BOUCHARD COOPERAGES

COOPER COMPARISONS

– Next Phase of Study: Results with Wine –

A follow-up study has just been completed, with the generous cooperation of **Cakebread Cellars, Lafond Winery,** and **Edna Valley Vineyards.** Many of the barrels used in the "water rinse" study were employed in aging wines (Cabernet Sauvignon, Pinot Noir, and Chardonnay) in a systematic manner. The wines have been analyzed for the same oak aroma compounds, and these results have been compared to the original study. We were interested to determine the correlation, if any, between the water extracted compounds and their presence in wine.

The following observations, contributed by Eric Hervé, PhD (ETS Laboratories), may be useful to understand the data collected and expressed as graphs.

Chardonnay (experiment conducted at Edna Valley Vineyards)

Comparison of water vs. wine extraction:
(Figure 12) Note: the barrels used were all medium toast. The water rinses predicted the general shapes of charts obtained for wines, from barrels appearing less toasted (Cadus) to more toasted (Damy). On the other hand, final concentrations of aroma compounds in wines aged in Cadus barrels are less than expected, while (relatively) more than expected with the Damy barrels. The compounds for which the prediction is the less accurate are aldehydes (Vanillin, Furfural and 5methylFurfural). Note that final concentrations of those compounds can be strongly influenced by yeast metabolism (reduction to non-odorant alcohols during the alcoholic fermentation).

Wine comparison at 3 month vs. 7 months:
(Figures 13a and 13b) Concentrations for all compounds increased in similar proportions (20% to 40%), with charts obtained showing almost identical shapes and sizes. Wines in Cadus barrels exhibit relatively low concentrations in aldehydes, but this may be caused by a degradation by yeasts during fermentation (see above). Interestingly, final concentrations of Furfural in the other wines (Billon and Damy barrels) are sufficiently high for this compound to participate directly in wine aroma (odor threshold for Furfural: 15 000 ug/L in a model wine. source: P. Chatonnet).

Pinot Noir (experiment conducted at Lafond Winery

Comparison of water vs. wine extraction:
(Figure 14) Note: the barrels used were all M+ toast. The similarity of the charts obtained for water extracts compared to wines is quite striking. Despite the use of a different solvent (water only) and the extremely short contact time with wood, the profiles obtained with wines are accurately predicted. The discrepancies observed for Chardonnay do not appear here. The fact that the Pinot Noir wines were barreled after the alcoholic fermentation, therefore minimizing possible interactions of aroma compounds with yeasts, is a likely explanation.

Wine comparison at 3 month vs. 7 months: (Figures 15a – 15b) The increase for Furfural and 5methylFurfural (5MeF) is striking (10 fold increase!), while the increase for other compounds is similar to what is observed with Chardonnay wines. This is most likely a consequence of crosslinking reactions with tannins and anthocyanins. Some background: Moutounet's group (Montpellier) demonstrated that acetaldehyde and other aldehydes bind with tannin and anthocyanins, resulting in the formation of polymers that do not easily precipitate, hence stabilizing the structure and color of red wines. Cheynier's group also showed that polymers involving Furfural and 5MeF are even more stable than those made with acetaldehyde. This cross-linking of Furfural and 5MeF with polyphenols is a very interesting (and useful) interaction of wood with wine. This property would also explain levels observed for Furfural and 5MeF in the various wines in this experiment. Intermediate levels in Pinot Noir would be caused by its relatively low content of polyphenols (low for a red variety). During this trial, it is likely that Furfural and 5MeF extracted during the first months of aging crosslinked with Pinot Noir polyphenols, but that the process stopped at some point, allowing a dramatic increase of levels in wine, as seen after 7 months.

Cabernet Sauvignon (experiment conducted at Cakebread Cellars)

Comparison of water vs. wine extraction: (Figures 16a – 16b) Barrels from all 4 coopers were used (Billon, Cadus, Damy, and Vicard French and Eastern European). Due to racking constraints, the experiment was only able to observe the interaction of wine and barrel for 3 months.

Three groups are apparent in this portion of the experiment with Cabernet Sauvignon: Billon + Damy (more char markers), Vicard French + Vicard Eastern European, and Cadus (with a trans Oak Lactone "sticking out"). Important remark: after the water rinses, we were surprised by higher relative abundance of trans Oak Lactone (tOL) in woods aged 3 years vs. 2 years, while, reportedly, cis Oak Lactone (cOL) is supposed to increase with longer seasoning. According to Pascal Chatonnet's thesis, during the first 3 years the tOL increases more quickly than the cOL and levels out afterwards. It would take more than 3 years for a cOL increase to become apparent.

The same three groups are still apparent when comparing wine charts, even if shapes are not as identical as observed with Pinot Noir. Also interesting to note is that Furfural and 5MeF are very low in Cabernet Sauvignon wines, most likely consequences of binding with polyphenols (see Pinot Noir comments) and probably do not significantly contribute to aroma. They are still markers of the whole class of Maillard products with their sweet/caramelized odors, however, and are interesting to measure as such: several odorant Maillard compounds (maltol, cyclotene...) do not participate in cross-linking reactions with polyphenols and are still available to influence wine aroma, regardless of the fate of Furfural and 5MF.

Conclusion

We have compared water-extracted compounds and those present in wine samples at different intervals, and observed that their correlation is not consistent in all instances. With Pinot Noir, the water rinse did accurately predict the compounds extracted by wine, although with Chardonnay it did not. However, we suggest that discernable toasting styles can be revealed or validated in these types of studies.

Acknowledgements

Bouchard Cooperages wishes to thank:

Gordon Burns and Eric Hervé, PhD (ETS Laboratories)
for assistance in experimental design and analytical services.

John Montero (Hemispheres Consulting
for design and supervision of the study. C-Line Warehouse for providing space and personnel.

We also wish to thank the following winemakers, who provided indispensable and generous support of this portion of the study:

Harry Hansen at Edna Valley Vineyards (San Luis Obispo, CA)

Bruce McGuire at Lafond Winery (Buellton, CA)

Julianne Laks at Cakebread Cellars (Rutherford, CA)

Figure 12 – Chardonnay

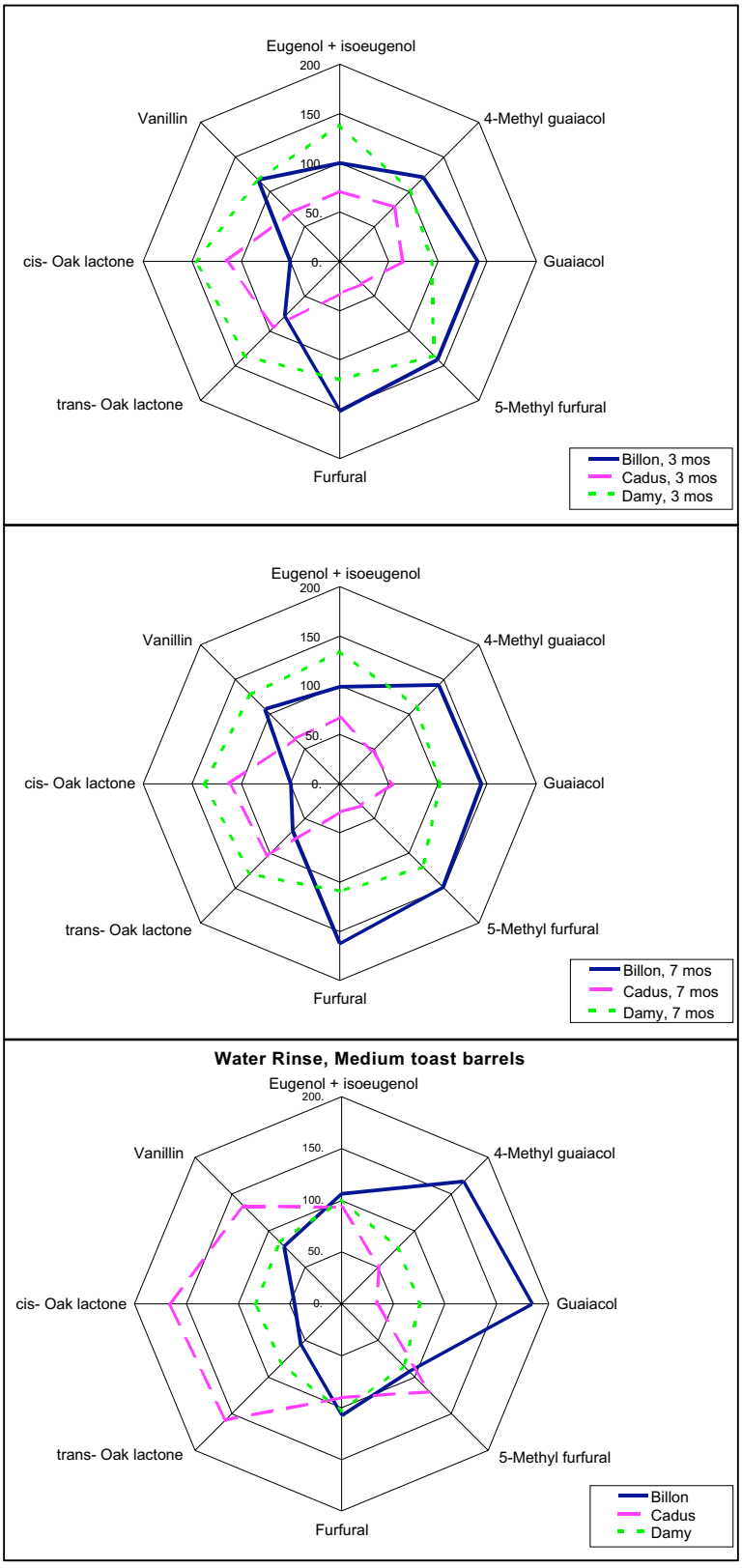
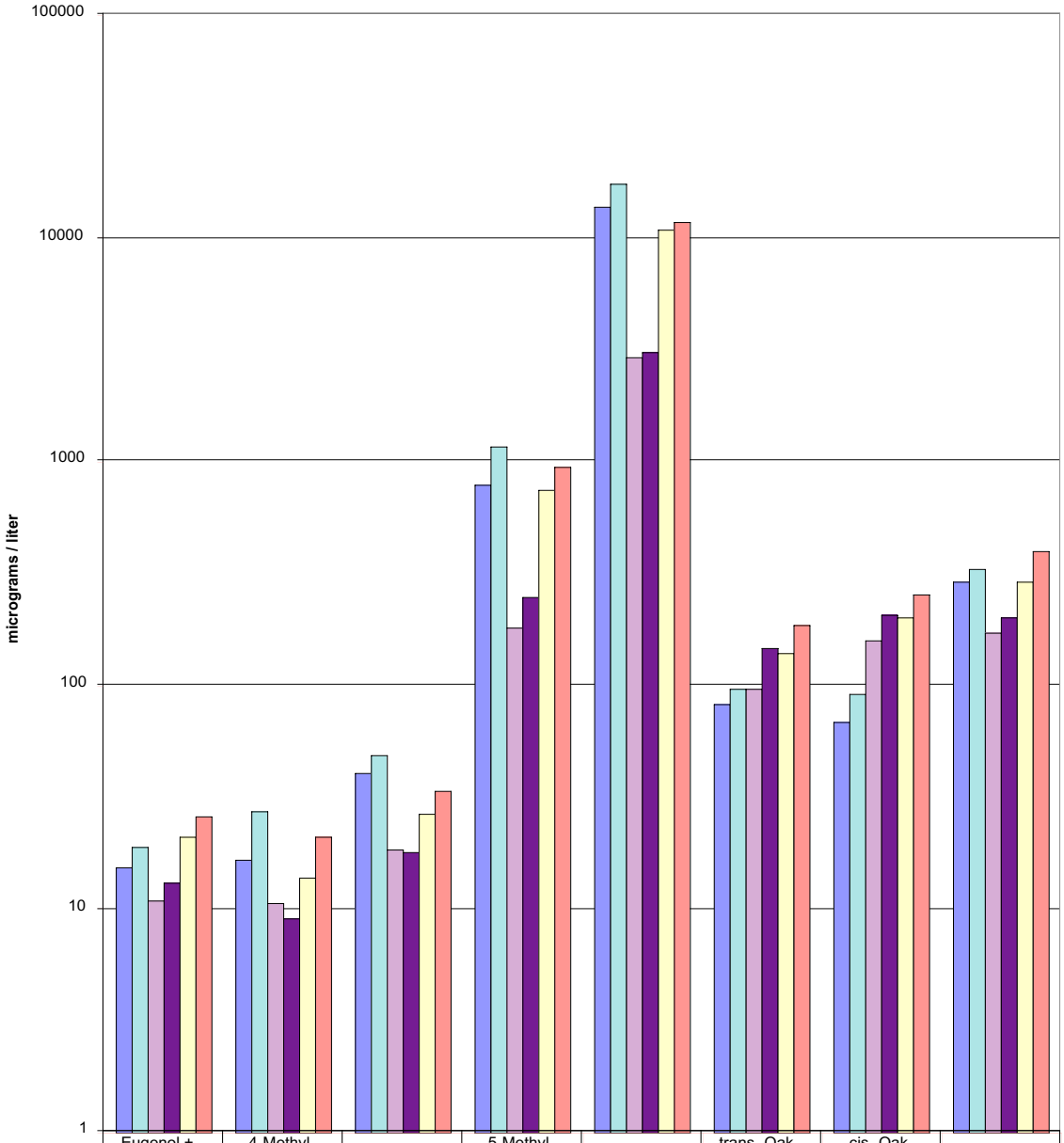


Figure 13a – Chardonnay

Oak Aroma in Chardonnay, Aged 3 and 7 months, Medium toast barrels (logarithmic scale)



	Eugenol + isoeugenol	4-Methyl guaiacol	Guaiacol	5-Methyl furfural	Furfural	trans- Oak lactone	cis- Oak lactone	Vanillin
Billon, 3 mos	15	16	40	780	13848	81	68	290
Billon, 7 mos	19	27	48	1167	17520	96	91	332
Cadus, 3 mos	11	11	18	180	2970	97	157	173
Cadus, 7 mos	13	9	18	245	3120	148	206	200
Damy, 3 mos	21	14	27	747	10935	140	200	288
Damy, 7 mos	26	21	34	940	11817	184	254	395

Figure 13b – Chardonnay

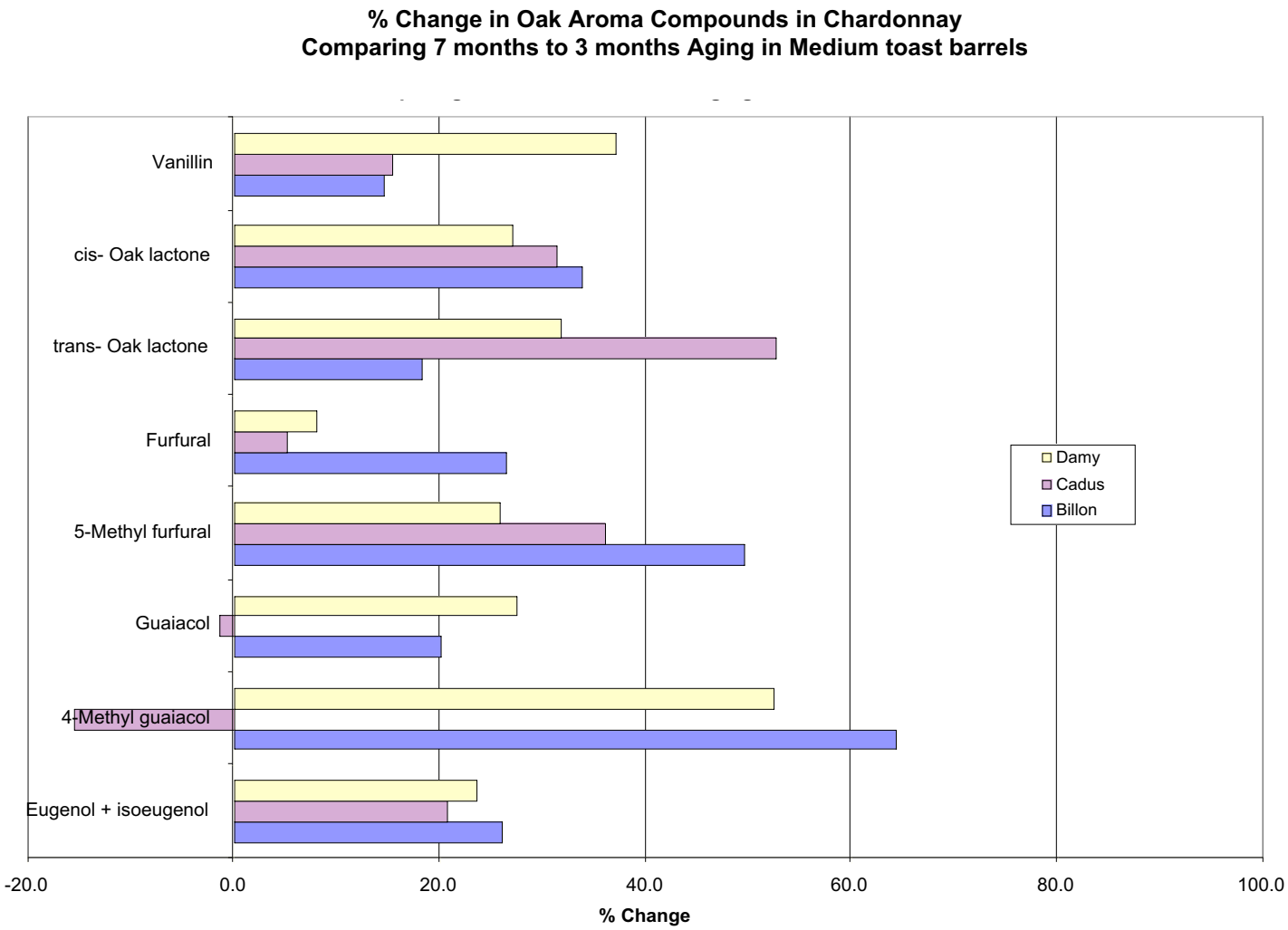


Figure 14 – Pinot Noir

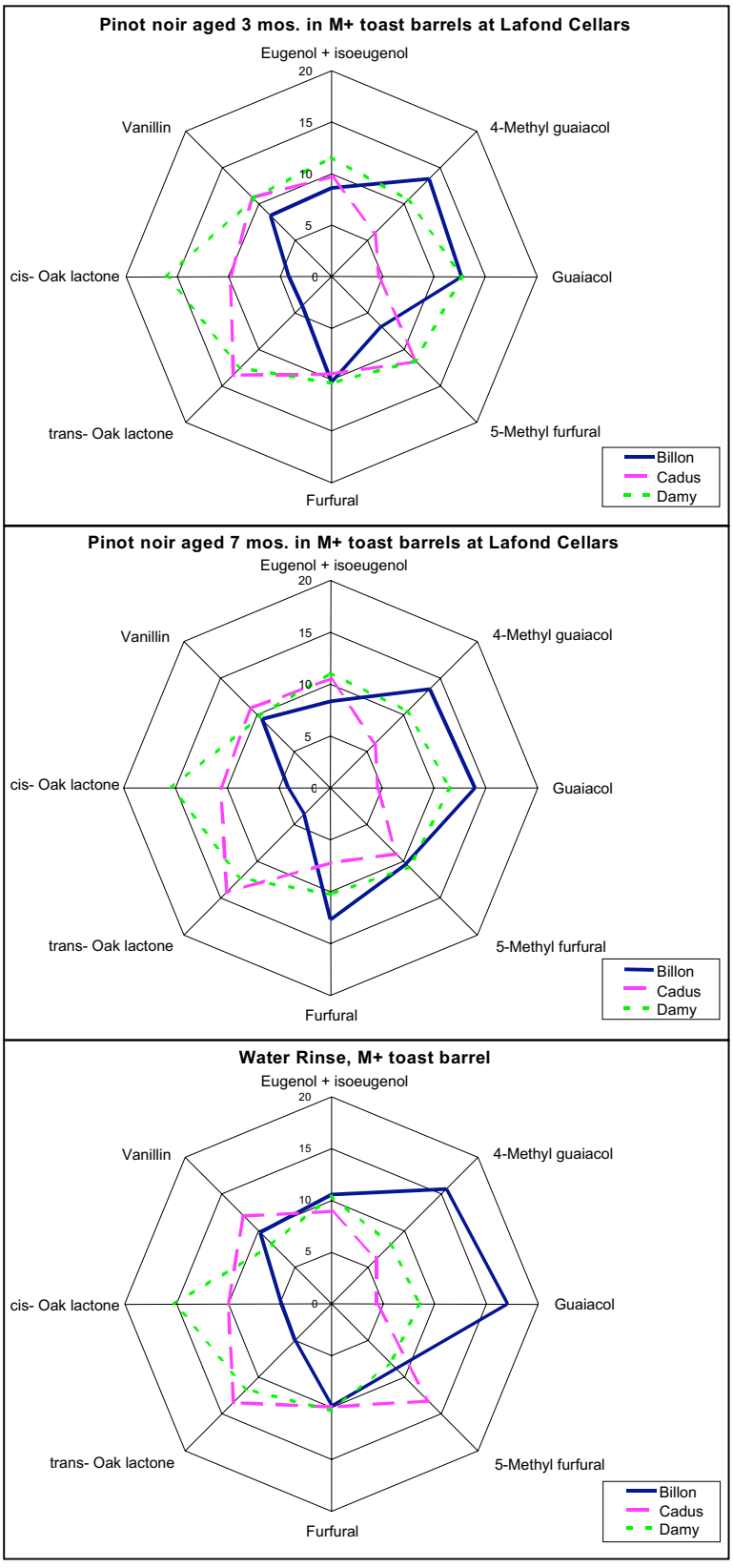
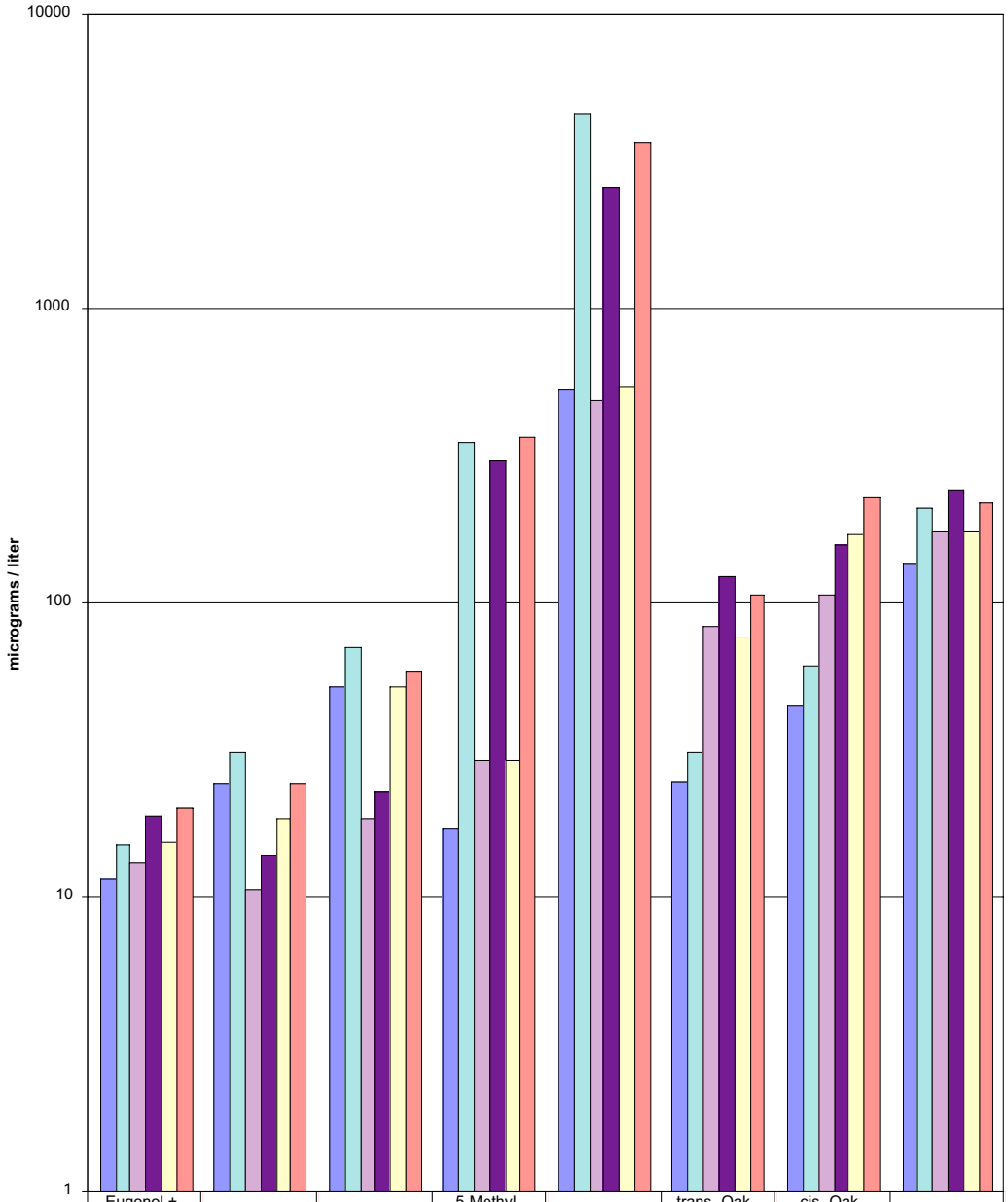


Figure 15a – Pinot Noir

Oak Aroma in Pinot Noir, Aged 3 and 7 months, M+ toast barrels (logarithmic scale)



	Eugenol + isoeugenol	4-Methyl	Guaiacol	5-Methyl furfural	Furfural	trans- Oak lactone	cis- Oak lactone	Vanillin
Billon, 3 mos	12	24	52	17	534	25	45	135
Billon, 7 mos	15	31	71	353	4564	31	61	210
Cadus, 3 mos	13	11	19	29	493	83	106	175
Cadus, 7 mos	19	14	23	307	2591	123	159	243
Damy, 3 mos	16	19	52	29	540	76	172	173
Damy, 7 mos	20	24	59	367	3689	106	230	218

Figure 15b – Pinot Noir

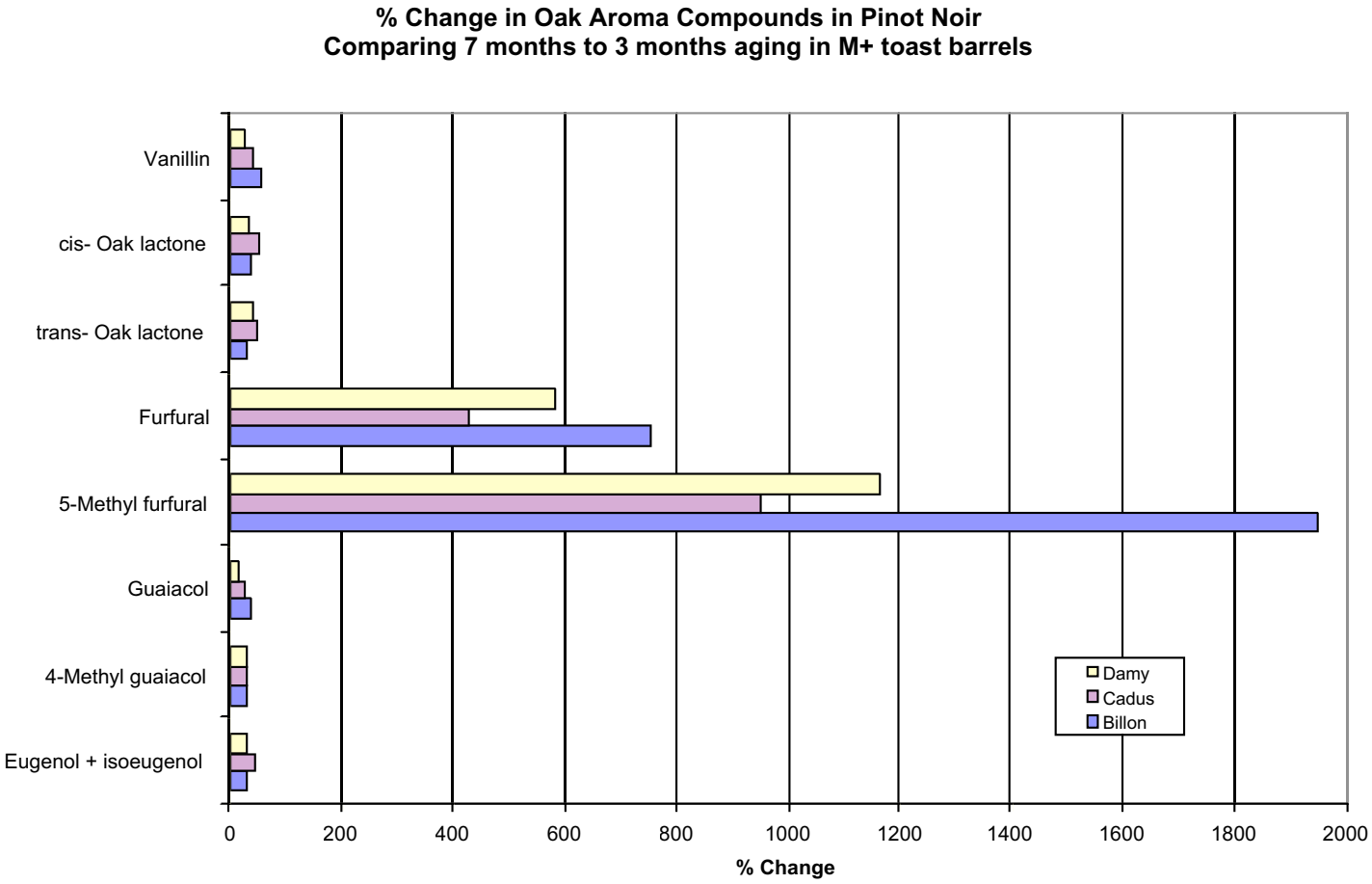
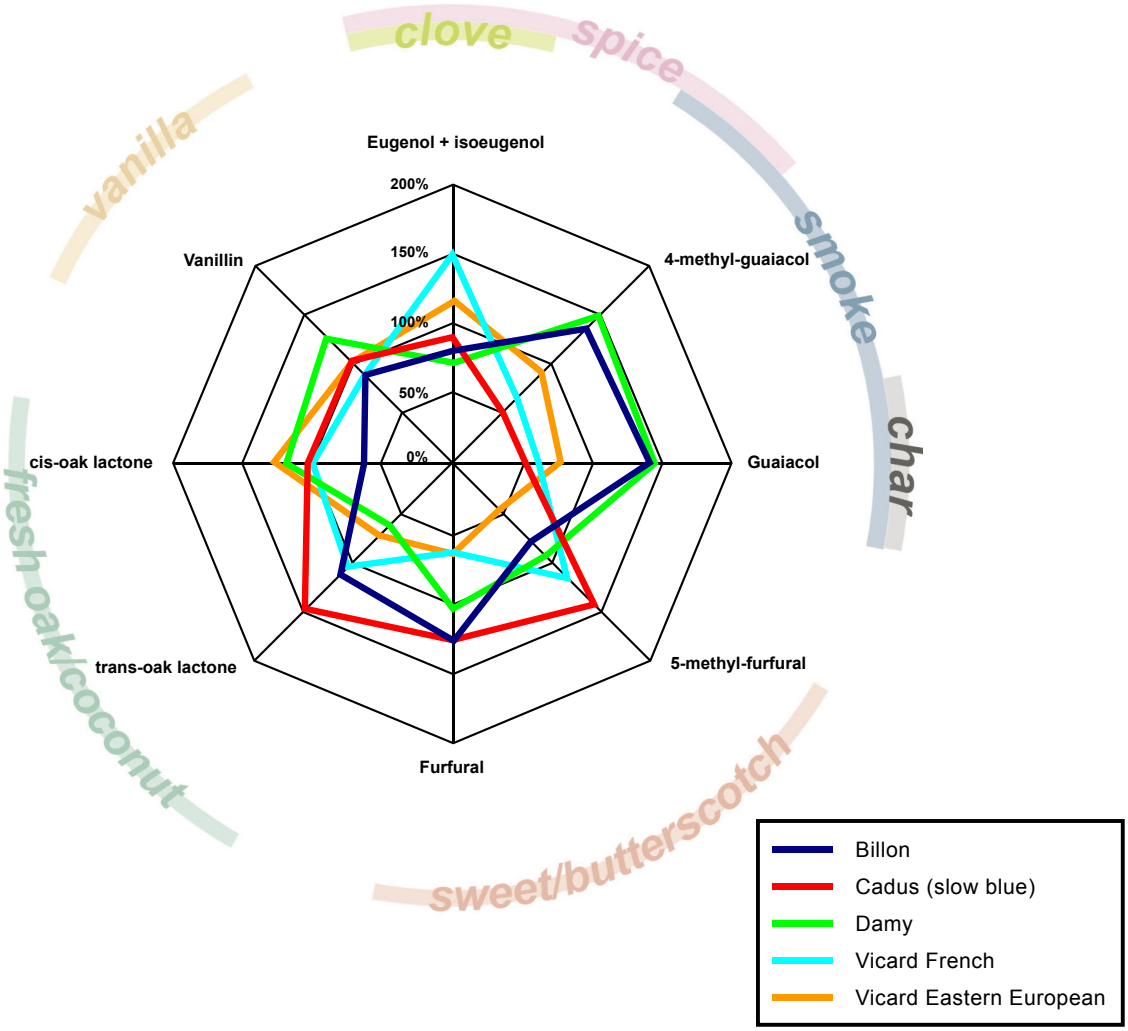


Figure 16a — Cabernet Sauvignon

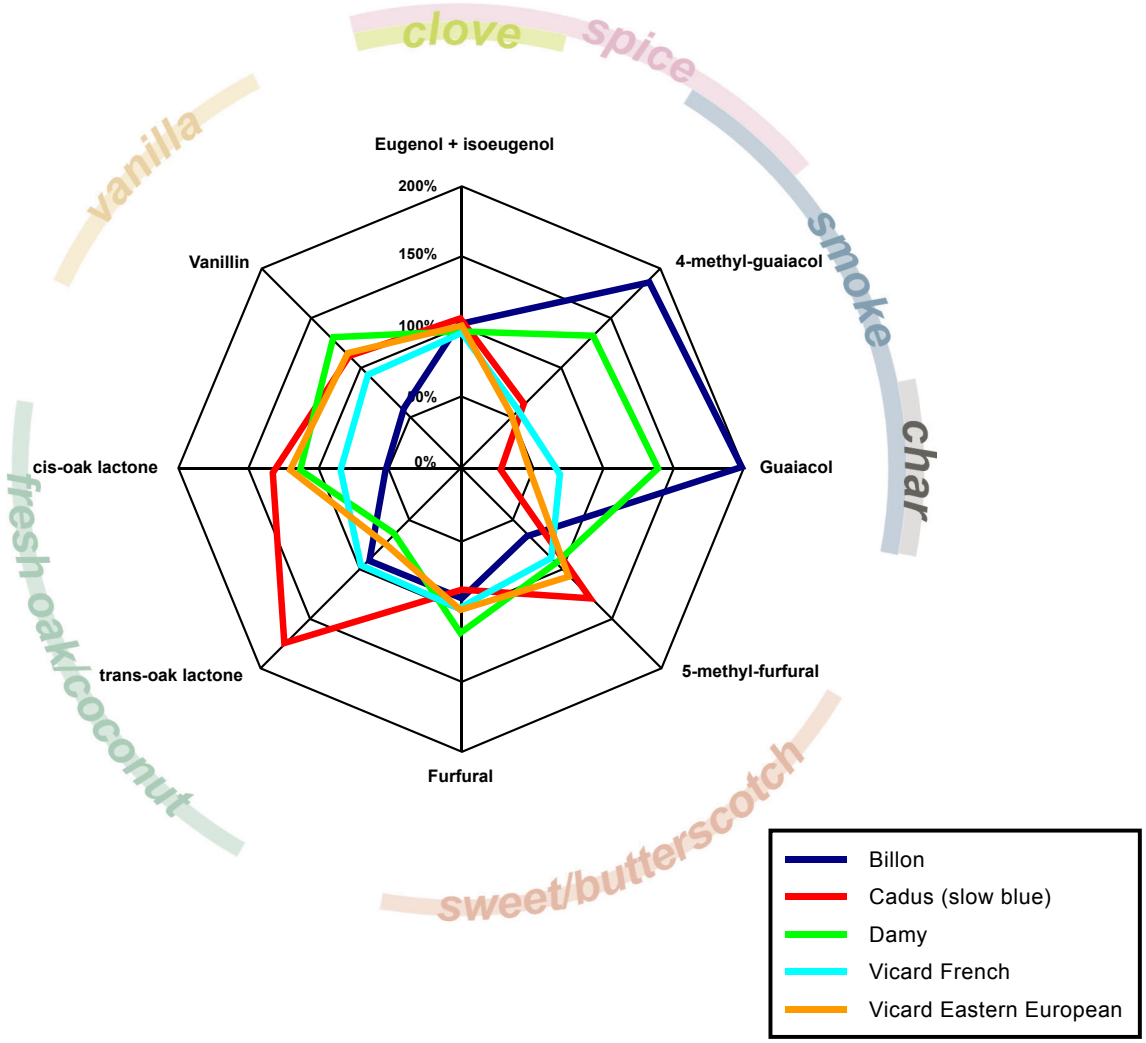
Cabernet Sauvignon aged 3 months in Medium toast barrels at Cakebread Cellars



Averages for all Cabernet sauvignon samples in this group

eugenol (ug/L	8.5		furfural (ug/L)	318.6
isoeugenol (ug/L	2.6		trans-oak lactone (ug/L	42.9
4-methylguaiacol (ug/L)	8.9		cis-oak lactone (ug/L	59.0
guaiacol (ug/L)	18.7		vanillin (ug/L)	255.1
5-methylfurfural (ug/L)	36.0			

Figure 16b — Cabernet Sauvignon
Water rinse, Medium toast barrels



eugenol (ug/L)	3.4		furfural (ug/L)	1396.9
isoeugenol (ug/L)	<0.5		trans-oak lactone (ug/L)	7.3
4-methylguaiacol (ug/L)	3.2		cis-oak lactone (ug/L)	10.0
guaiacol (ug/L)	2.9		vanillin (ug/L)	28.9
5-methylfurfural (ug/L)	89.4			