Young Scientists and Technologists in Malting, Brewing and Distilling

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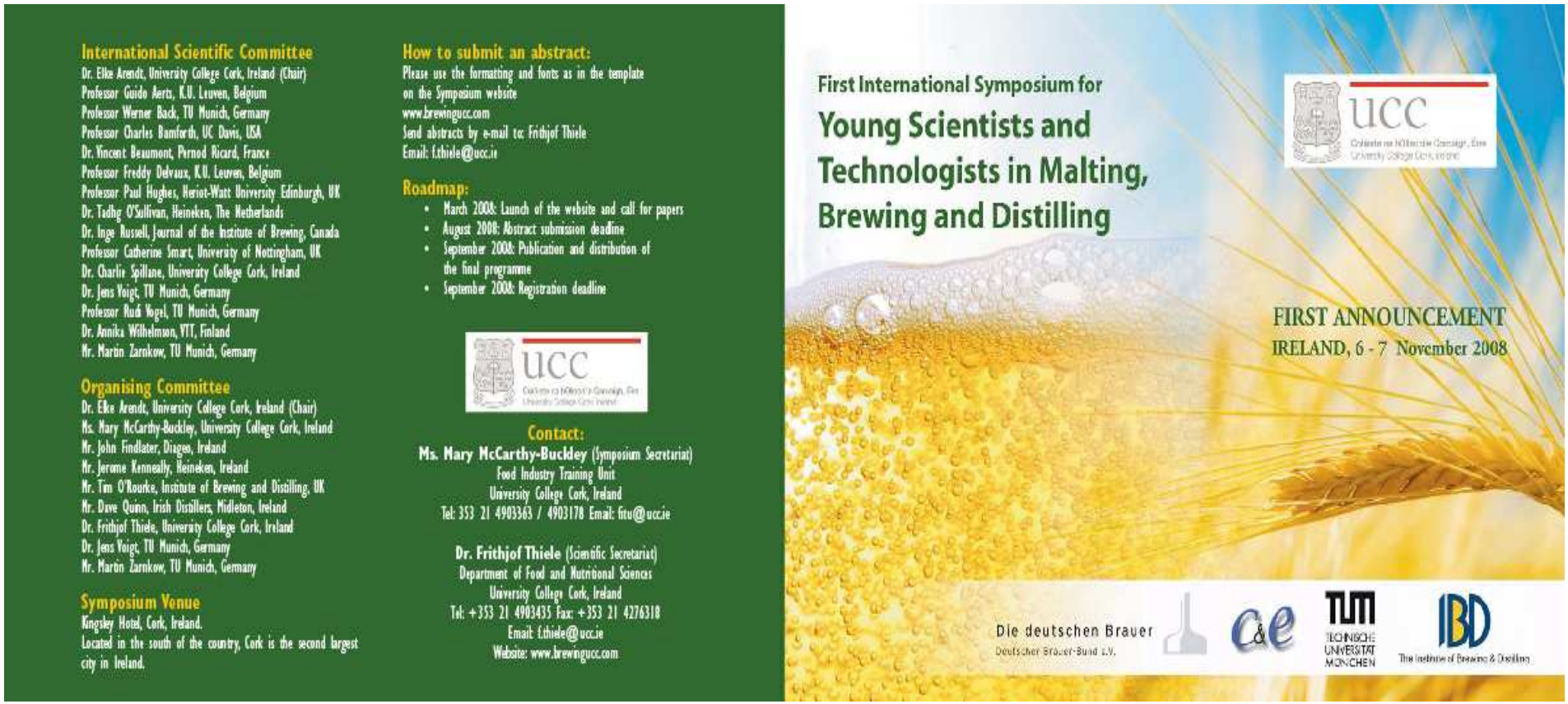
Lehrstuhl für Technologie der Brauerei I



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Symposium Venue
Kingsley Hotel, Cork, Ireland.
Located in the south of the country, Cork is the second largest city in Ireland.

How to submit an abstract:
Please use the formatting and fonts as in the template on the Symposium website
www.brewingucc.com
Send abstracts by e-mail to: Frithjof Thiele
Email: f.thiele@ucc.ie

Roadmap:
- March 2008: Launch of the website and call for papers
- August 2008: Abstract submission deadline
- September 2008: Publication and distribution of the final programme
- September 2008: Registration deadline

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First International Symposium for
Young Scientists and Technologists in Malting, Brewing and Distilling

FIRST ANNOUNCEMENT
IRELAND, 6 - 7 November 2008

Die deutschen Brauer
Deutscher Brauer-Bund e.V.

Cork/Ireland 6.–7. November 2008

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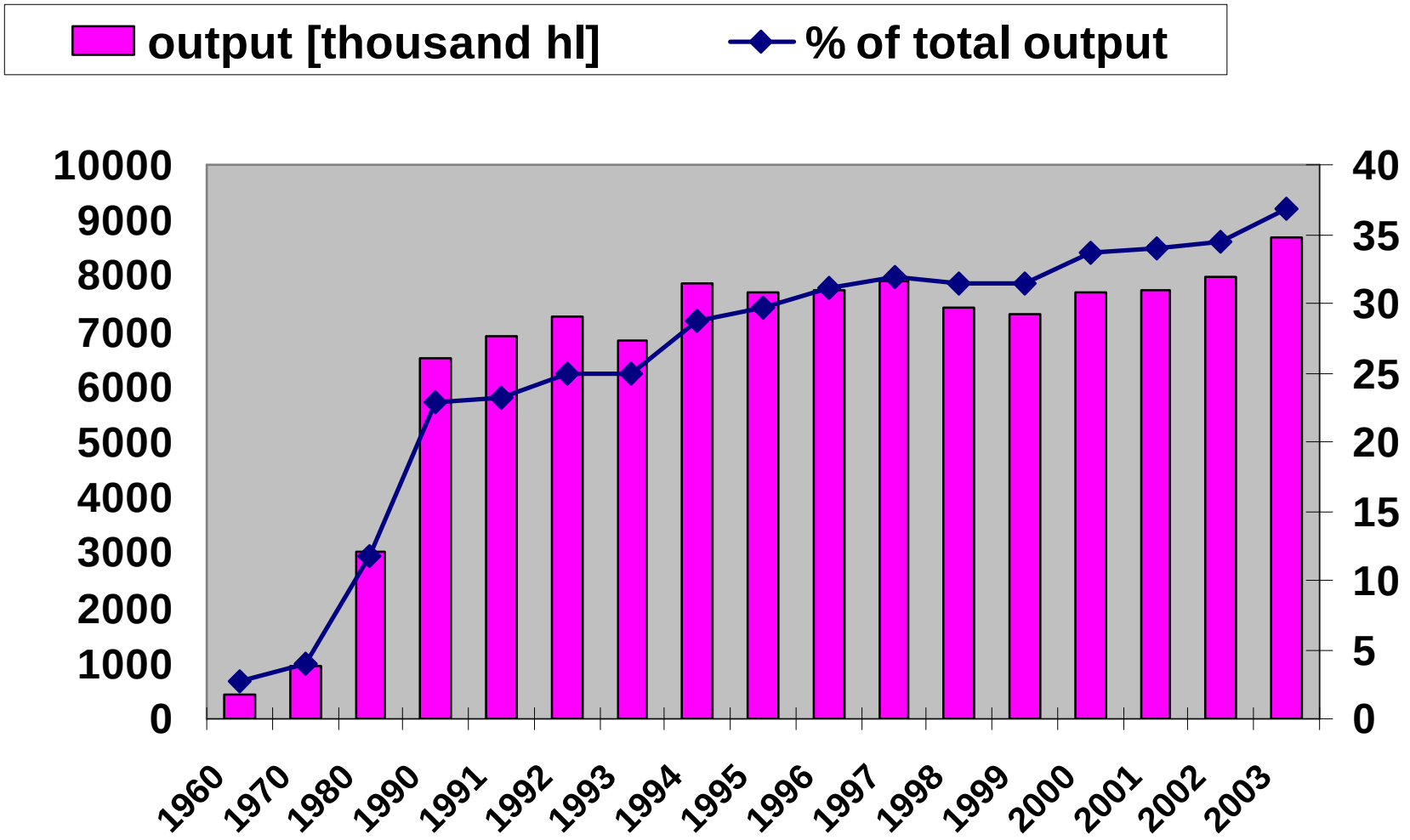
Martin Zarnkow

Flavours of Wheat Beers

Wheat Beer Production in Bavaria



Definition in Germany

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"Purity Law" => Vorläufiges Biergesetz

wheat beer is:

- malt charge has to be at least 50 % wheat malt

- mandatory top fermenting yeast with > 15 °C fermenting temperature

Aroma Compounds in Wheat Beer and Pale Beer

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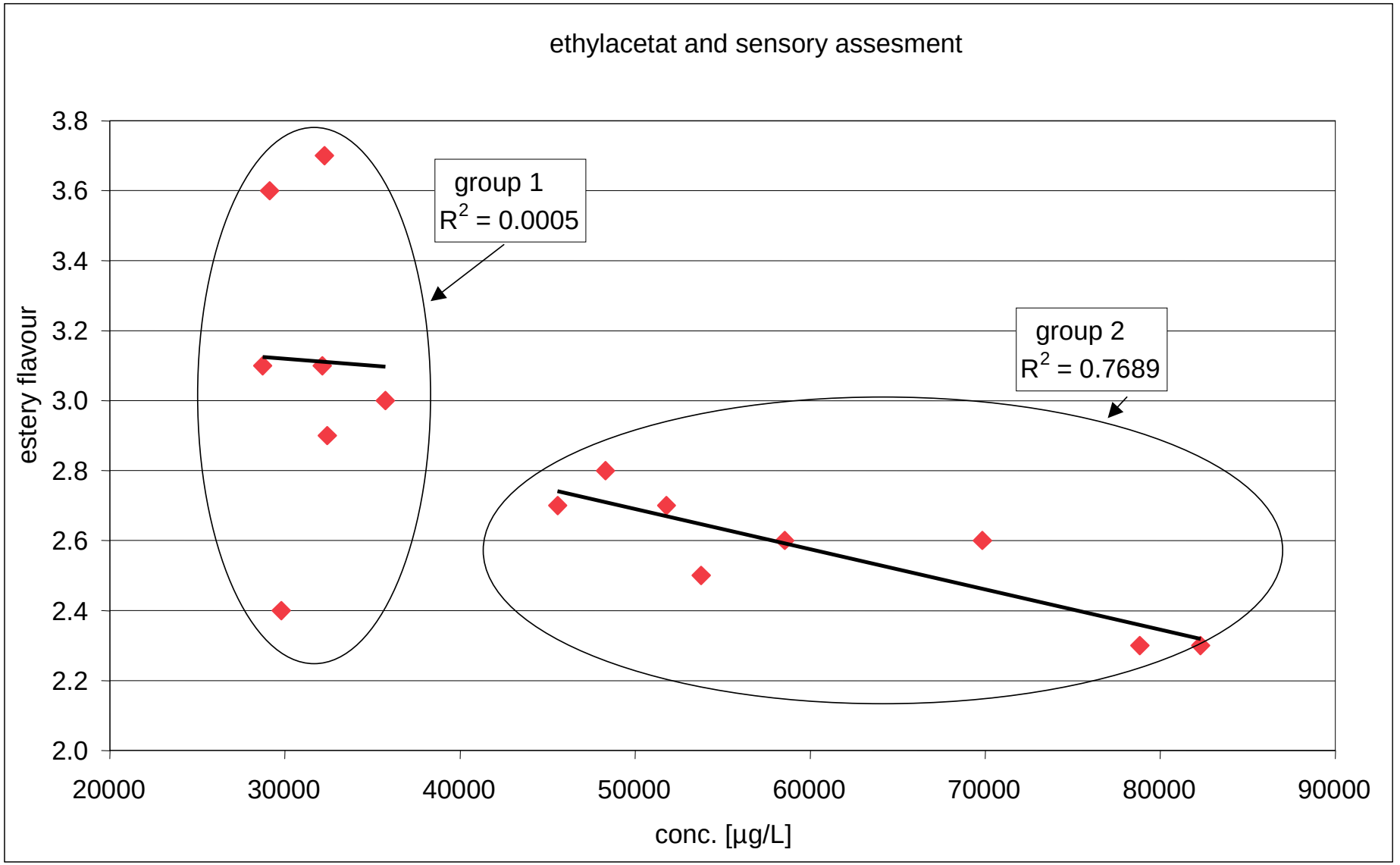
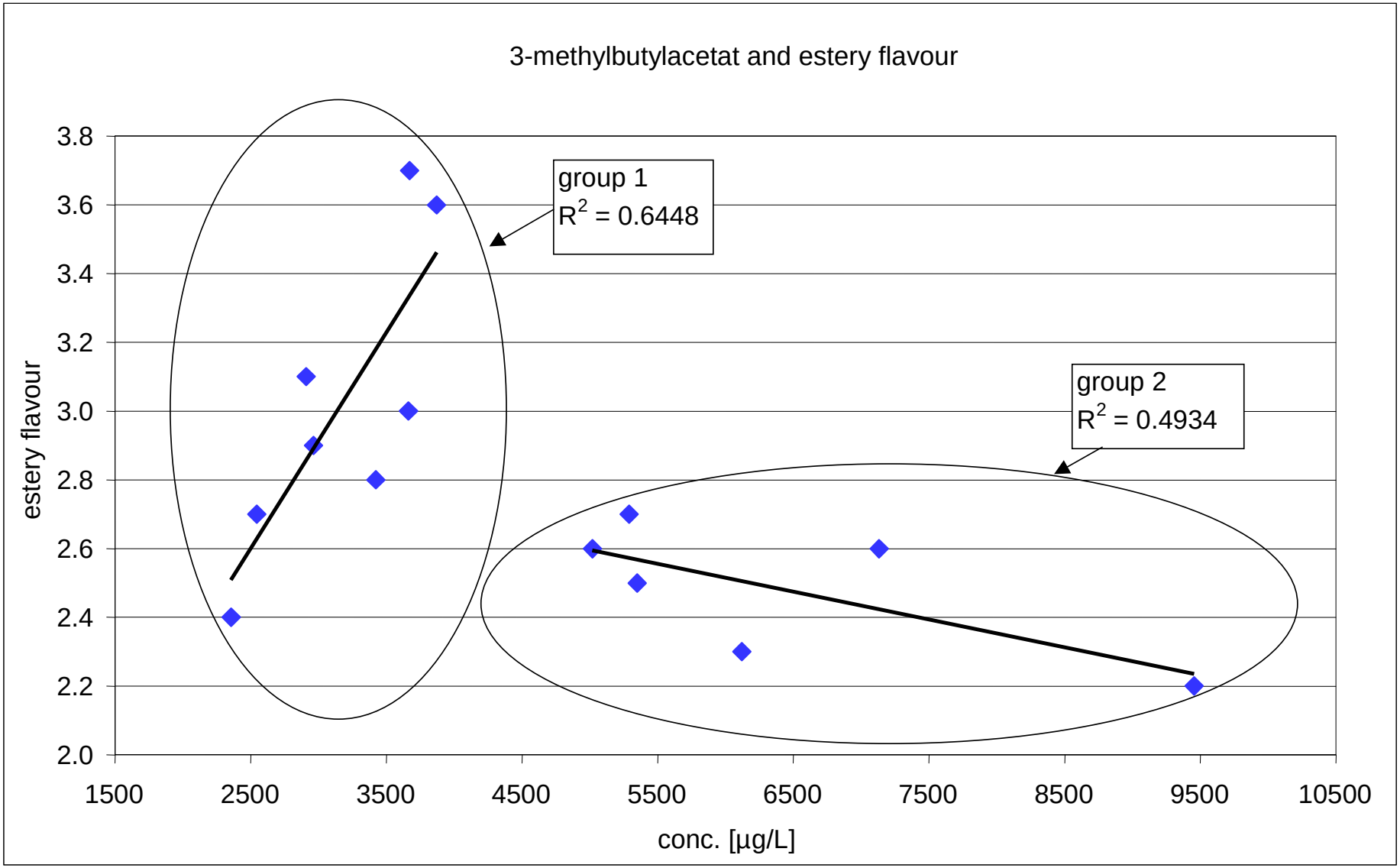
aroma compound		range in wheat beer	range in pale beer
propanol-1	mg/L	15–30	5–20
3-methyl-butanol-1	mg/L	40–100	30–50
hexanol-1	µg/L	15–50	10–30
octanol-1	µg/L	10–40	20–40
2-phenylethanol	mg/L	15–45	10–30
ethylacetat	mg/L	10–50	5–20
isobutylacetat	mg/L	0.05–0.8	0.05–0.1
isoamylacetat	mg/L	0.5–8	0.5–2
hexylacetat	µg/L	3–15	3–15
isovaleriansäure	mg/L	0.2–1	0.2–1
hexanacid	mg/L	1–4	0.5–2
octanacid	mg/L	2–10	2–10
gamma-nonalactone	µg/L	20–50	20–40
4-vinylguajakol	mg/L	0.5–3.5	0.1–1

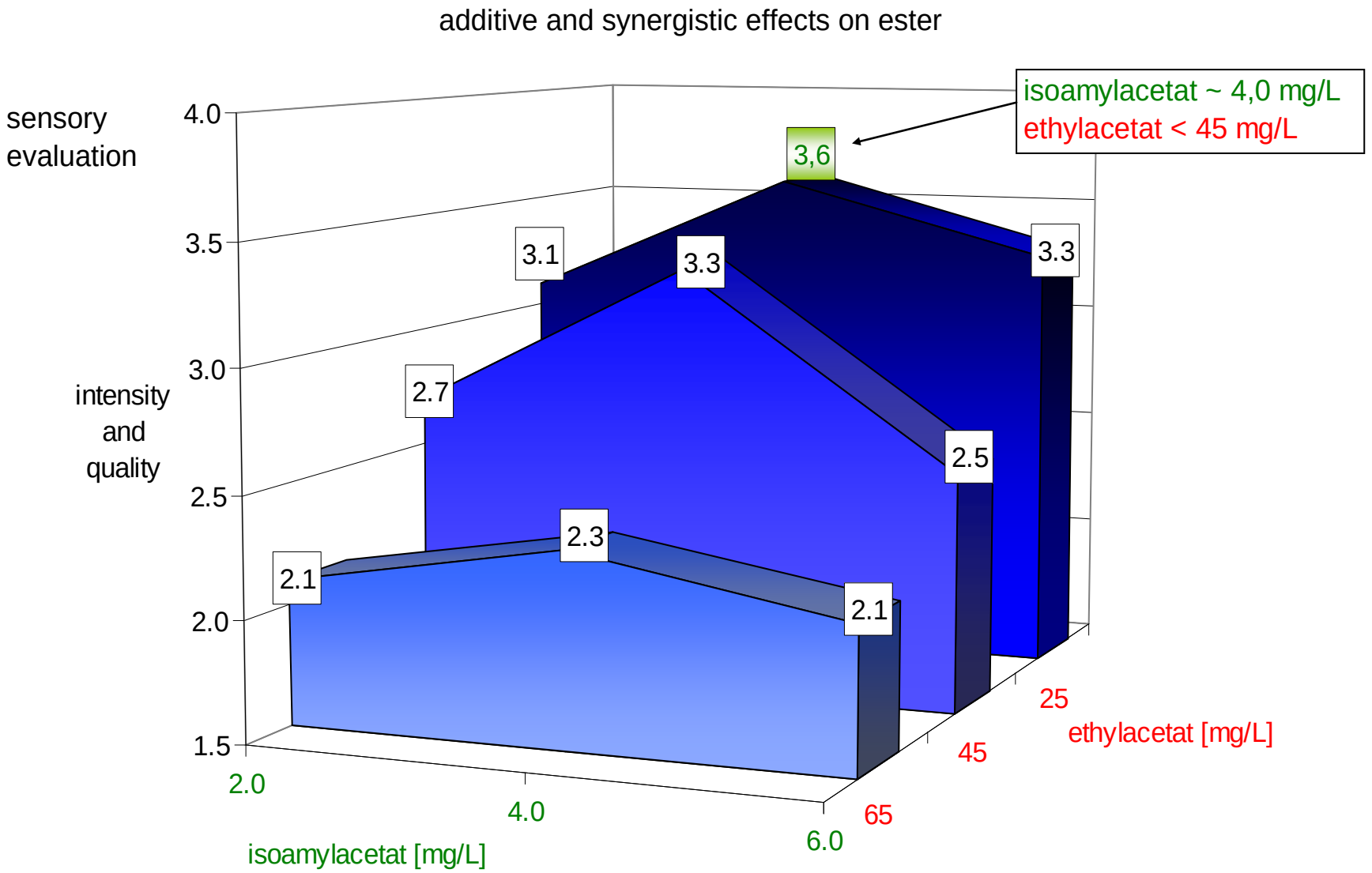
Ester and Sensory Assessment (1)



Ester and Sensory Assessment (2)



Ester and Sensory Assessment (3)



Wheat Beer Flavour (1)

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Phenolic flavour:

- "pleasantly" phenolic (clove-like = 4-vinylguaiacol)
- "unpleasantly" phenolic (hard, bitter, "medicinal") (p-kresol high concentration of 4-VG and 4-VP)

Estery flavour:

- typical estery (fruity, banana-like = isoamylacetate)
- atypical estery (solvent-like = ethylacetate, apple-like = hexylacetate)

Wheat Beer Flavour (2)

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Yeasty flavour:

- neutral
- "pleasantly" yeasty (substances unknown)
- sulfuric-yeasty
- yeast autolysis flavour (various middle and short chain fatty acids)

Malty flavour:

- in some pale and most dark wheat beers (Maltol, Furaneol)

Raw Material:

Wheat Malt

Importance of Wheat Beer for the Rural Economy

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		Germany	Bavaria
barley production	(mio. t)	5.1	1.2
usage of brewing barley	(mio. t)	2.5	0.5
usage of barley malt	(mio. t)	2.0	0.6
% used for brewing industry	(%)	48	50
wheat production	(mio. t)	16.0	3.1
usage of brewing wheat	(mio. t)	0.11	0.09
ussage of wheat malt	(mio. t)	0.09	0.07
% used for brewing industry	(%)	0.7	2.9

Characteristics of Pale Barley Malt and Wheat Malt

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	Pale barley malt	Pale wheat malt
Extract (%, dried malt)	80.0 - 83.5	81.5 - 86.0
pH	5.75 - 6.05	5.90 - 6.20
Final Attn. (%)	80.0 - 83.0	78.0 - 82.0
Colour (EBC)	2.2 - 3.8	3.0 - 4.5
Colour, boiled (EBC)	3.7 - 6.0	4.0 - 7.0
Viscosity (mPas, 8.6%)	1.50 - 1.57	1.55 - 1.80
ß-Glucan (Grist, mg/100g dried Malt)	300 - 750	n.a.
ß-Glucan (EBC-Mash, mg/100g MT)	70 - 200	n.a.
solub. N (mg/100g MT)	650 - 750	600 - 800
Kolbach (%)	38 - 42	35 - 45
FAN (mg/100g MT)	135 - 155	100 - 140
DK (°WK)	230 - 380	230 - 450
α-Amylase (ASBC)	35 - 60	30 - 60

Processability of Wheat Varieties

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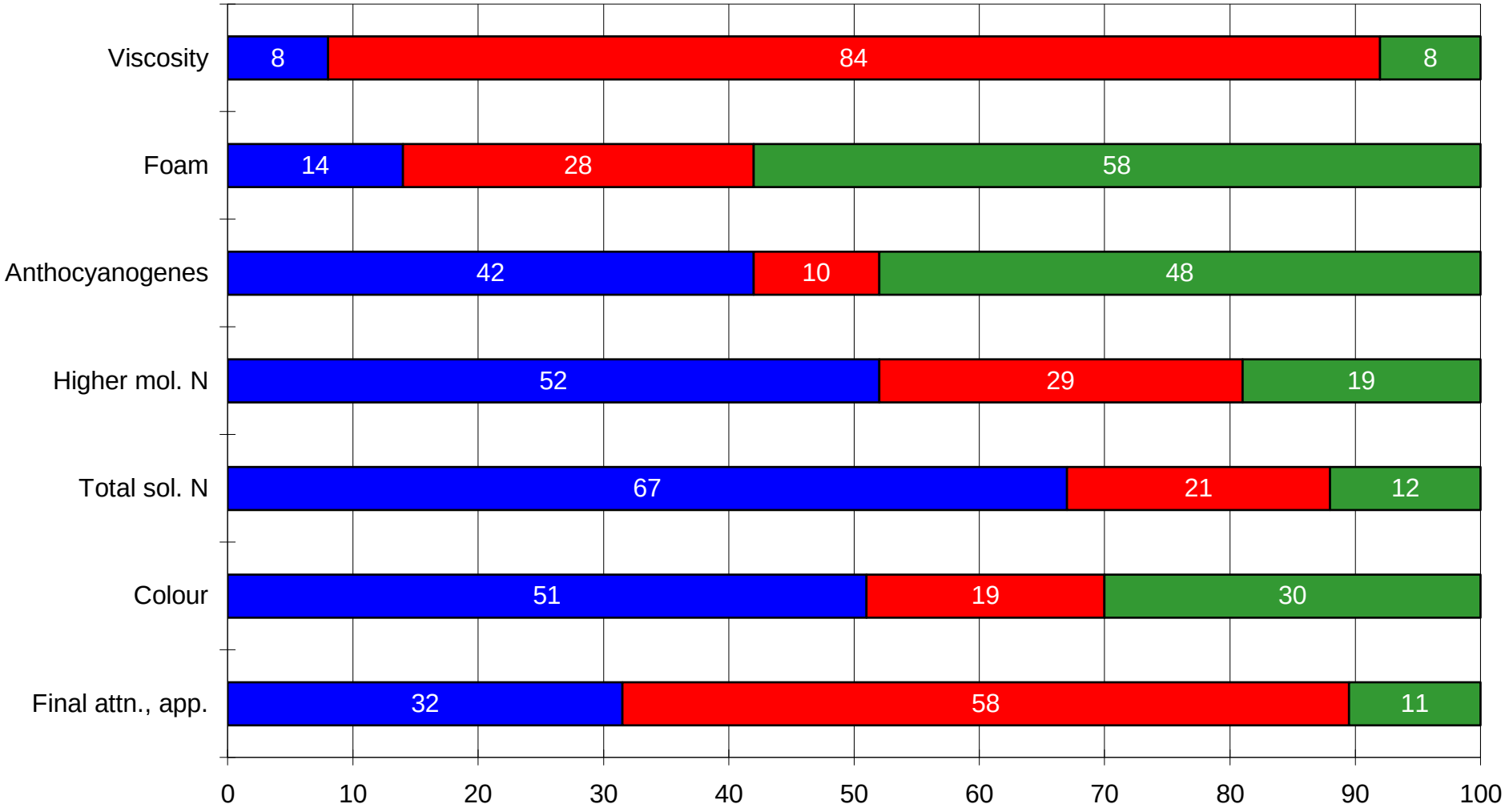
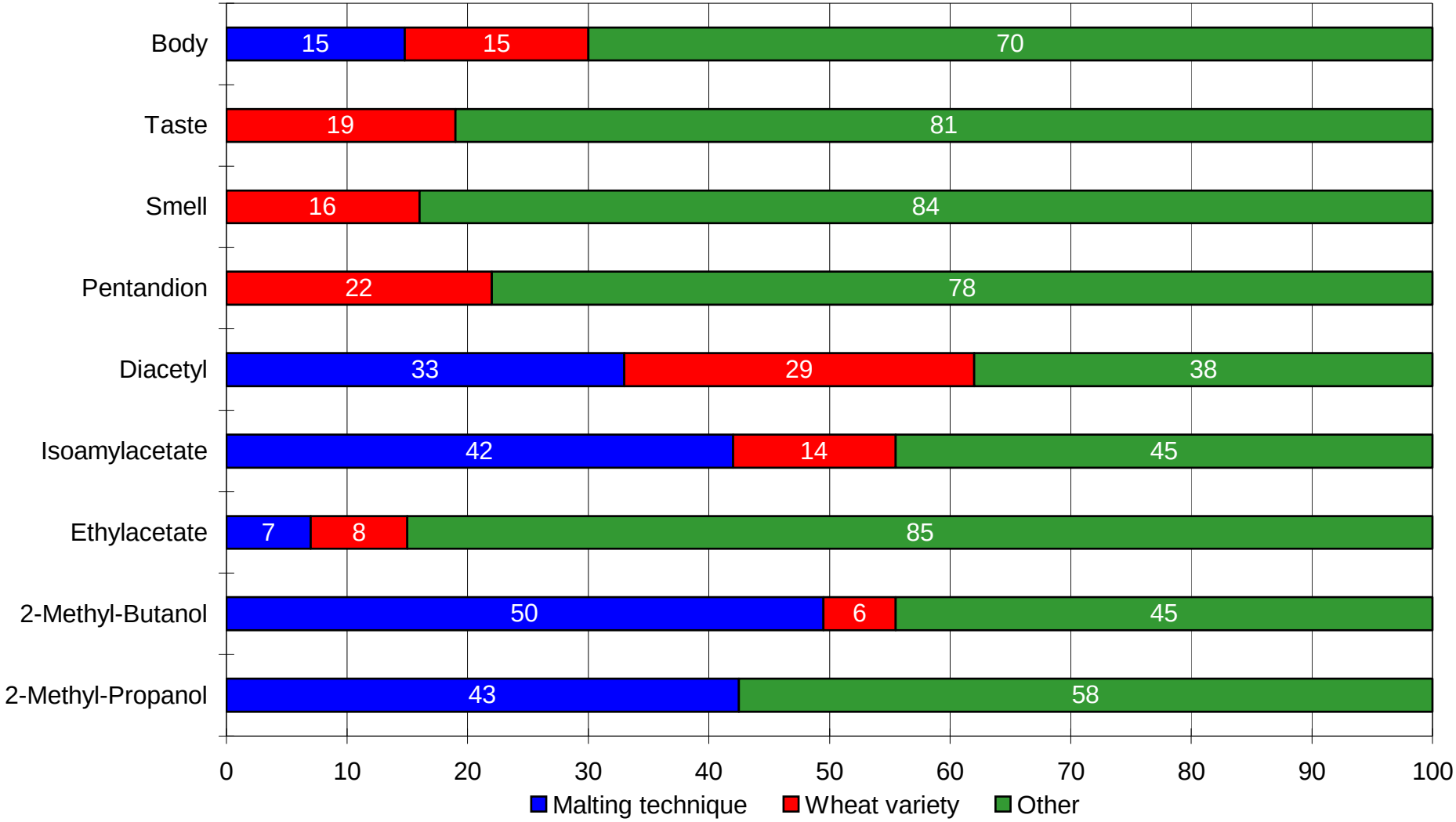
	Variety	Viscosity	sol. N	ß-Amlyase	α-Amylase	Malting technique
Group 1: low to medium viscosity and low to medium protein content	Estica	0	-	++	+	no special technique neccessary
	Obelisk	0	-	++	0	
	Andros	0	-	++	+	
	Kanzler	--	-	++	+	
	Orestis	0	--	++	0	
	Atlantis	-	0	+++	+	
Group 2: low to medium vicosity & high protein content	Florida	0	++	++	++	rising temperature and low steeping grade
	Claudius	-	+	+	0	
Group 3: high viscosity and low to medium protein content	Longos	++	-	+	0	falling temperature and high steeping grade
	Boheme	+	-	+	++	
	Piko	++	0	0	+	
	Greif	++	0	0	0	
Group 4: high viscosity and high protein content	Gorbi	+	+	-	0	not possible
	Toronto	+	+	+++	-	
	Herzog	+	++	-	--	

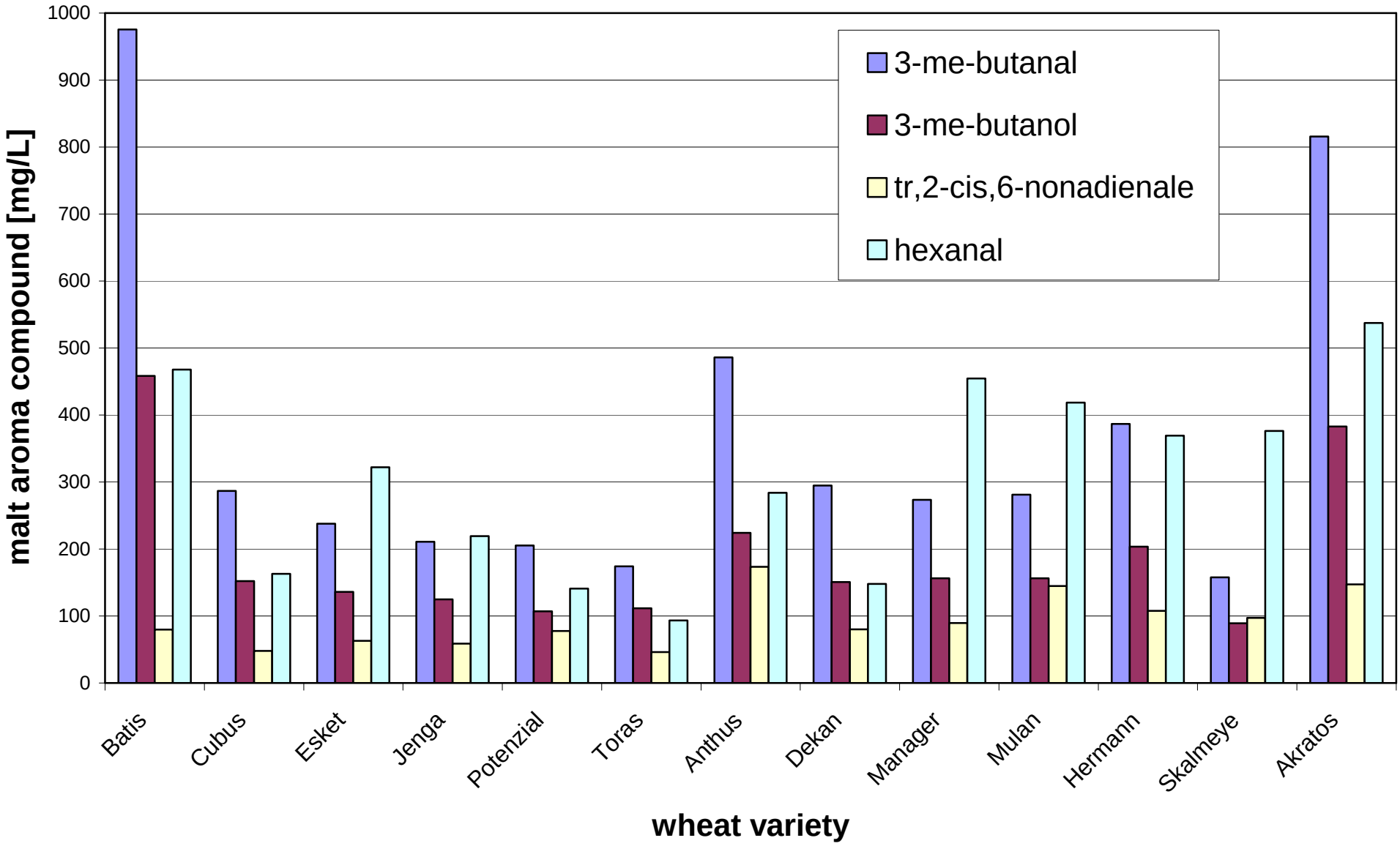
Influence of the Wheat Variety and Malting Technique on Wheat Attributes (1)



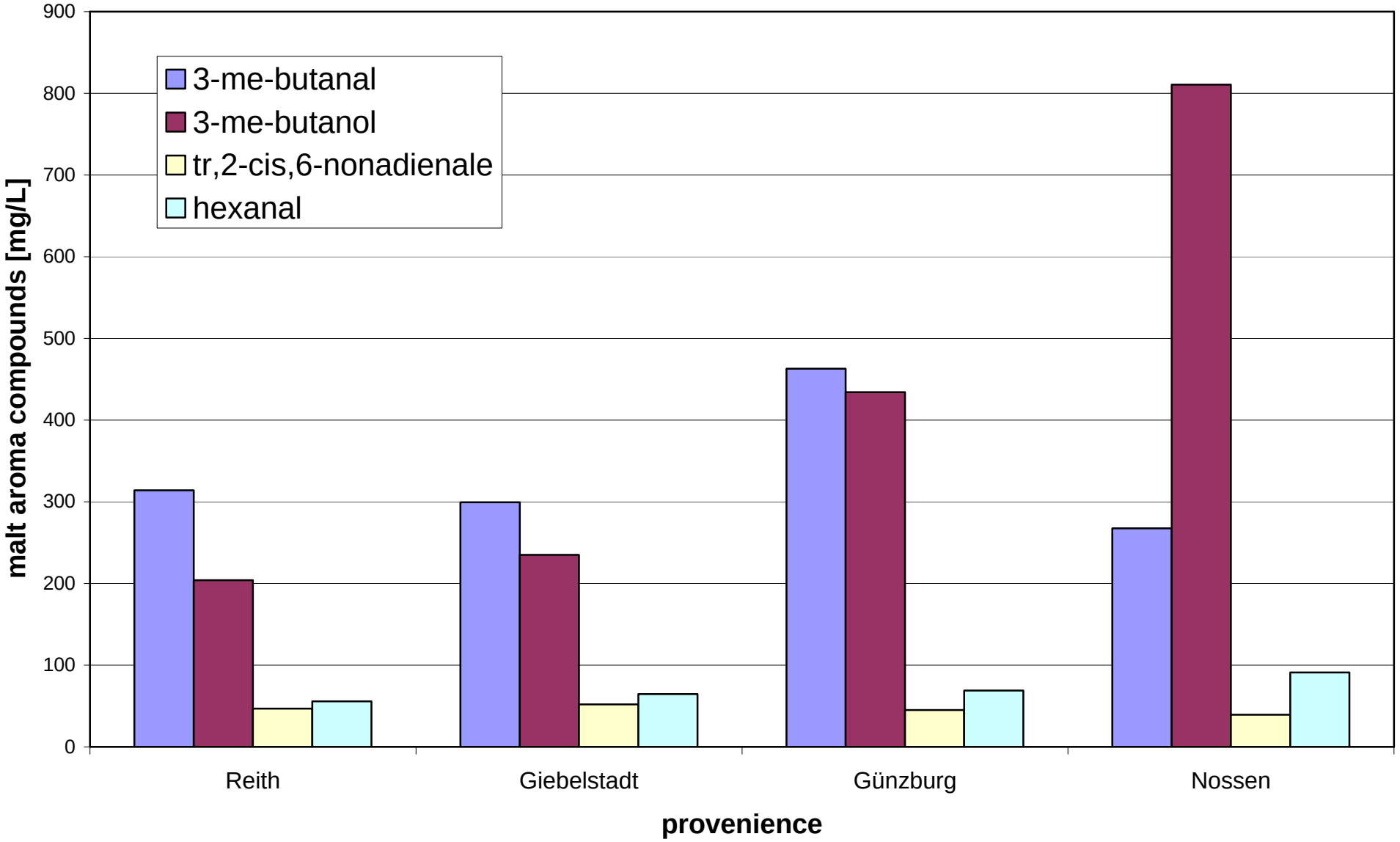
Influence of the Wheat Variety and Malting Technique on Wheat Attributes (2)



Malt Aroma Compounds Depending on Variety



Malt Aroma Compounds Depending on Provenience

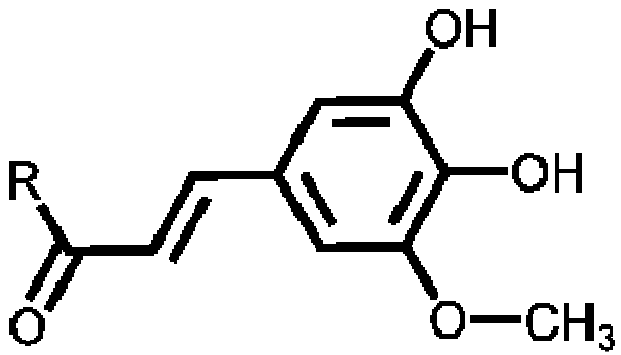


Ferulic Acid in Wheat and Barley Malt

Wheat malt has a significantly lower ferulic acid content than barley malt. The barley/wheat ratio is therefore a decisive factor in determining the phenolic flavour of wheat beers.

It is the predecessor to 4-Vinylguaiacol. It arises through thermic (boiling) and mainly enzymatic (i. e. yeast strain) decarboxylization of ferulic acid.

Ferulic acid is bound to arabinoxylan in wheat and barley malt and is released during mashing by hydrolytic enzymes.



Ferulic Acid

Overview Wheat Beer Technology

Wheat Beer Technology (1)

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Technolog. parameter:	Range:
malt charge (wheat)	50–100 %
Mashing regime	40 % decoction 60 % infusion
Mashing-in temperature	30–57 °C
Intensity of the proteolytic rest	45–58 °C, 10 –26 minutes
Intensity of the amylolytic rest	59–69 °C, 20 –200 minutes
Mash acidification	18 %
Boiling time	50–210 minutes

Wheat Beer Technology (2)

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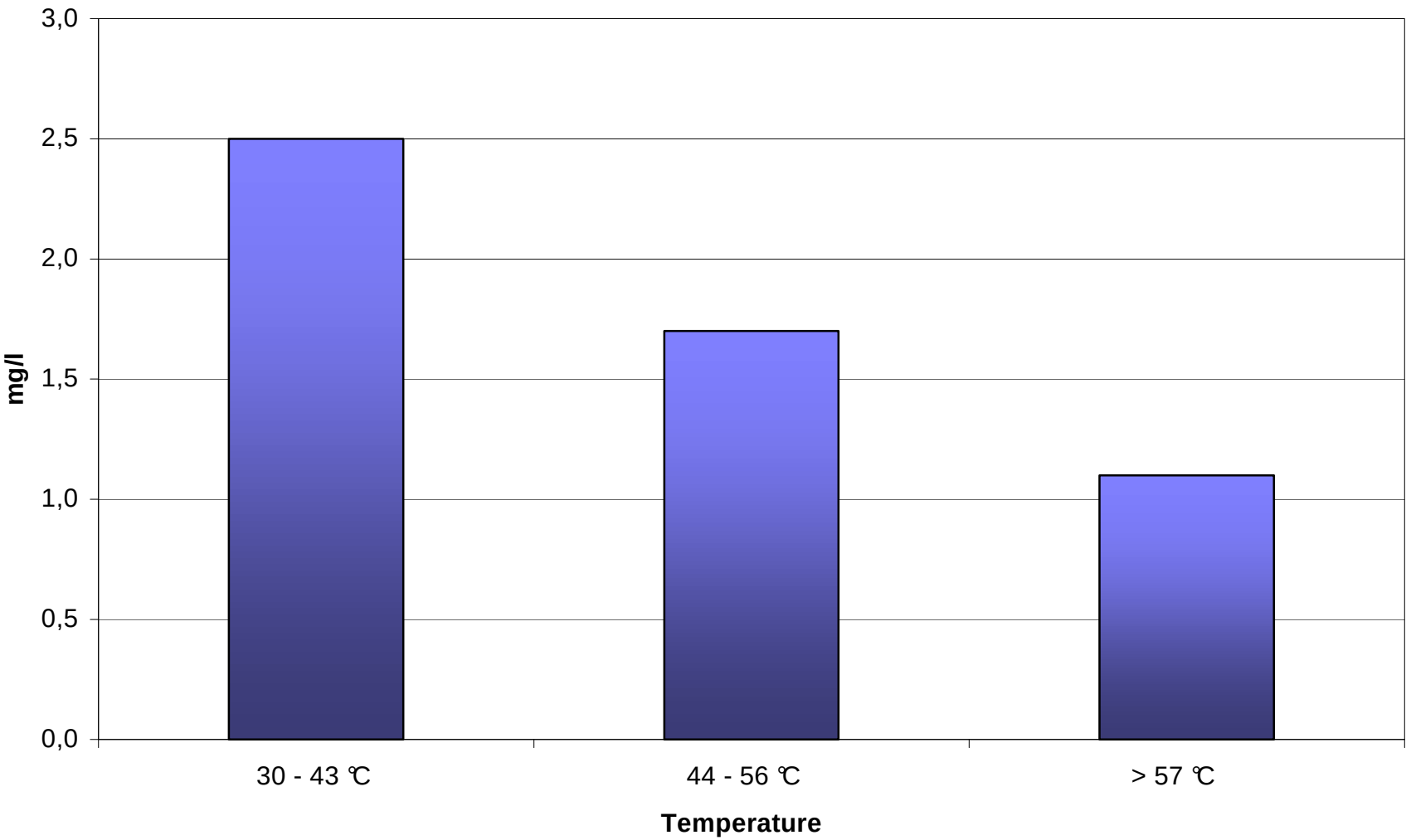
Technolog. parameter:	Range:
Cold trub separation	25 %
Fermentation vessel	25 % vat 19 % horizontal tank 25 % vertical tank 31 % CV
Fermentation temperature	18–25,5 ℃
Fermentation time	2–7,5 days
„Speise“ (Feed) addition	42 % cast wort 8 % sweet wort 23 % bottom-fermenting crausen 7 % mixture of bottom/top fermenting crausen

Wheat Beer Technology (3)

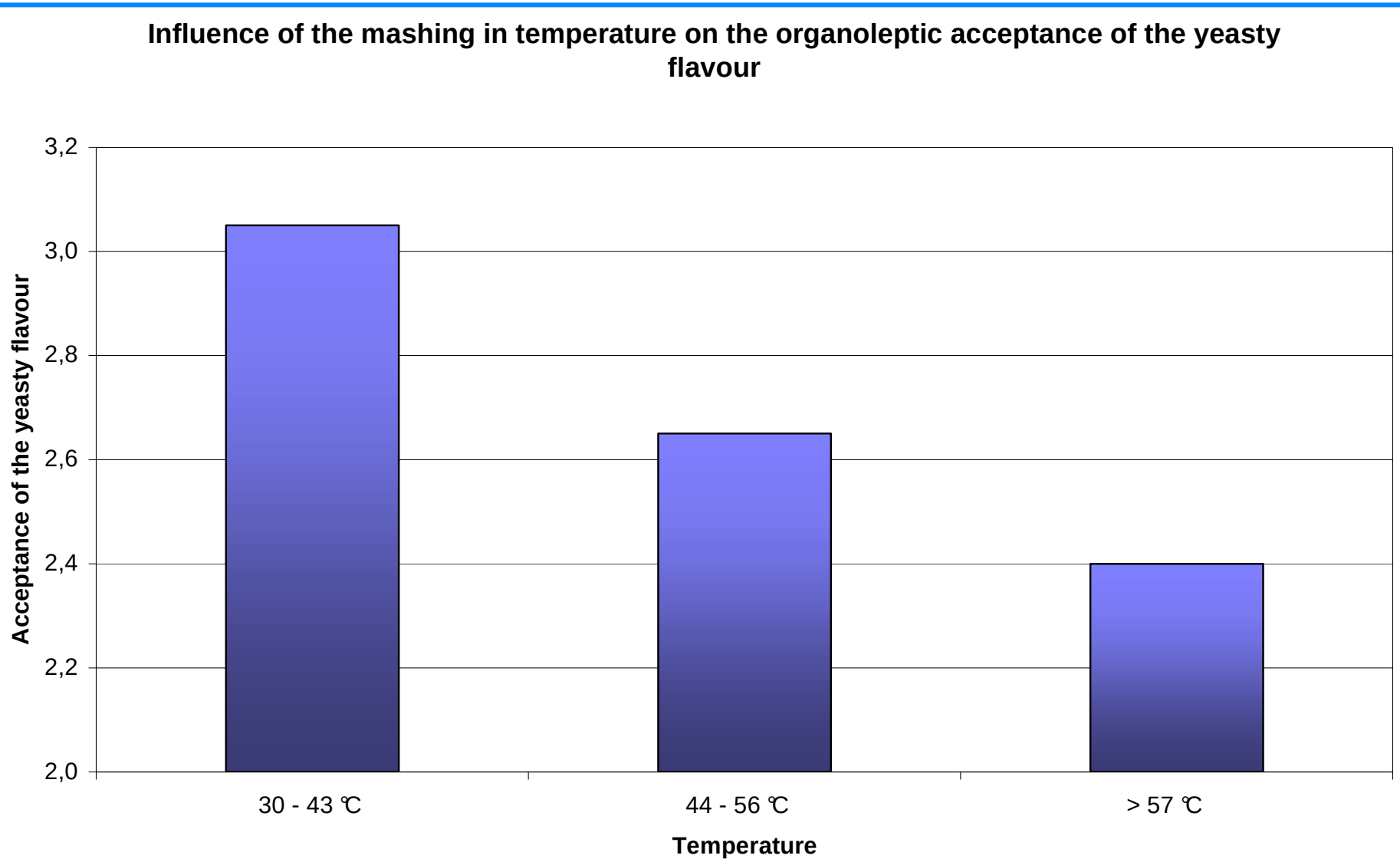
Technolog. parameter:	Range:
Bottle - Tank conditioning	75 % bottle 25 % tank
Warm storage	16–22 °C
Cold storage	4–10 °C
Yeast addition for conditioning	40 % no additional yeast 7 % top-fermenting yeast 25 % bottom-fermenting yeast 7 % bottom- and top-fermenting yeast
Flashing	47 % use flashing 53 % do not use flashing

Mashing

Technological Parameters (1)



Technological Parameters (2)



Technological Parameters (3)

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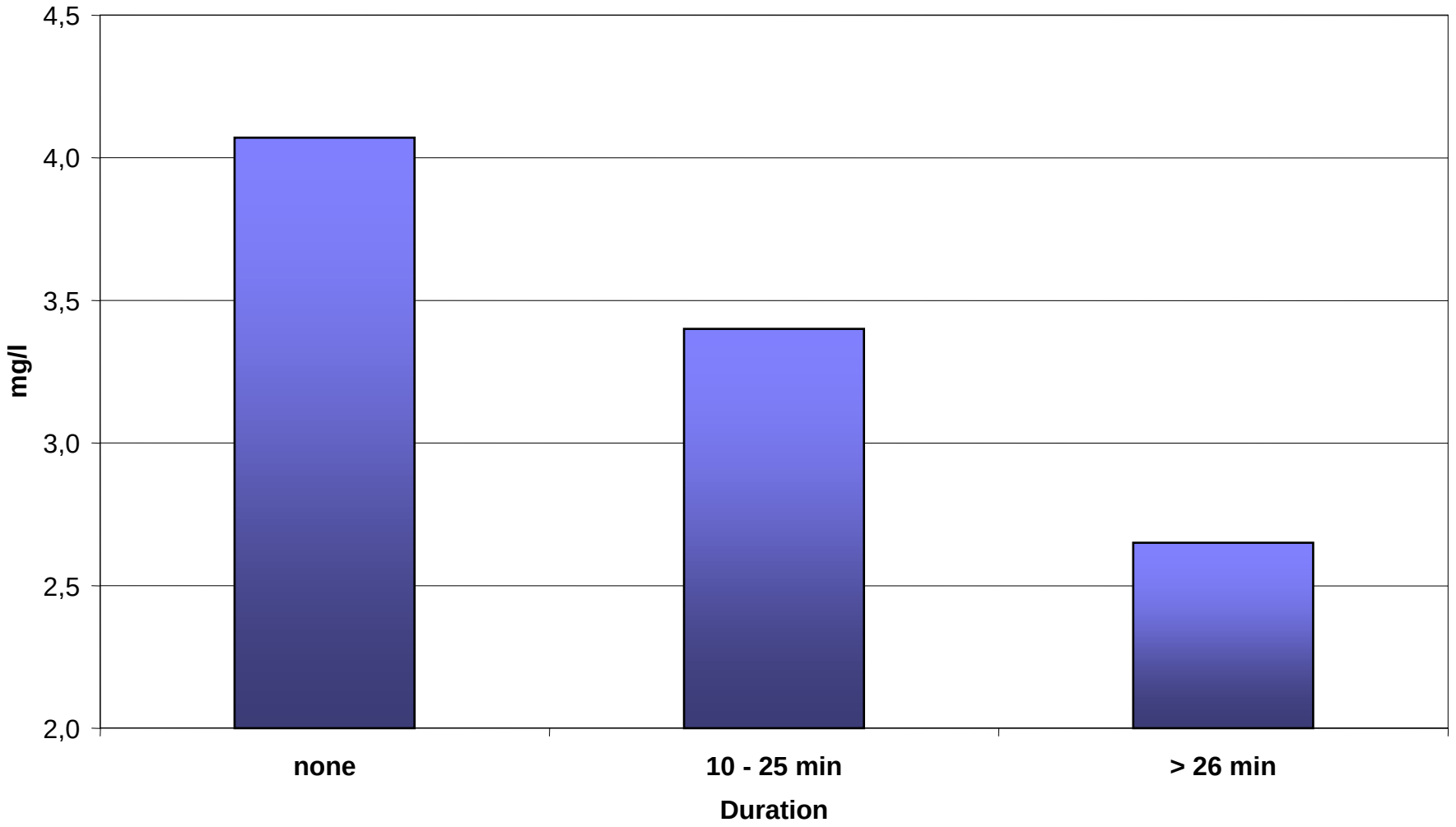
Influence of the mashing-in intesity on the isoamylacetate content



Technological Parameters (4)

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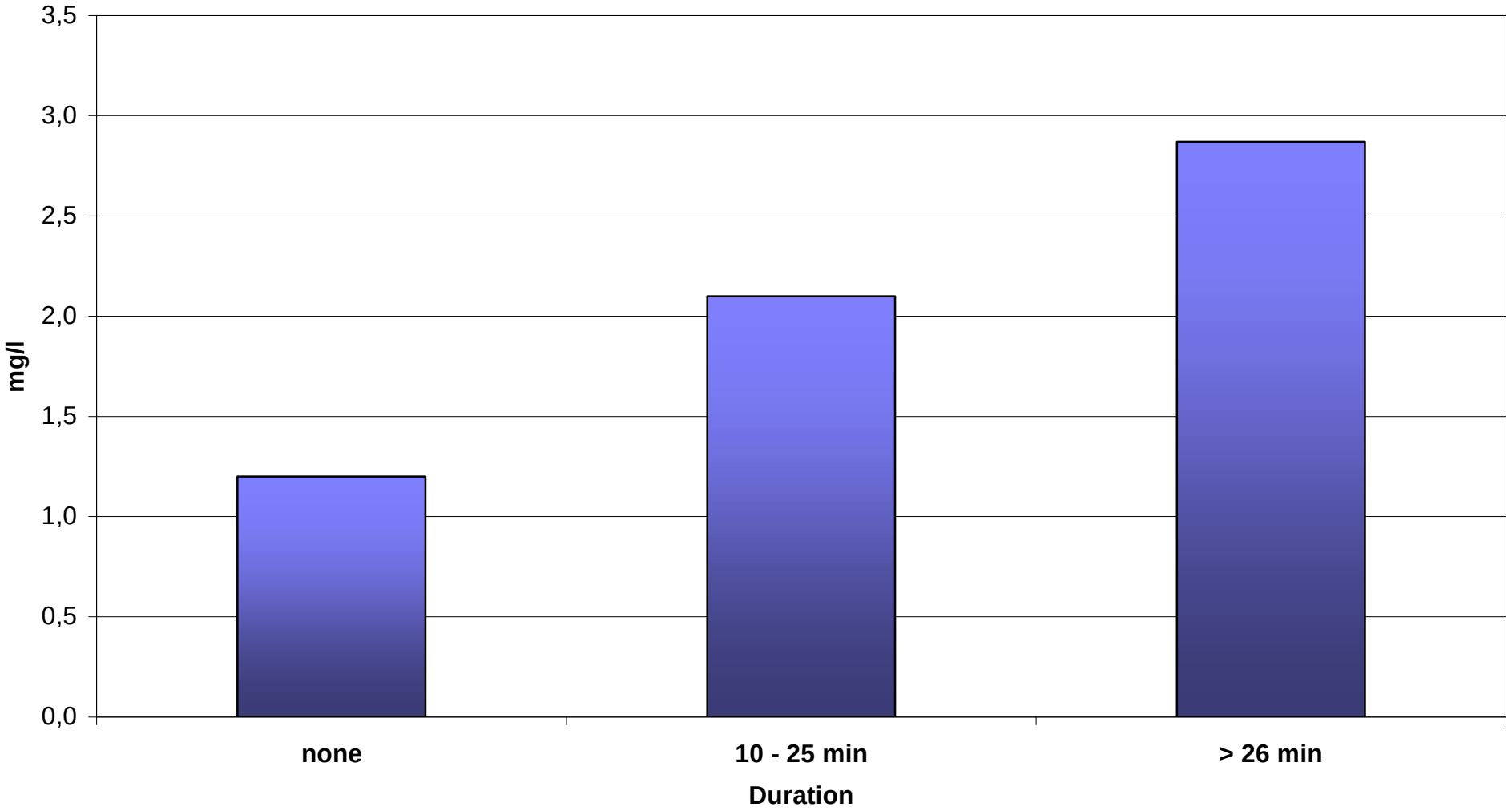
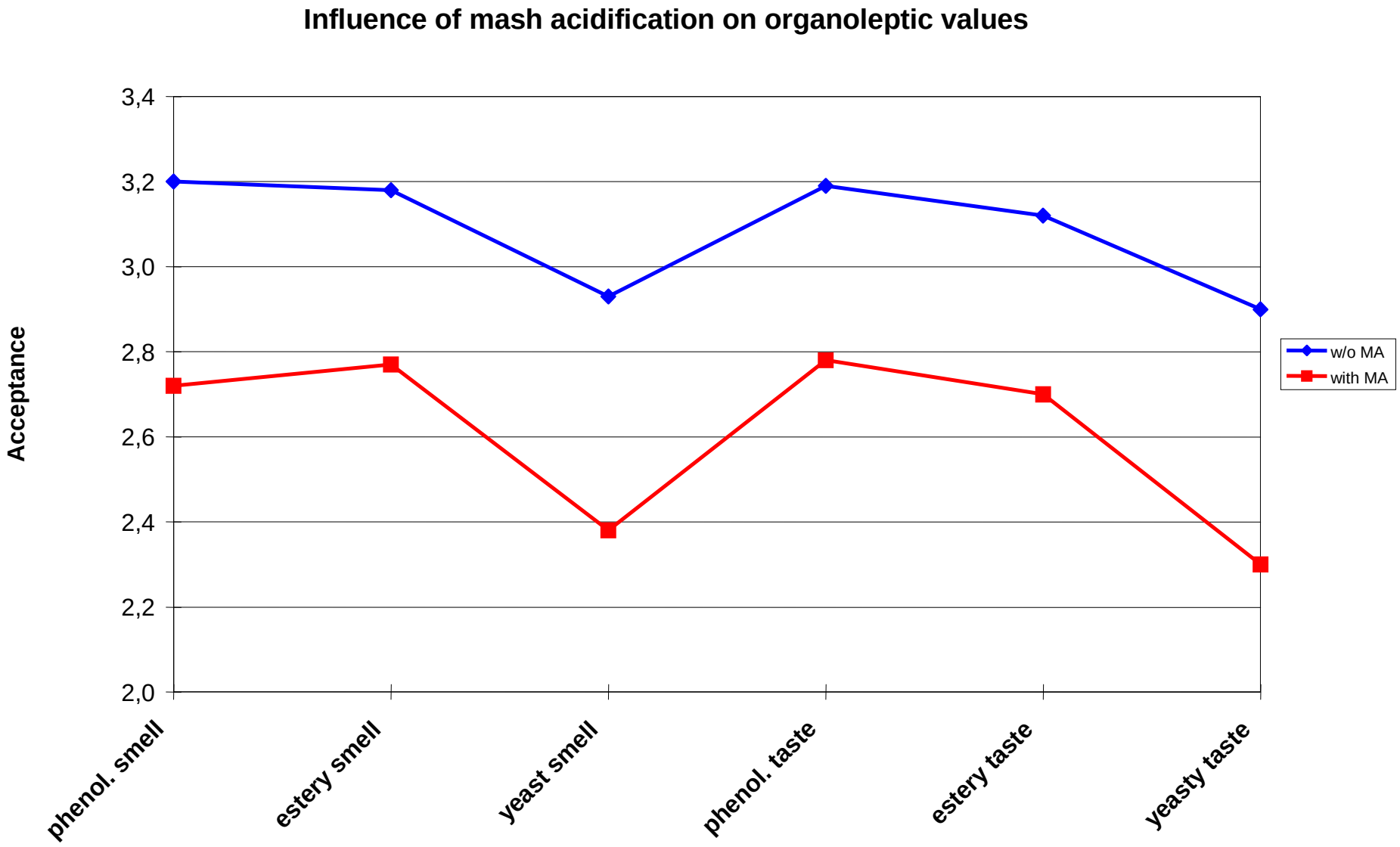
Influence of the mashing-in intesity on the 4-VG content



Technological Parameters (5)



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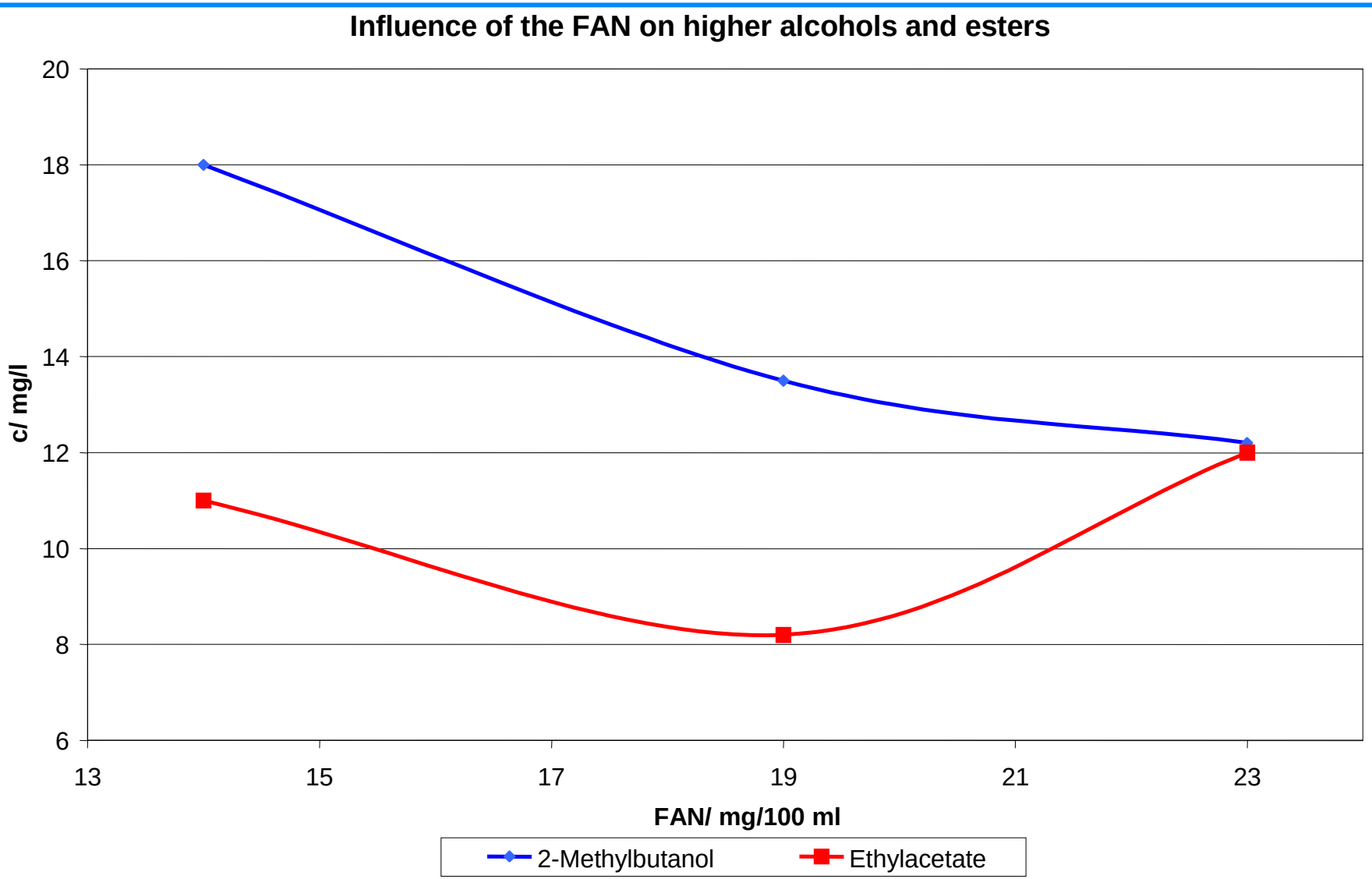

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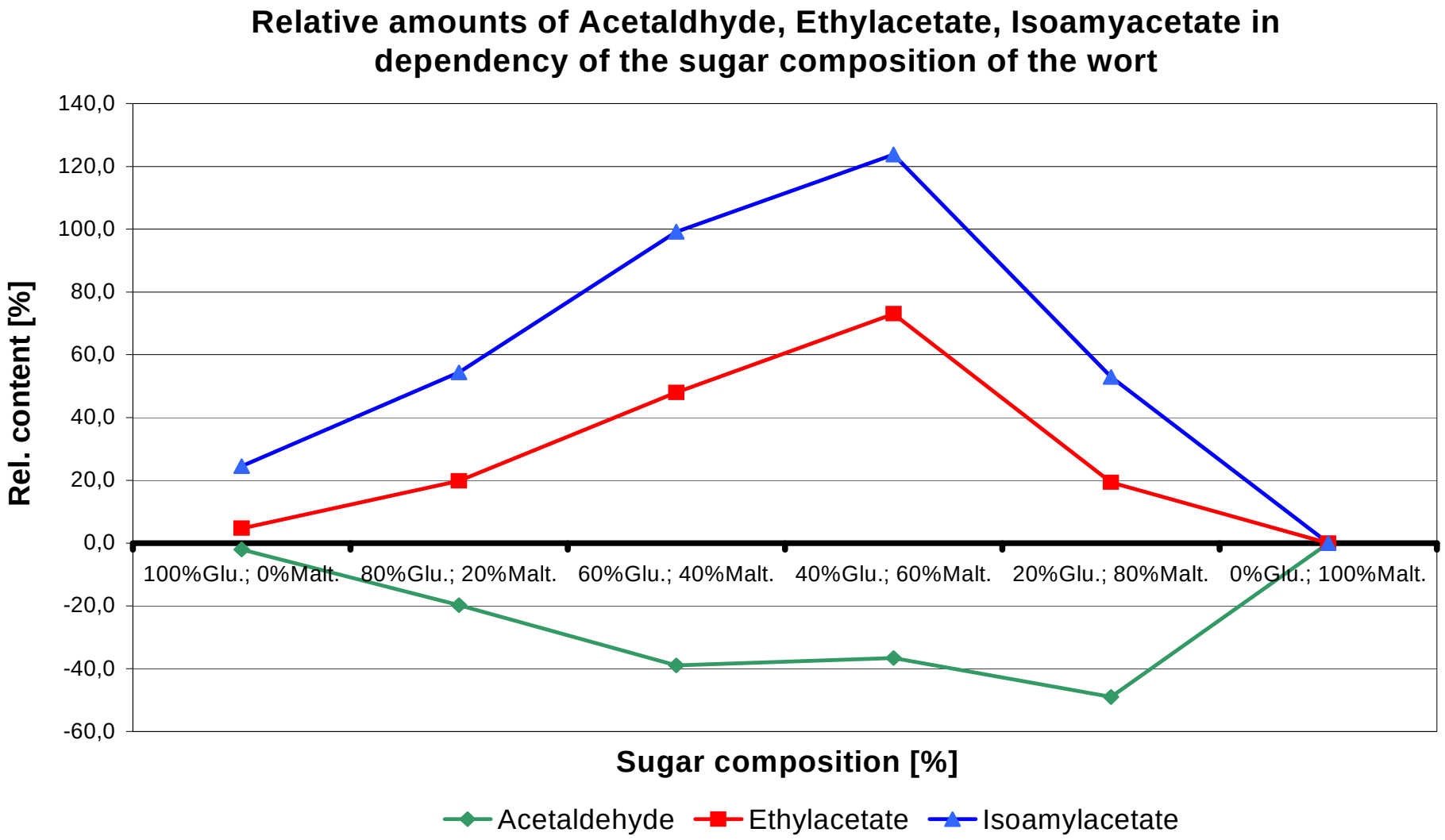
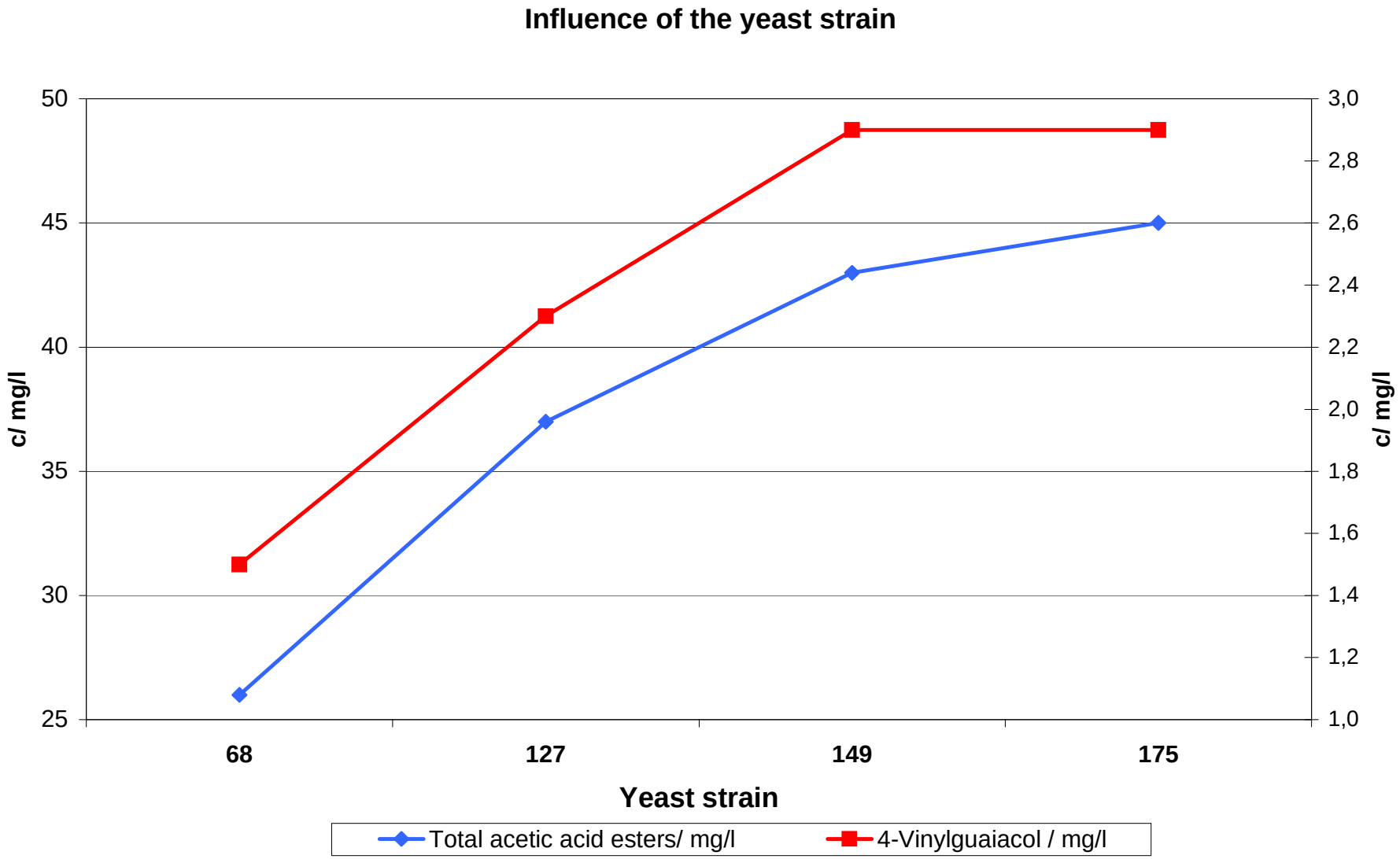
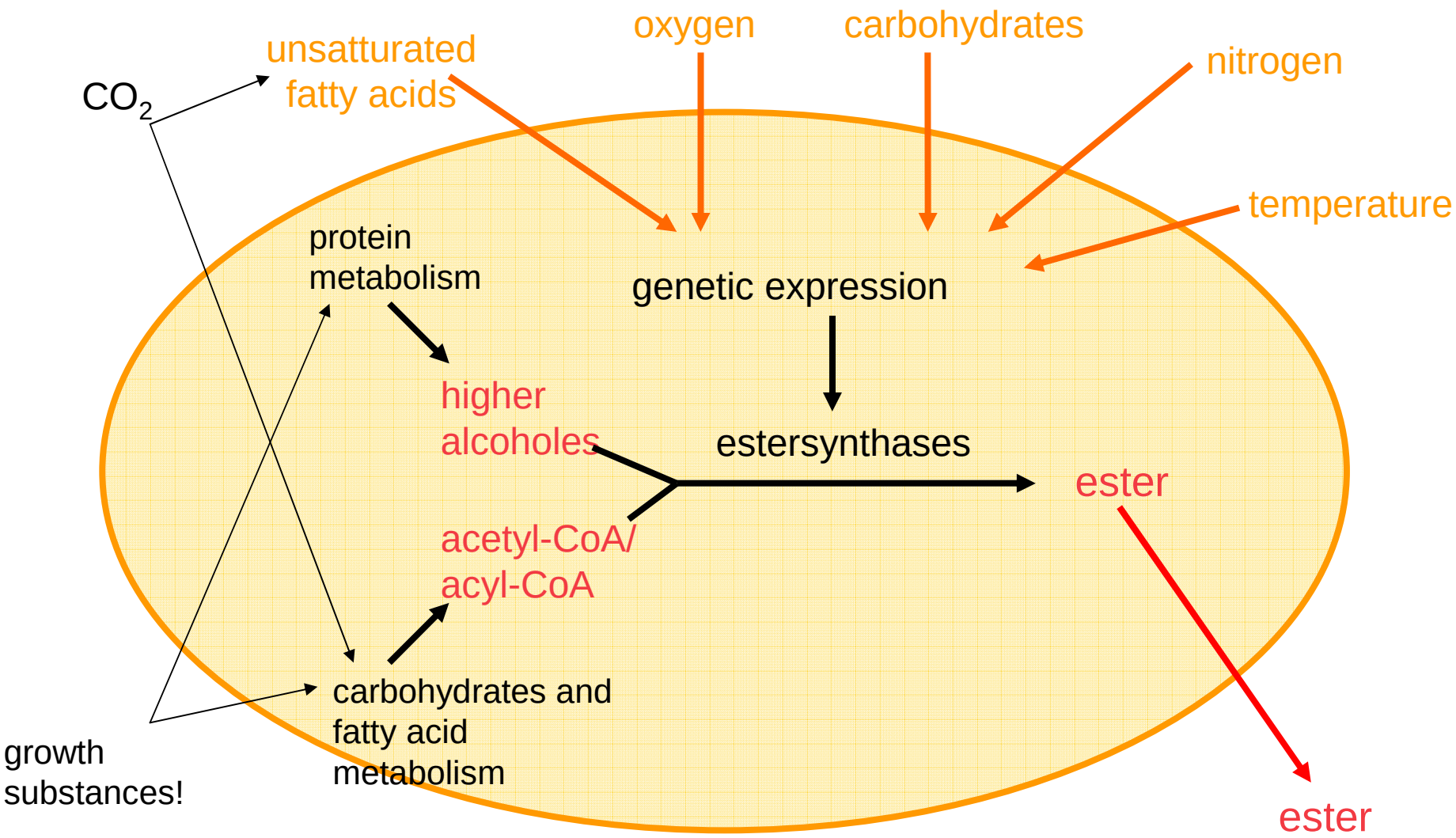


Fermentation

Technological Parameters (6)

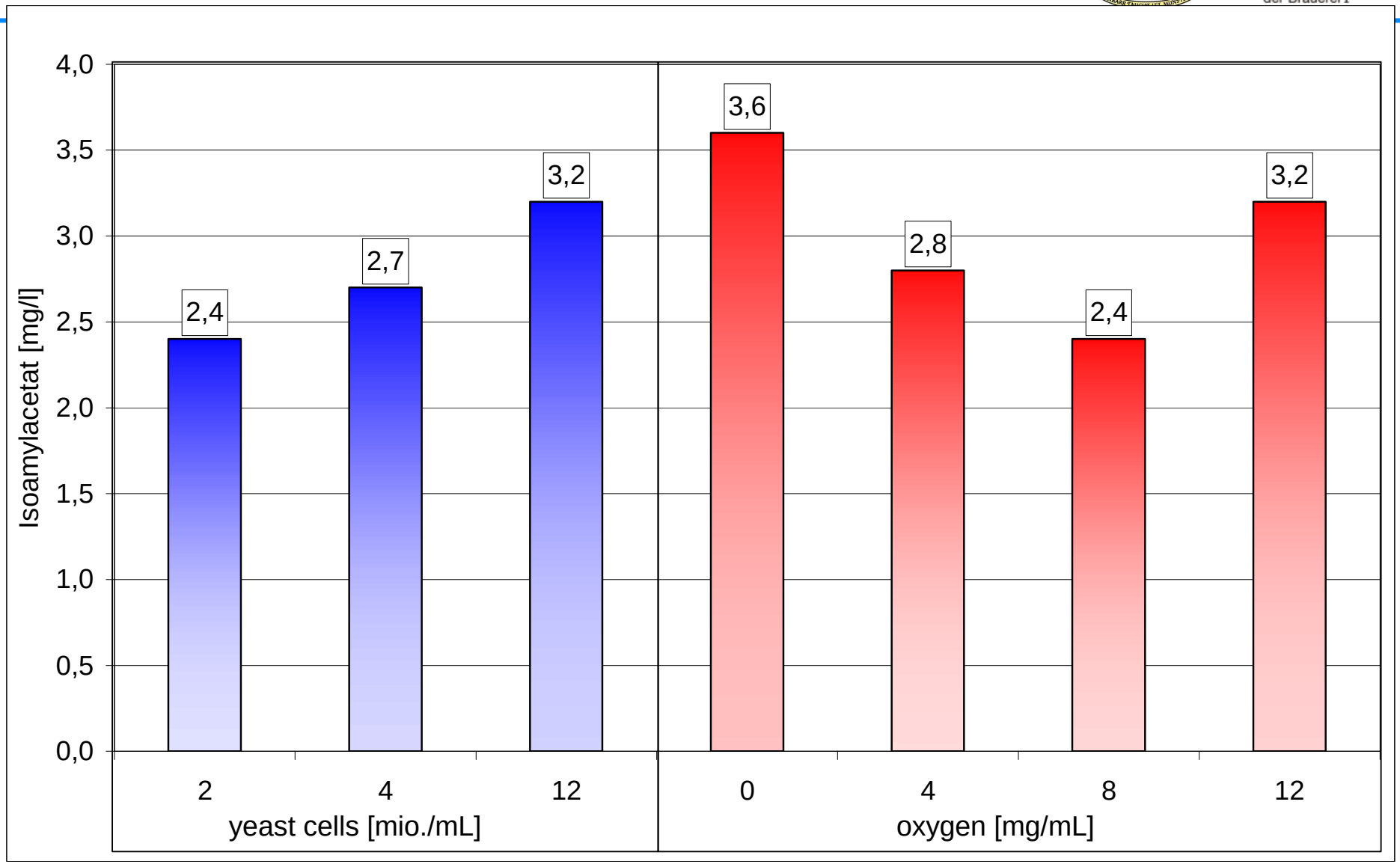


Impact Factors on Ester Formation



source: Verstrepen et al.: Flavor-Active Esters: Adding Fruitiness in Beer. J. Biosc. a. Bioe. Vol. 96. No. 2. S. 110-118. 2003.

Impact Factors on Ester Formation



Technological Parameters (9)

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Generic parameters:

- Increased ester content with higher fermentation temperature.

- Increased ester content with higher oxygenation level.

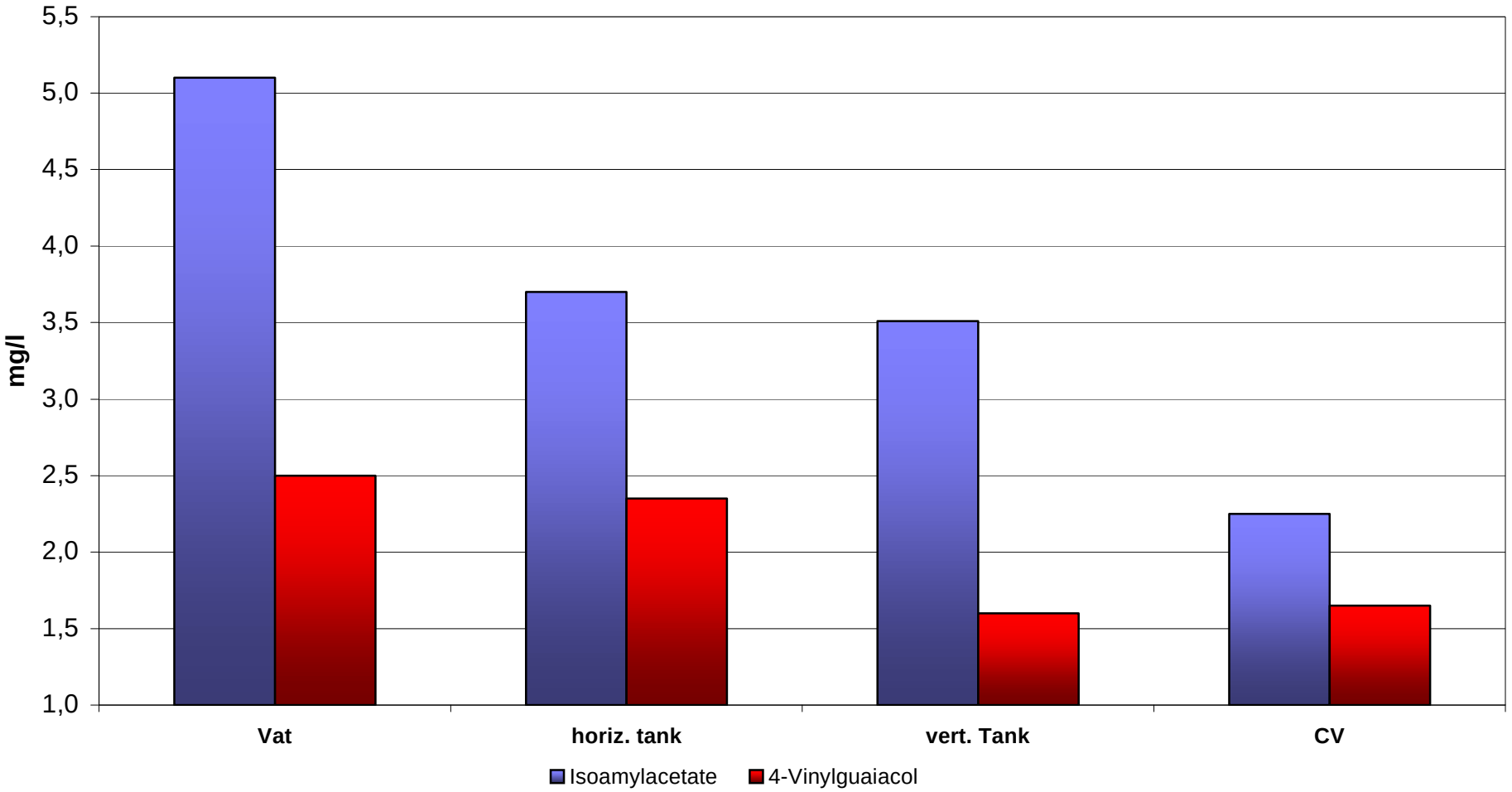
- Increased ester content with higher pitching rate (usual pitching rate: 2 Mio. cells/ml)

- Neither temperature, oxygenation nor pitching rate influence the 4-Vinylguaiacol content significantly.

Fermentation Vessels

Technological Parameters (10)

Influence of the fermentation vessel on 4-VG and IAA content



Technological Parameters (11)

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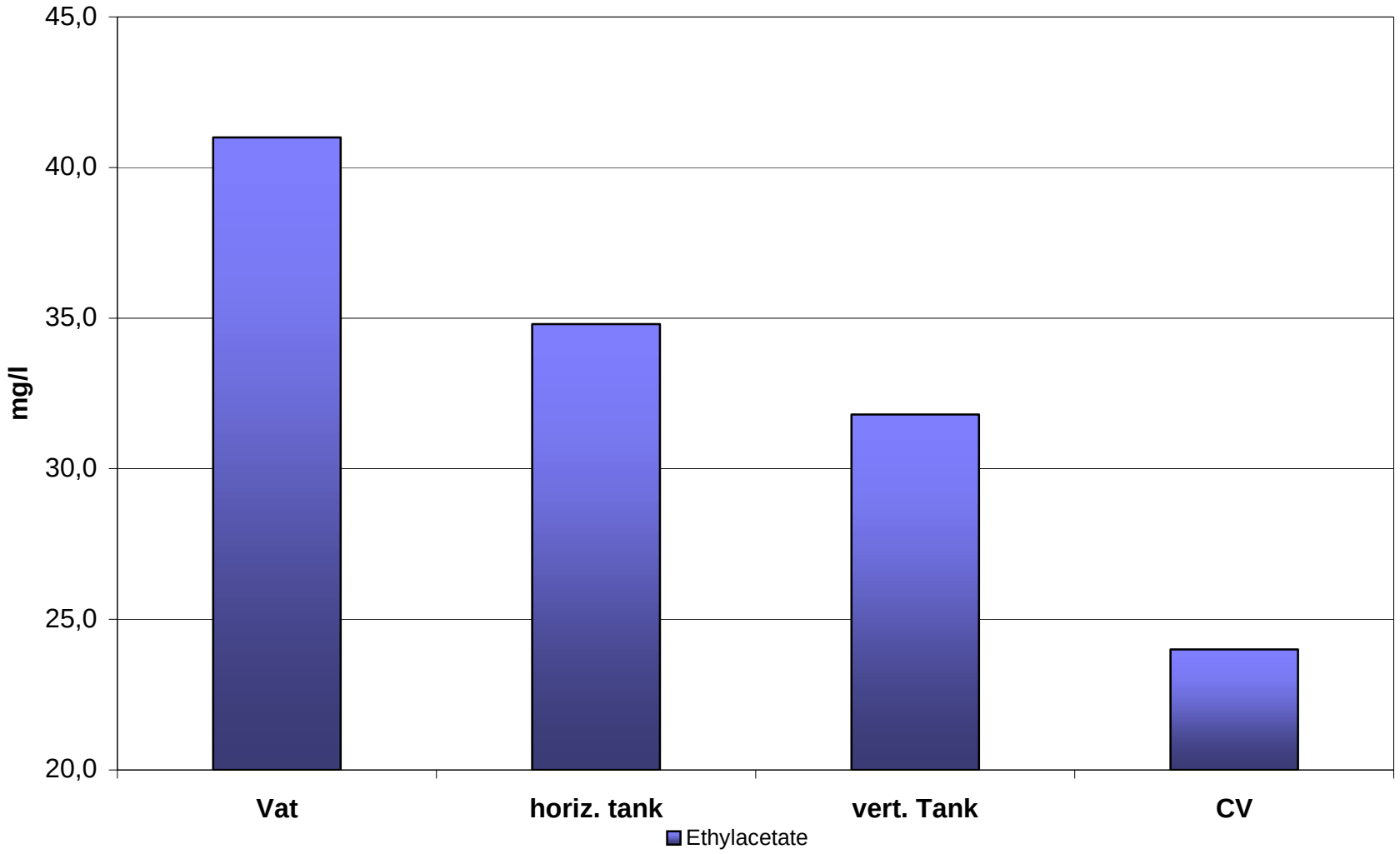
Influence of the fermentation vessel on Ethylactate content



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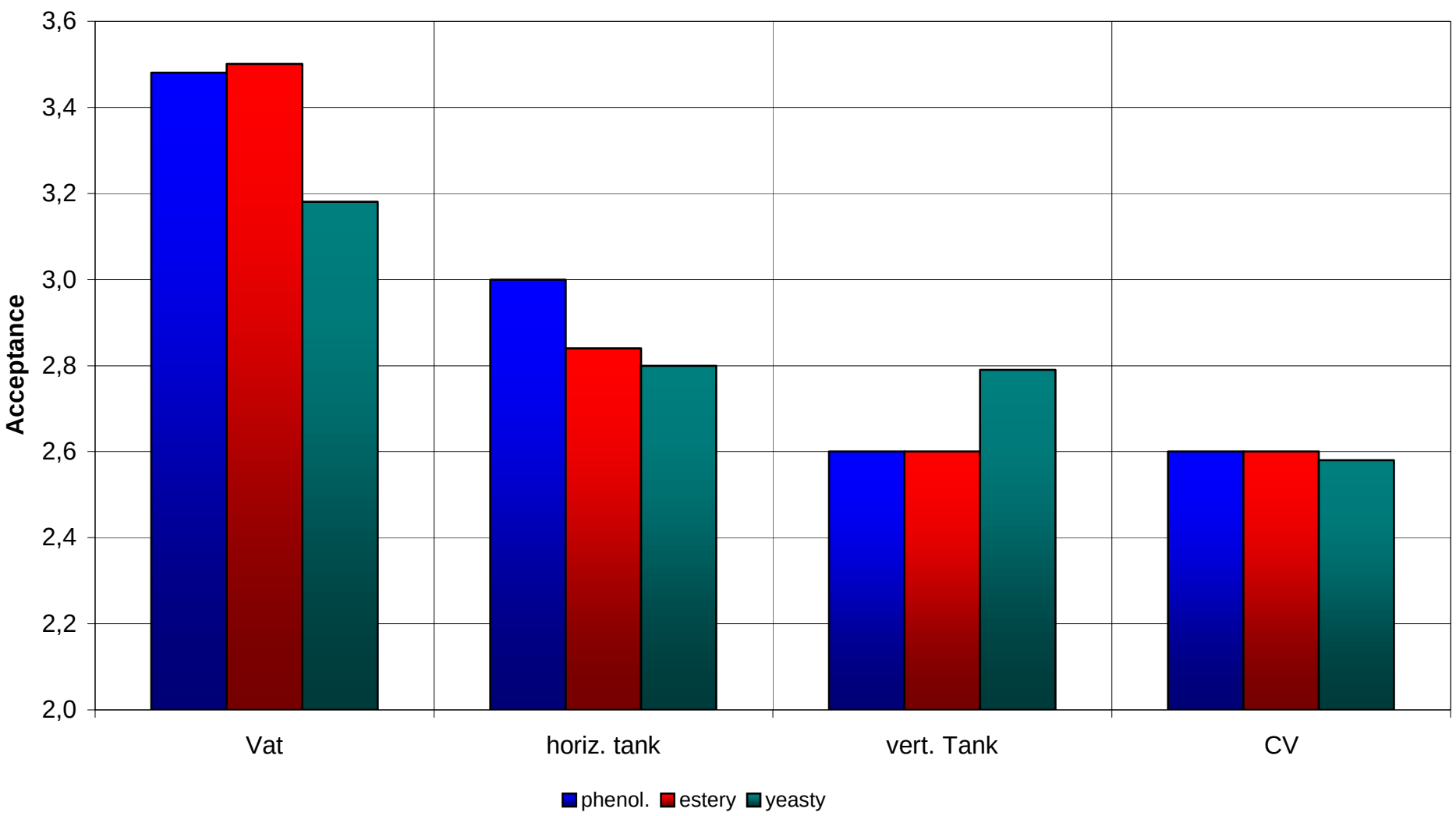
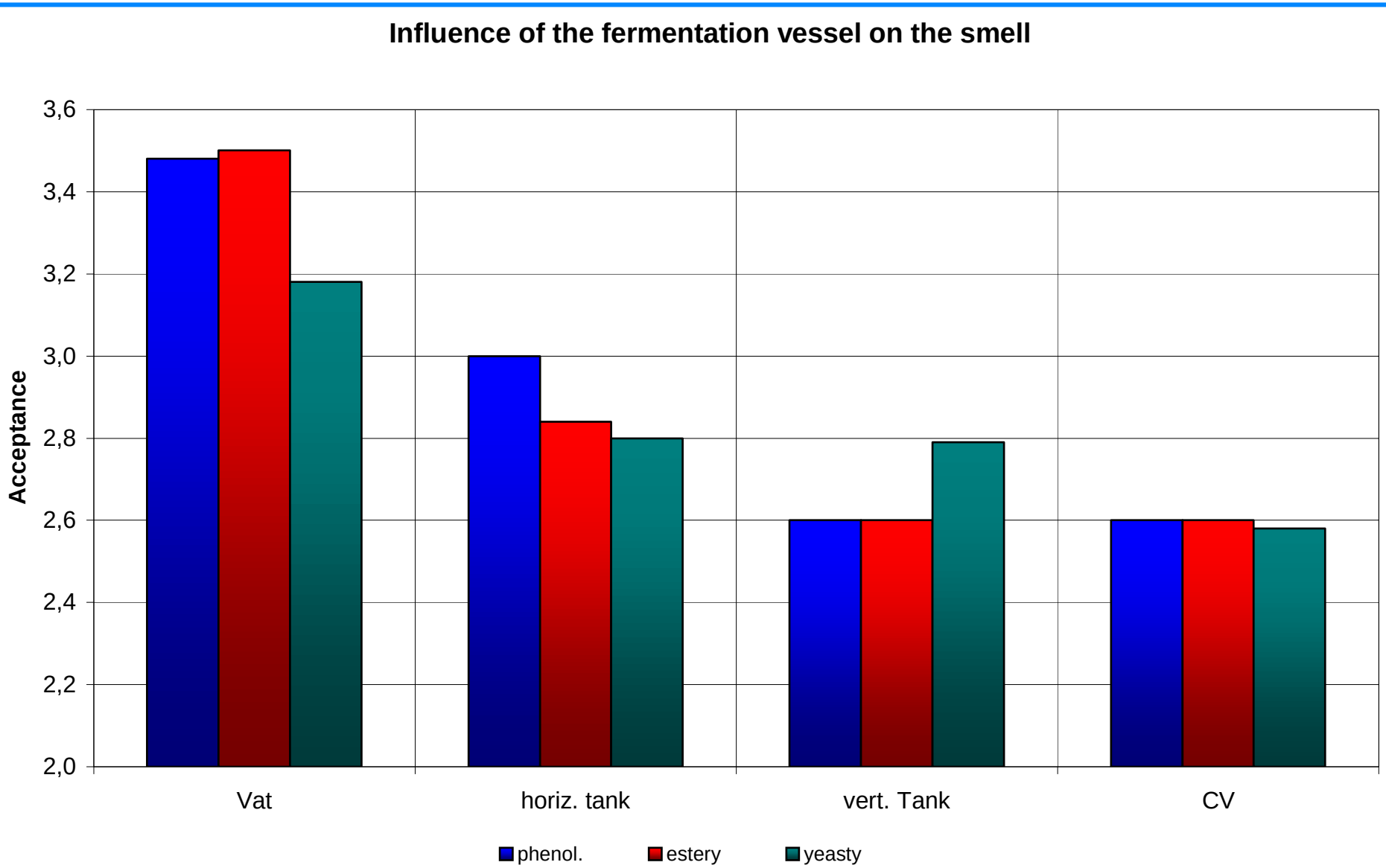
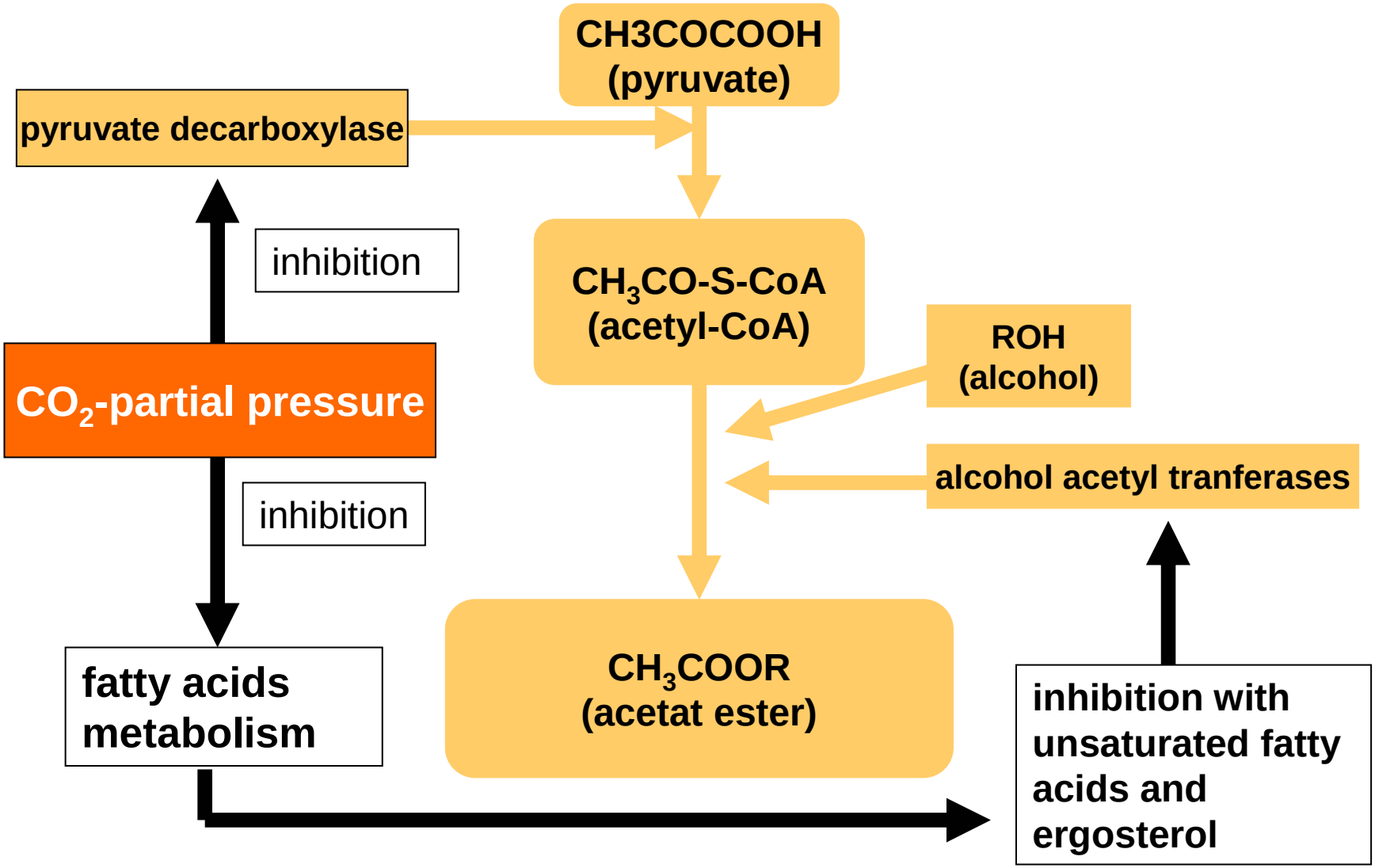


Technological Parameters (13)



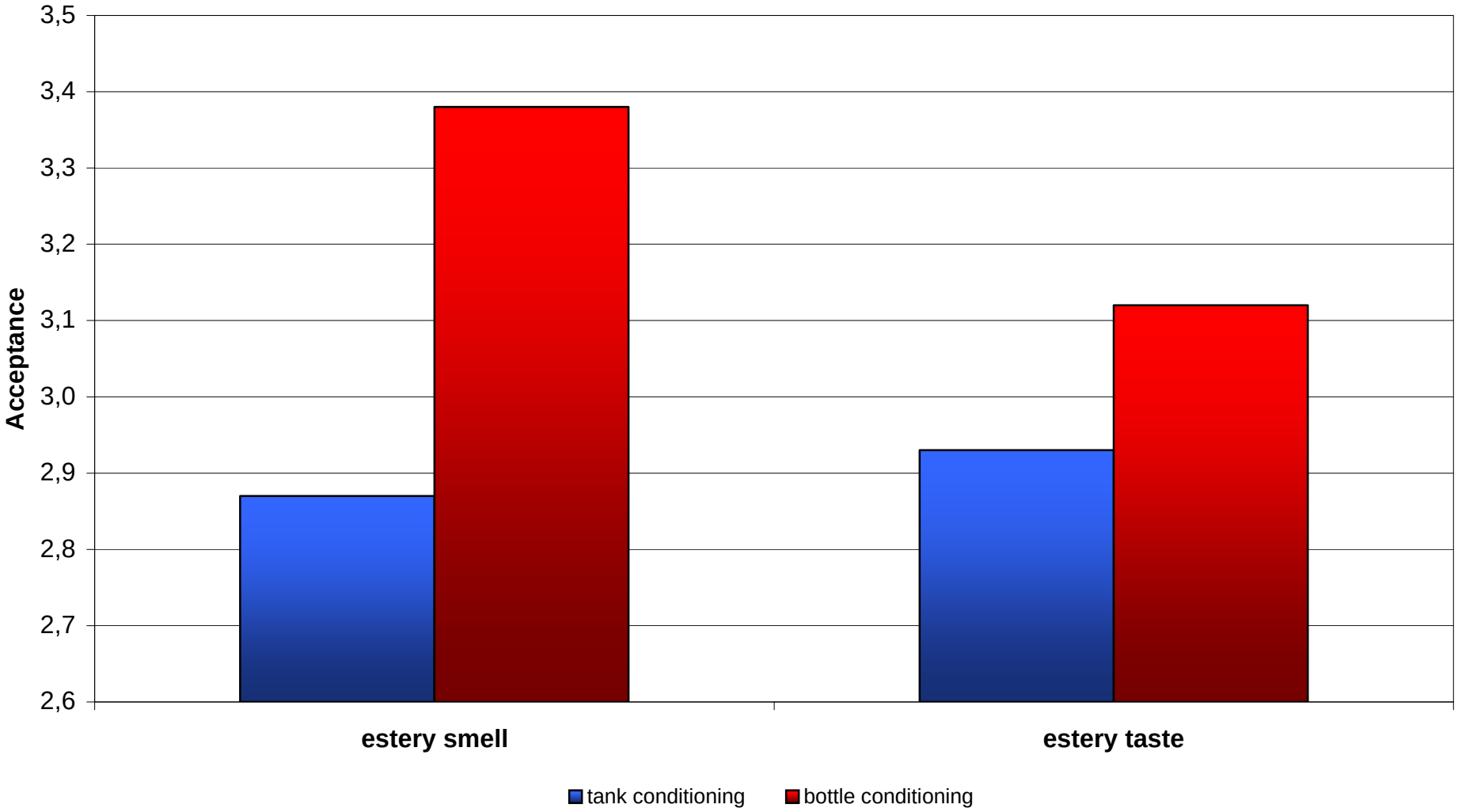
Impact of CO_2-Partial Pressure



source: Shanta Kumara. H.M.C et al.: Regulation Mechanism of Ester Formation by Dissolved Carbon Dioxide during Beer Fermentation. In: MBAA Tech. Q.. Vol. 32. No. 3. 1995. S. 159-162.

Conditioning

Technological Parameters (14)



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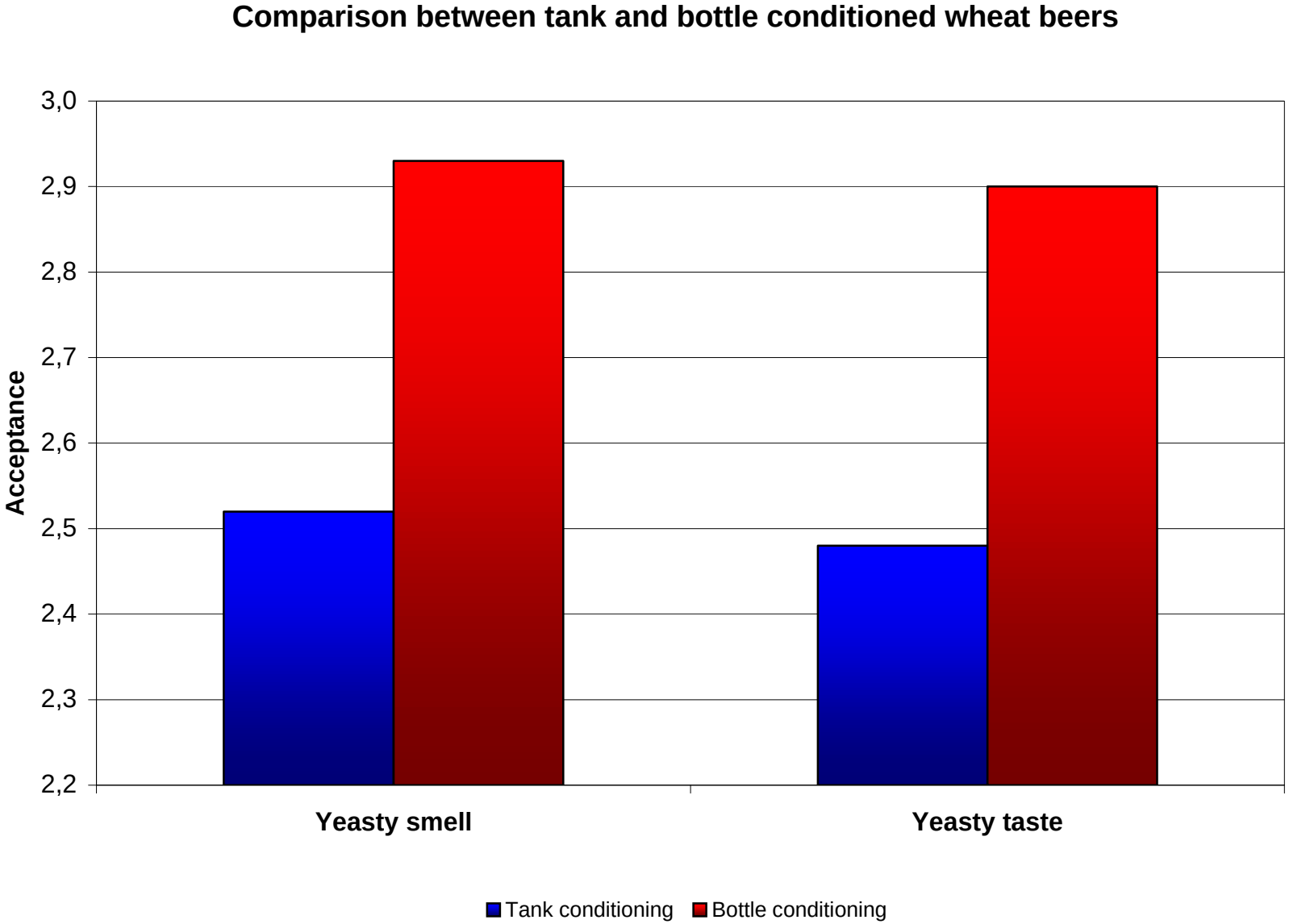
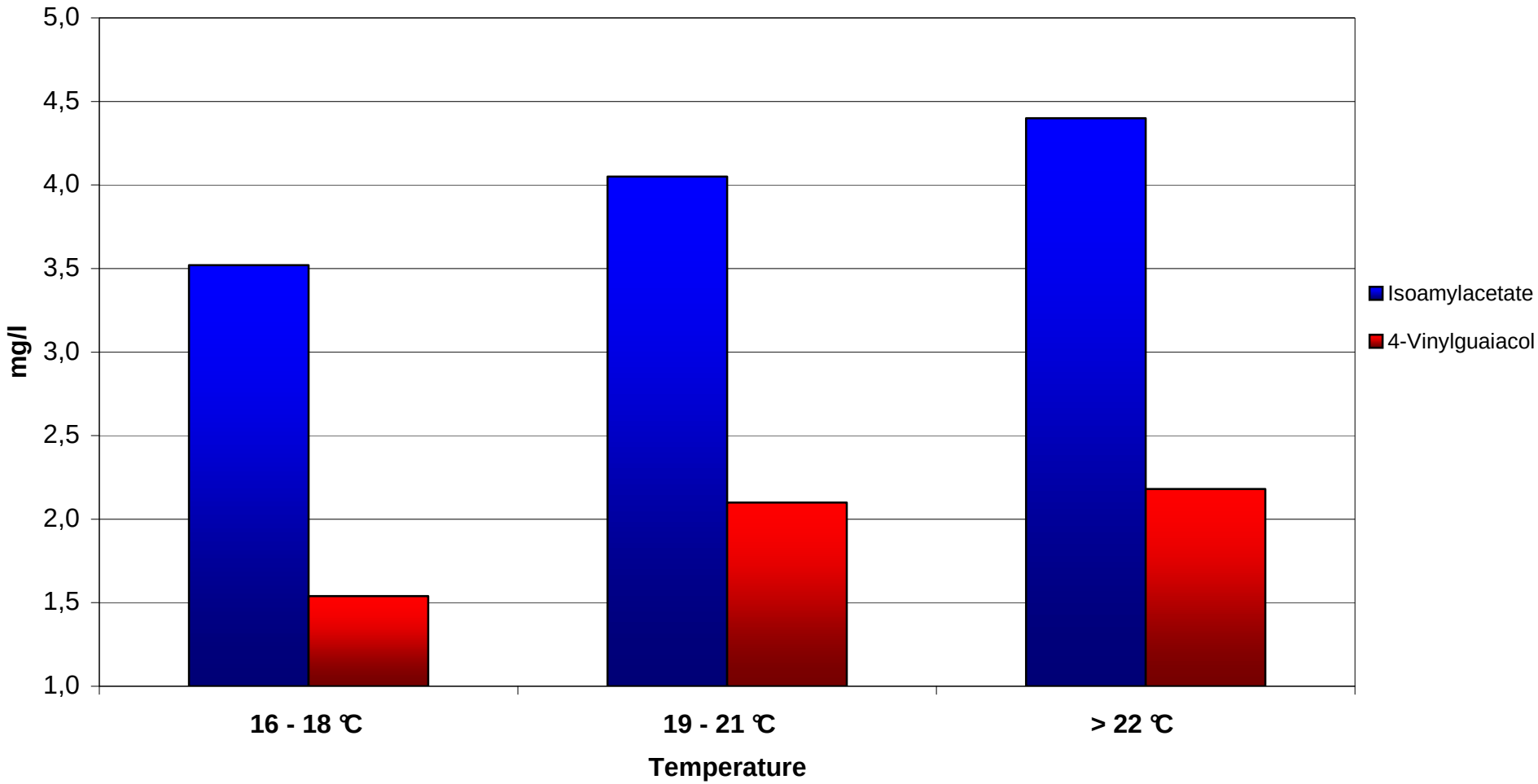


Technological Parameters (16)

Effects of warm storage temperature on the 4-VG and IAA content



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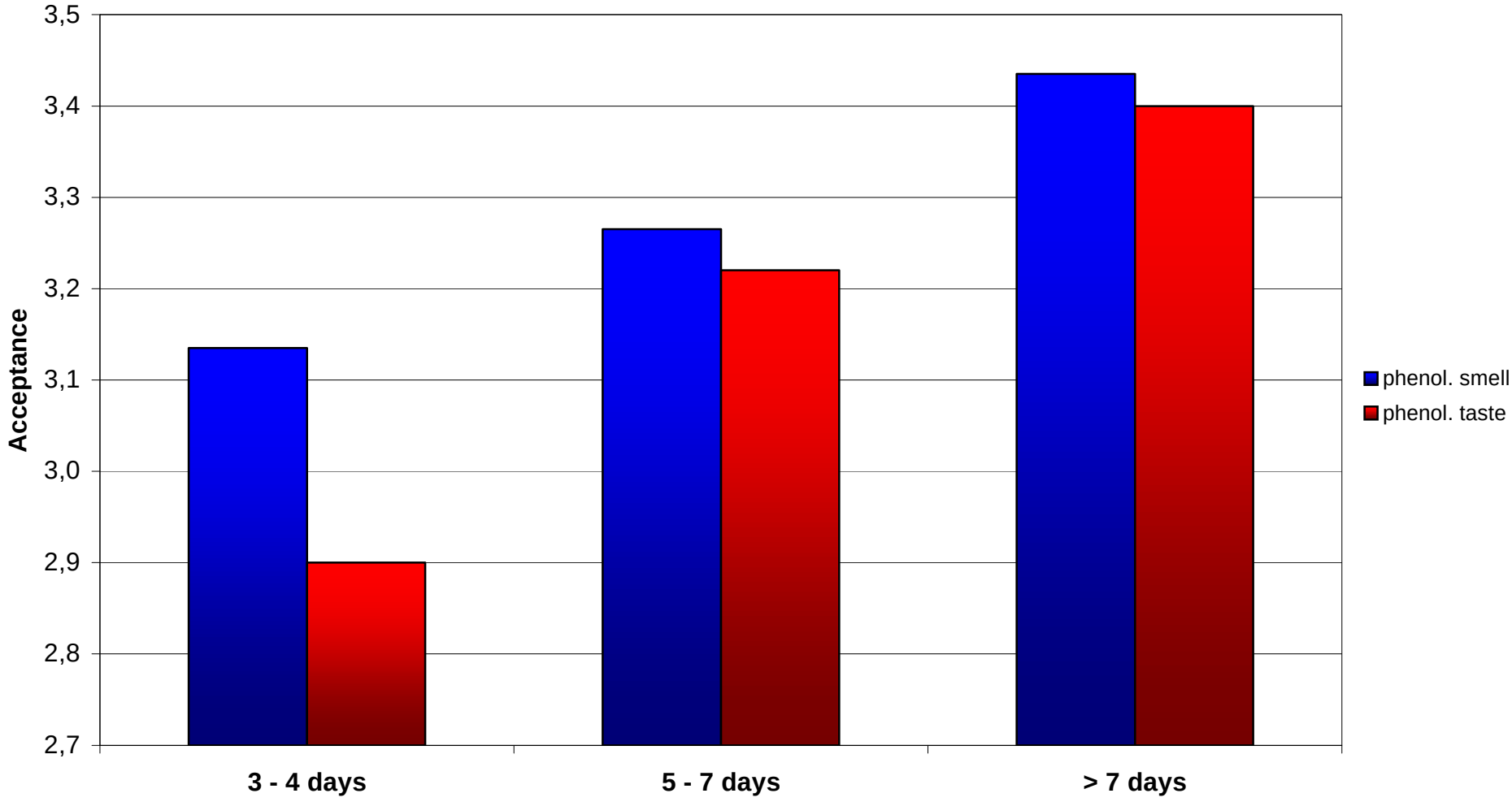

Conclusion

four types of wheat beer aroma:

- phenolic
- estery
- yeasty
- malty

wide range of influence

Acknowledgement

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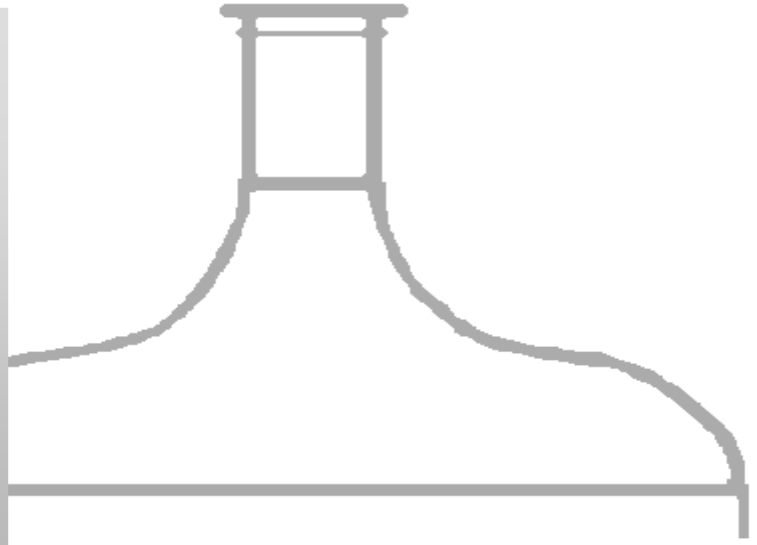

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