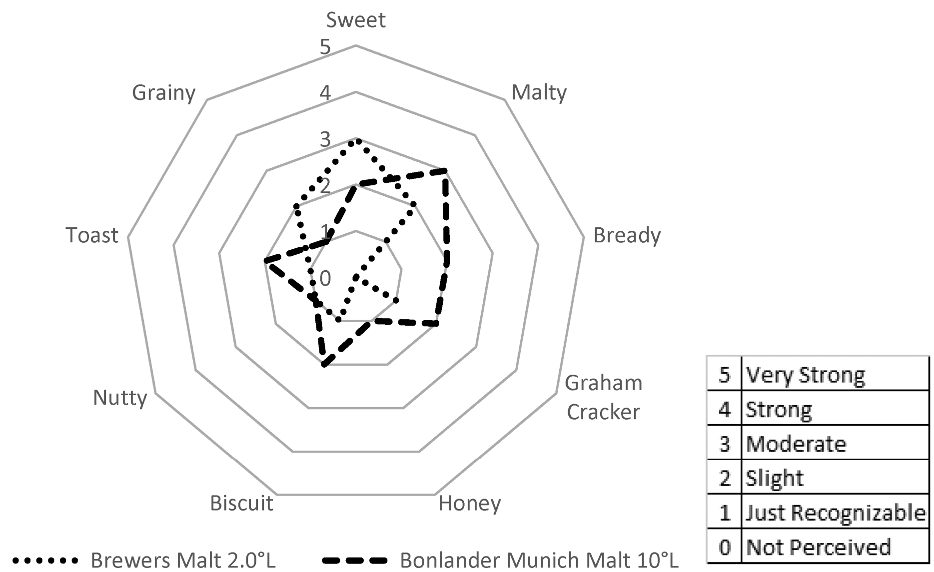

Figure 8. Spider web diagram displaying the average intensity of flavors and aromas perceived by the Briess Malt Sensory Panel in two different kilned malts.

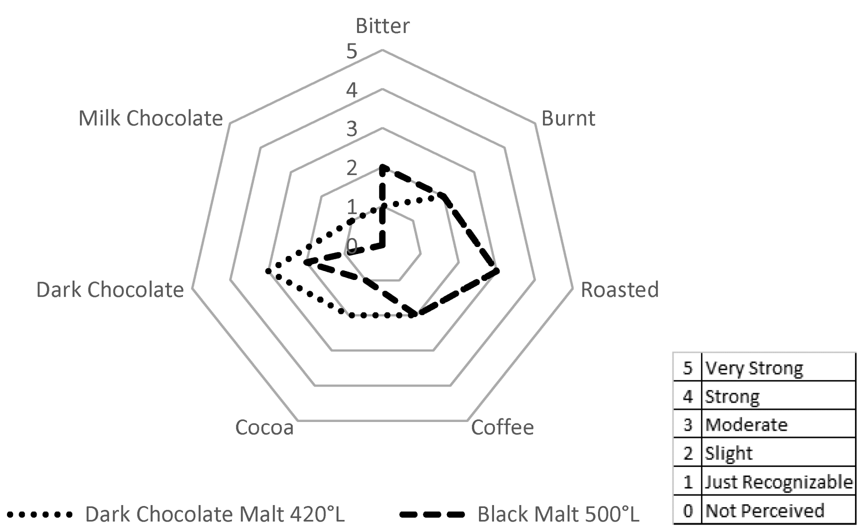

Figure 9. Spider web diagram displaying the average intensity of flavors and aromas perceived by the Briess Malt Sensory Panel in two different dark roasted malts.

Special Roast. Typical usage rates of 0.1–0.2 lb/gal will impart subtle toasty, biscuity, bran flakes, sourdough, and tangy flavors. At higher usage rates (>0.2 lb/gal) the tangy and toasty aspects of this malt will quickly overtake the flavor of the beer.

Carabrown. At usage rates of 0.4–0.5 lb/gal this malt will impart a toastiness with flavors of biscuit, nut, and graham cracker. Lower usages (0.2–0.3 lb/gal) will add lightly toasted flavors with a subdued biscuit and nut flavor. At rates above 0.5 lb/gal, beer may begin to exhibit a bitter coffee flavor.

Extra Special. When used at 0.2–0.3 lb/gal this malt will exhibit flavors of toasted marshmallow, mild coffee, and prunes. At usages under 0.2 lb/gal these same flavors will be subtle but still noticeable; they can help to develop flavor complexity and may give a toffee-like flavor quality. Usages in excess of 0.3 lb/gal will be perceived as having a strong toasted, burnt sugar character.

Chocolate Malt. Bitter, dark chocolate, and cocoa flavors are achieved when this malt is used at 0.1–0.2 lb/gal. Usage in excess of 0.3 lb/gal will display a bitter quality.

Black Malt. Bitter and roasted coffee notes are achieved when this malt is used at 0.1–0.2 lb/gal. Usage in excess of 0.2 lb/gal will display a burnt, bitter quality.

Roasted Caramel Malts

Roasted caramel malts, also known as crystal malts, are steeped, germinated, and roasted. These types of malts undergo conversion in the roasting process, resulting in a crystalized, or glassy, interior. As a consequence of high-temperature processing, roasted caramel malts lose their enzymatic power and must partner with a base malt for conversion of other malt starches in the brew.

Manipulation of time, temperature, and moisture targets in the roasting drum will determine the colors and flavors that are produced in these specialty malts. Low-color (10–20 Lovibond) roasted caramel malts are dominated by sweet and caramel flavors. Toffee and toast become more apparent in the 30–40 Lovibond range. Raisin and roasted marshmallow are perceived more readily in the 50–60 Lovibond range. Upward of 60 Lovibond, burnt sugar becomes more intense. Starting around 90 Lovibond, prune and other dried fruit flavors become more dominant, and at over 100 Lovibond, sourdough flavor is more readily perceived. In an extreme generalization, roasted caramel malts range from sweet, caramel, and toffee flavors on the low end of color development (10 Lovibond) to dried fruit, burnt sugar, and sourdough flavors on the high end of color development (120 Lovibond) (Fig. 10).

Typical Usage Rates of Roasted Caramel Malts

Caramel 10 Lovibond. Typically used at 0.1–0.3 lb/gal for a caramel candy-like sweetness.

Caramel 20–40 Lovibond. Contribute a caramel toffee-like sweetness when used at 0.1–0.3 lb/gal.

Caramel 60 Lovibond. Small amounts (<0.1 lb/gal) can give a slight balancing sweetness to lighter beers. When used at 0.1–0.3 lb/gal this malt will impart sweet, pronounced caramel flavors akin to toffee with a slight raisin note.

Caramel 80–90 Lovibond. Small amounts (<0.1 lb/gal) can give a slight balancing sweetness and dark fruit flavor to lighter beers. When used at 0.1–0.3 lb/gal this malt will impart pronounced caramel flavors with hints of burnt sugar, raisins, and prunes.

Caramel 120 Lovibond. Small amounts (<0.1 lb/gal) can give a slight dark fruit flavor to lighter beers. When used at 0.1–0.3 lb/gal this malt will impart pronounced caramel flavors of burnt sugar, raisins, and prunes. Usages above 0.3 lb/gal begin to develop an overwhelming burnt sugar character.

Roasted Barley

Specialty malts in this category are not actually malts at all; they are produced by roasting raw barley kernels at high temperatures to achieve colors in the range of 300–500 Lovibond. Because germination has not taken place, roasted barley does not have enzymatic power. As with all roasted products, manipulation of time and temperature settings in the roasting drum will determine the degree of colors and flavors that are produced.

Dark roasted barley products generally have an intensely bitter taste. They are dominated by burnt, roasted, and coffee flavors, with roasted, coffee, and chocolate flavors becoming more intense in the higher color range (Fig. 11).

Typical Usage Rates of Roasted Barley. Roasted barley usage is commonly restrained, because excessive usage will be

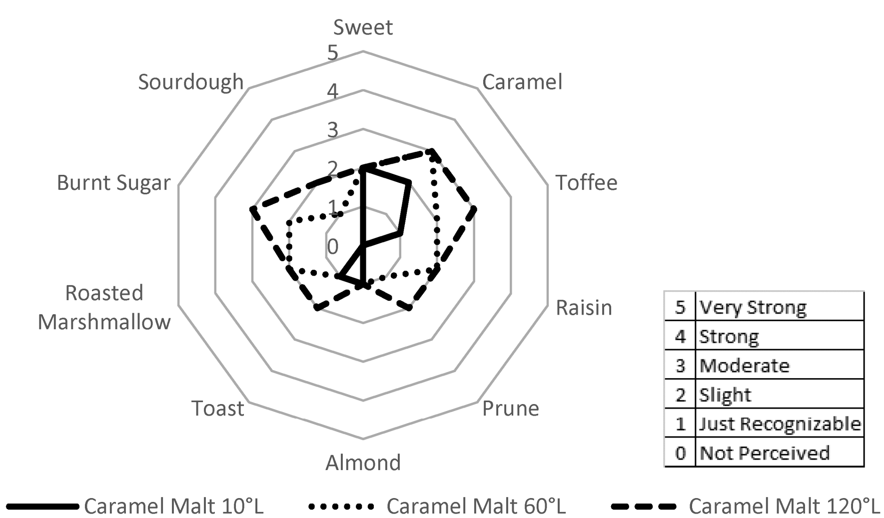

Figure 10. Spider web diagram displaying the average intensity of flavors and aromas perceived by the Briess Malt Sensory Panel in three different roasted caramel malts.

perceived as burnt and bitter. Typically used at 0.1 lb/gal for a bitter coffee flavor with a hint of dark chocolate.

Smoked Malts

Smoked malts are steeped, germinated, dried, and smoked in a process that results in each kernel acquiring a strong wood smoke aroma. Smoked malt flavors can be described as sweet, ashy, smoky, and earthy. The type of wood used for smoke generation will determine the specific smoked flavor perceived in the malt, such as cherry wood or apple wood. Smoked malt offerings from maltsters are each unique, and the smoke intensity and overall character can vary widely. Depending heavily on the malt used and the desired effect, usage rates for smoked malts may range from 0.1 to 1.2 lb/gal.

Acidulated Malts

Acidulated malt, also known as sour malt, can be produced in several different processes, all of which result in the malt becoming more acidic owing to growth of lactic acid bacteria. Some of the production methods include steeping barley under anaerobic conditions or spraying green malt with *Lactobacillus* bacteria prior to kilning (2). Historically, the intended use of acidulated malt was to adjust brewing water pH without breaking the purity laws of the Reinheitsgebot (10). The flavors that are associated with acidulated malt, including sour, tangy, tart, and lactic, are desirable characteristics of sour beer styles. For most recipes, acidulated malt may be used up to a rate of 0.2 lb/gal.

Acidity from Malt

Today the concept of pH is essential for efficient and consistent production of most beer. However, the concept of pH was not developed until 1909 (14), over 100 years after many iconic beers, such as Guinness and Bass, were well established. Prior to the concept of pH, brewers were formulating beers they knew to be successful, but they may not have necessarily understood why. One tool for making these formulas

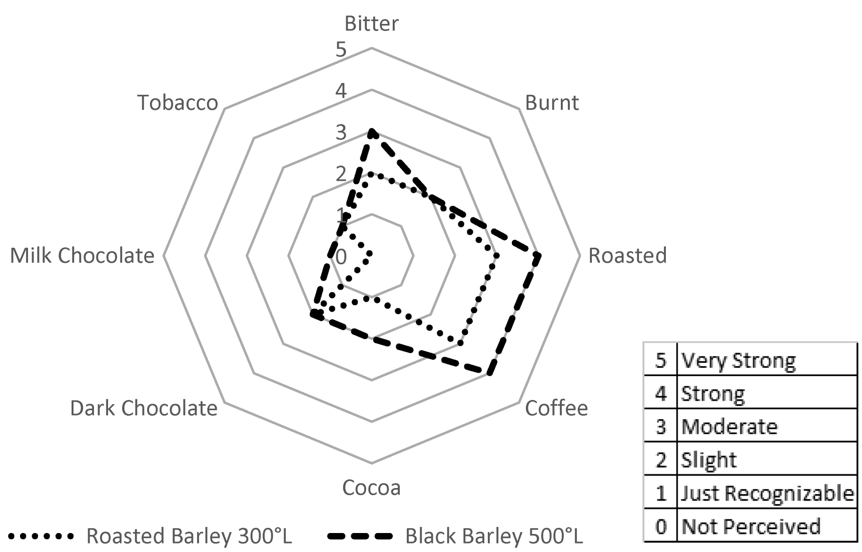

Figure 11. Spider web diagram displaying the average intensity of flavors and aromas perceived by the Briess Malt Sensory Panel in two different roasted barley products.

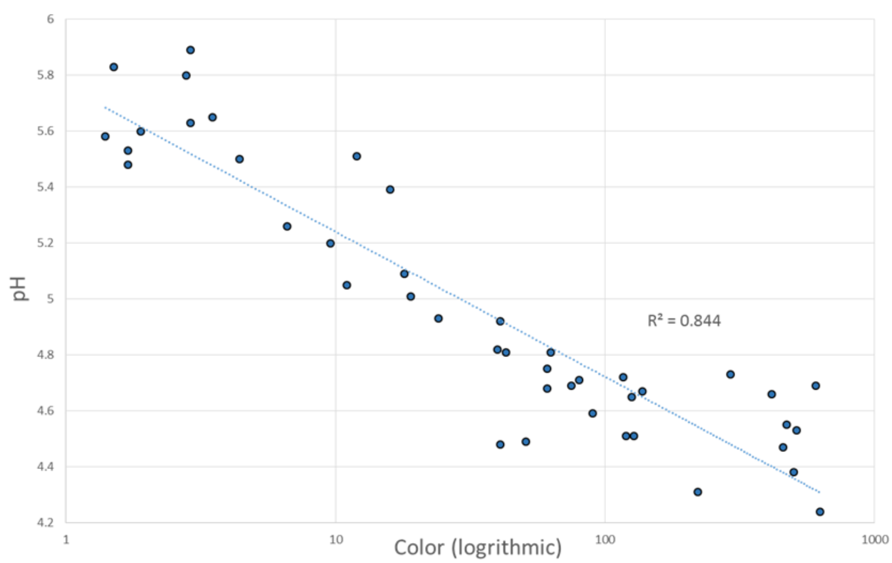

Figure 12. Mash pH as a function of color (SRM) (7).

work would have been darkly colored or acidulated malts because of their ability to affect mash and beer pH. The acidity from these malts likely helped with mash pH and, thus, allowed for beer to be successfully brewed in in areas with hard water. Direct measurements of malt acidity can be used to predict mash pH; however, talking about acidity in terms of its effect on pH is more common, because it is more easily measured and adjusted for in a modern brewery. Additionally, acidity cannot be separated from the color and flavor, and therefore it is not practical to use malts to adjust pH when additional color or flavor is inappropriate. It is important to understand the influence that specialty malt acidity has on beer so that recipes can be formulated or adjusted appropriately.

Loose relationships between acidity and color can be observed. The effects of specialty malts on acidity and pH have been studied by several people (e.g., Troester and deLange) (6,17). Within a specific mode of production malts can show strong correlations between color and acidity as well as color and pH (Fig. 12) (7), assuming that the source of these acidic compounds comes from thermal processing and not from intentional souring in the process. Acidulated malts are produced to be formulated with and used in beers marketed as all natural or obeying Reinheitsgebot. Normally used in small amounts, around 1 lb/brl, it can be used to reduce wort pH by as much as 0.1. Because acidulated malts are produced by letting the malt naturally sour with lactic acid bacteria, high usage rates (greater than 5 lb/brl) can also be used to contribute unique lactic or wild fermented notes (19). This section primarily focuses on those malts that are not acidified.

The malts with the highest levels of acidity are black malts and dark caramel malts. On a pound for pound basis, these will carry the same amount of acidity, meaning that they will have the same effect in adjusting mash pH. And although these two malts will show similar effects on pH, they themselves do not exhibit the same pH when mashed in deionized water. Black malt will typically exhibit a lower pH value when mashed alone (7), which suggests that it has less of a buffering capacity than dark caramel malt. For this reason it is important to focus on acidity when formulating for pH with specialty malts, because pH does not tell the whole story. The combined acidity and alkalinity of all ingredients (including the water) will determine the ionic concentration in the mash, which will determine whether or not the target pH is achieved. Kilned malts have less acidity than caramel or dark roasted malts, and they commonly have pH values higher than the desired mash pH. There does appear to be a general trend of increased acidity with color, but the correlation is not strong, and kilned malts result in an undesirably high mash pH in alkaline water. Dark roasted malts also show a general trend, but a weak correlation, between acidity and color. Caramel malts produced in a roaster show a good correlation between color and acidity, because as these malts develop color they also develop acidity in a logarithmic relationship to color.

In the process of gathering data on acidity, many different malts were analyzed from a variety of maltsters (Fig. 13) (7). For many of the samples malting schedules and production processes were unknown, and data from these showed highly variable results in the relationship between color and acidity (7). The takeaway is that the process used in the production of specialty malts appears to be essential in the development of specialty malt acidity.

	Color (° L)	pH	Titratable Acidity (mEq)
Caramel 10	10.3	5.13	0.99
Caramel 20	18.5	5.05	8.21
Caramel 40	41.3	4.85	24.57
Caramel 60	61.7	4.75	33.58
Caramel 120	121.7	4.58	49.74

Figure 13. Color, pH, and titratable acidity (titrated to pH 5.3) of caramel malts mashed at a 4:1 deionized water to grist ratio (7).

Summary

In this article we have discussed specialty malts with regard to the contributions that they make to the color, flavor, and acidity of wort and beer. When it comes to selecting specialty malts for brewing, it is of the utmost importance to understand the role that each will play, because their hand-crafted uniqueness often requires them to be used in a specific manner to achieve success. Brewers who understand specialty malts have the knowledge to manipulate not just the color but also the hue of their beer. They know how to bring out certain malt flavors, which can be as predictable as bready, biscuit, or toast but can also be as intriguing as roasted marshmallow, dried fruit, or coffee. Such brewers may even know how to predict mash pH based on malt color or to adjust mash pH while obeying Reinheitsgebot. In closing, a brewer who understands how specialty malts function is one who is likely to brew amazing beer—on purpose.

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