



Aging Spirits in Oak

Bourbon whiskey getting its groove on in a Labrott and Graham warehouse, above. A new barrel produced at the Kelvin Cooperage in Louisville, KY, below.

BY MICHAEL DELEVANTE

THERE ARE STILL MYSTERIES attached to the aging process and while it has a significant influence on the character of an aged spirit it is still not as understood as the other aspects, namely the raw material, fermentation and distillation.

Aging is related to the chemical changes that take place as a result of reactions with congeners in the spirit through oxidation and extraction of chemicals from a wooden container. It is thus a two fold process and the characteristics developed are related to the strength of the spirit, the charring of the oak, the temperature and humidity in the aging warehouse and of course the length of time that aging takes place.

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STRENGTH OF THE SPIRIT

Bourbon	Malt Whisky	Grain Whisky*	Canadian Flavor	Tequila	Rum
55%	63.5 – 68 %	68 % - 74%	57%	56%	78%

* 68 % for grain spirit is Scotland; 74% for Canadian grain whisky. The strengths are approximate and may differ from company to company. The Tequila strength refers to 100% Agave made in pot stills.

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Strength of the spirit

Spirits are usually aged at varying strengths which may be more a function of law and warehouse space considerations than on the final quality of the product.

The level of lignin fractions, lignin derivatives, and tannin extracted from oak, as well as the amount of congeners formed, is dependent on the alcohol concentration, with the optimum being 55% ABV. Strength is a factor in the development of color; the higher strength will develop more color and a higher vanillin – floral character because of the deeper penetration into the wood but it also extracts more tannin which results in a harsh product. The happy medium is a weaker strength with less color development and harshness but slower aging.

Barrels that are used more than once can age the stronger grain spirits effectively since the tannin content diminishes as the barrel gets older. There is also a lower level of congeners so “aging” except for the legal requirement is not that critical. The pH of the spirit, of which we have no control, can also affect the extraction process.

At 55% ABV, barrels were found to have a greater porosity for water, with the higher alcohols, acids, esters, aldehydes and furfural being retained. Further studies confirmed that lower strengths result in an increase in alcohol content after aging, whereas a decrease in strength is found when spirits are aged at the higher ABV due to a loss in alcohol. The humidity in the warehouse also plays a significant role, high humidity usually results in a strength gain; dry warehouses usually have the opposite effect. Humidity also affects the character of the final spirit; it has been found that the extraction of vanillin is better at low humidity; low humidity aging does generally result in spirits that have a better sensory quality.

The oxidation reactions will take place as a result of temperatures in the warehouse. Since these are great contributors to the aging of the spirit, it is obviously advantageous to age at higher temperatures. Acids and esters increase due partly to the oxidation of ethanol to acetic acid via acetaldehyde which is then partially converted to ethyl acetate. A consequence of aging therefore is an increase in the concentration of acids, esters, furfural, tannins

and aromatic compounds as a result of oxidation, condensations and interaction with the wood.

Tropical temperatures especially when there are variations between night and day are obviously ideal for “faster” aging and it has been found that aging may not take place in temperate climates if the warehouse is not heated in the winter. Movement of barrels during the aging period will also help but this is obviously not a practical approach.

The type of oak also plays a role – European oak is not as dense as American white oak so you get a higher color but some harshness. It is also interesting to note that once used Bourbon staves shipped to Scotland are rebuilt with new, larger heads so that the 180 liter barrel is built into a 250 liter hogshead. The Bourbon barrel also influences the taste of the product to be aged, a sherry cask will give the spirit a slightly different character and if it was an Oloroso sherry, color development will be faster. New barrels will impart a darker color but the more neutral spirits will be harsh after aging.

Summary: The availability of barrels and warehouse space can be the determining factor in the aging strength of a spirit but it is a general rule that heavier spirits are better aged at lower strengths (55% - 65%) whereas the lighter spirits can be aged at the higher strength. This is more economical despite the higher losses that can occur.

The temperature effect is almost as significant as the aging strength. Thus there is a trade off which must be determined by the blender and brand owner as to the optimum aging strength for their product.

The charring effect and use of oak chips

Spirits aged in charred barrels mature faster than those aged in toasted or de-charred barrels. The charring process for new barrels definitely contributes to the aging of a spirit; it acts like a filter to adsorb sulfur compounds and it provides a passage for the spirit into the pores of the oak. The law in the United States dictates the depth of char for a barrel. This is in spite of the fact that over-charring can actually destroy some of the flavors that are needed to develop the finish of the spirit. This is why toasting may be the better route but it is illegal to age Bourbon in toasted barrels. A medium depth char is required just to crack the wood – the heavier char flakes off when the barrel is dumped.

Charred barrels produce a deeper colored spirit (temperature is also



Charring barrels at Kelvin Cooperage in Louisville, KY.

a contributor) and there is a greater production of esters. In some spirits, mainly rum, it has been found that new charred barrels may actually mask the flavor of the rum and some manufacturers have actually de-charred barrels to avoid this phenomenon. It is also felt that once used bourbon barrels are better for aging spirits than a new charred barrel. Using these barrels more than once, without de-charring and re-charring, also produce the desired effect especially when the older barrels are used with lighter spirits.

Toasted oak chips added to a barrel (illegal in Scotland) do provide additional lignin and this can augment the aging effect of a barrel. They do provide a significantly different congener profile than that produced by a once used charred barrel.

Summary: The charring of the barrel, a legal requirement in

the aging of Bourbon, is also beneficial in developing the flavors and color that will be extracted during the aging process. These include vanillin, honey, spicy, oily and a myriad of other flavors that can be detected by the experienced taster. The flavors we detect are sometimes subjective but they do mimic the flavors present in the foods that we are familiar with.

Conclusion: Spirit products are a wonderful combination of the science of fermentation and distillation, the influence of nature on the aging process, the artistry of the blender to combine all the above elements and last but not least, marketing which has to convince the public that the package and product is worthy of at least a first trial. In modern times this seems to be one of the most important elements in the success of a brand. ■

PRODUCTION FLOW SHEET FOR VARIOUS ALCOHOLIC BEVERAGES

GRAIN WHISKIES	MALT WHISKY	BOURBON WHISKEY/ RYE FLAVOUR	RUM/ CACHACA (BRAZIL)	BRANDY	TEQUILA
Cereal Grains (Rye, Corn, Wheat, Barley)	Barley	Corn or Rye	Molasses (55% sugar) and/or Cane Juice (16% sugar)	Grapes & Other Fruit (16% Sugar)	Blue Agave (Lilly family) produces a "Pina" which takes 10 years to weigh up to 40 kg
Grain Grinding (milling) dilution with H ₂ O and addition of liquifying enzyme (from malted barley or commercial liquifying enzyme). Batch or continuous cooking to rupture starch cells (100-150 °C) Cooling to 60 °C and addition of the saccharifying enzyme diastase (from malted barley or aspergillus niger mold) to convert starch to glucose	Malting – Barley steeped in water, spread out to germinate, turned regularly in large central maltings. Diastase in barley converts starch to sugar. 7 days later green malt dried in kiln with peat smoke. This halts the germination and the malt becomes sweet, dry and "peaty". Dried malt is ground (grist), mixed with hot water in mash tun and stirred. 3 washings done to obtain sweet liquid (maltose) that goes to "wash back". Grains left back in mash tun are dried for cattle feed.	Grain Grinding (milling) dilution with H ₂ O and addition of liquifying enzyme (from malted barley or commercial liquifying enzyme). Cooking at 80-90 °C to rupture starch cells. Cooling to 60 °C and addition of the saccharifying enzyme diastase (from malted barley or aspergillus niger mold) to convert starch to glucose. Still effluent may be added to 'sour' the mash as in "sour mash" Bourbon.	Molasses diluted to 16% sugar. Juice used as is. Enzymes in yeast convert sucrose to invert sugars. The invert sugars are then converted to alcohol and carbon dioxide by the enzyme zymase	Fruit crushing to extract juice. Main sugar is fructose.	Pina harvested, cut or crushed and cooked in ovens or autoclaves to convert inulin to sugar – fructose. This is done with the enzyme diastase which is present in the Agave. Agave is then crushed with cane style mills to extract juice. (Juice can be mixed with 49% cane/beet syrup). Better Tequila is made from pure Agave. Mescal is made from other Agave varieties. Bottles usually contain a real or artificial worm. Pulque is not distilled
Addition of yeast which converts sugars to ethyl alcohol (5-12%), aldehydes, esters, fusel oils and acids - congeners					
40 hour fermentation	48 hour fermentation	50 hour fermentation	40 hour fermentation	2-7 day fermentation	48-60 hour fermentation
DISTILLATION					
Coffey still – 95% a/v 3 column still 96.5% a/v	Wash still and spirit still 70% a/v	Beer still and Doubler 71% - 80% a/v	Pot still (heavy) 86% a/v 2 or 3 column still up to 96% a/v	Pot still 70% a/v 2 column still 95% a/v	Simple pot still 56% a/v Coffey Still 95% a/v
Light Whisky, Blended Scotch, etc. Grain Spirit for Vodka, Gin, Liqueurs	Straight Malt Whisky or Whisky for Scotch Blended Whiskies	Bourbon for straight Whiskey or Blended Whiskey, Rye for Canadian Whisky	Heavy rums for blends Light Rums Alcohol for Vodka, Gin, Liqueurs	Straight Pot Still for Cognac, Armagnac, or Light Brandy for blends	Aged for up to 1 year (Reposado), caramel added or unaged (White)

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