

Supplemental data

Effect of production technique on Pilsner type Non-alcoholic beer (NAB) flavor

Nils Rettberg^{±*}, Scott Lafontaine^{±*}, Christian Schubert, Johanna Dennenlöh, Laura Knoke, Patricia Diniz-Fischer, Johannes Fuchs, and Sarah Thörner

Research Institute for Beer and Beverage Analysis, Versuchs– und Lehranstalt für Brauerei in Berlin (VLB) e.V., Seestr. 13, 13353 Berlin, Germany

[±]NR and SL contributed to this work equally

*Correspondence: NR, n.rettberg@vlb-berlin.org; Tel.: +49 30 45080106;

SL, scott.r.lafontaine@gmail.com; Tel.: +49 176 63636721

Table of contents:

Table S1: Additional physiochemical analysis results, Table S2: Concentrations of acetaldehyde, higher alcohols, and esters (mg/L) as well as the concentration of 3-MBT (ng/L), Table S3: Concentration of staling aldehydes and ethyl nicotinate (µg/L), Table S4: Concentrations of hop derived aroma compounds, ethyl esters and DMS (µg/L), Figure S1. Ballot used for modified descriptive analysis., Table S5. Mixed model analysis of variance on the sensory attributes, Table S6: Least square mean values sensory terms sorted by overall harmony.

Table S1: Additional nonvolatile analysis results

Samples	Treatment	Fructose	Glucose	Sucrose	Maltose	Maltotriose	Glycerol	Protein	Dextrins	Fermentable Carbohydrates	Foam (SKZ)
		Sug1	Sug2	Sug3	Sug4	Sug5	GLY				
C1	COM	1.08	1.83	0.10	12.00	2.82	1.07	0.51	2.15	1.77	104.00
C2	COM	2.45	6.30	0.10	28.32	7.65	0.07	0.42	2.02	4.43	123.00
C3	COM	2.04	3.88	0.10	21.86	7.82	0.53	0.32	0.70	3.60	111.00
C4	COM	2.37	3.49	0.10	21.29	7.34	0.21	0.51	1.94	3.45	109.00
C5	COM	2.06	2.92	0.10	16.21	6.61	0.19	0.50	2.26	2.78	104.00
C6	COM	2.07	5.14	0.10	23.11	6.84	0.19	0.45	1.86	3.72	121.00
C7	COM	1.68	3.47	0.10	20.55	5.30	0.61	0.30	1.15	3.09	114.00
C8	COM	1.42	3.28	0.10	16.95	5.73	0.78	0.42	1.29	2.74	108.00
C9	COM	2.54	5.14	0.10	28.12	12.79	0.22	0.37	1.08	4.85	106.00
M1	M	0.10	0.10	0.10	0.40	0.20	0.55	0.35	0.94	0.10	105.00
MI1	MI	1.56	1.07	0.10	34.17	8.80	0.23	0.35	1.31	4.50	112.00
MI2	MI	0.47	0.10	2.83	33.11	12.69	0.15	0.30	1.71	4.98	120.00
RF1	RF	1.78	3.31	0.10	24.78	6.57	0.18	0.24	1.72	3.64	101.00
RF2	RF	2.58	6.50	0.10	29.70	7.91	0.19	0.54	1.97	4.69	118.00
RF3	RF	2.46	6.26	0.10	31.87	8.30	0.16	0.48	2.42	4.88	115.00
RF4	RF	2.19	5.11	0.10	29.26	8.65	0.27	0.45	2.34	4.55	113.00
V1	VAC	0.10	0.10	0.10	0.40	0.20	1.48	0.41	2.71	0.10	110.00
V2	VAC	3.21	7.39	0.10	33.24	11.21	0.50	0.44	2.22	5.49	108.00
V3	VAC	0.10	0.10	0.10	0.40	0.40	1.29	0.46	1.20	0.10	102.00
V4	VAC	0.10	0.10	0.10	7.21	4.25	1.67	0.52	1.67	1.16	107.00
	%RSD	0.7%	0.9%	3.6%	2.0%	1.5%	1.0%	< 0.5%	< 0.5 [#]	1.1 [%]	1.1 ^{\$}

The concentration of the individual sugars, glycerol, as well as the sum of fermentable carbohydrates is given in mg/L, while dextrins and proteins are given in g/100 mL. For analytes that were present in concentrations below the LOQ of the respective method of analysis values were by 1/3 of the LOQ prior to running statistical analysis. In this table, these values appear in grey. Concentrations/ values are the calculated means of duplicate measurements and not rounded.

[%]Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of sample C8

^{\$}Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of a reference lager beer with the reported mean as follows: foam (SKZ), 91.

[#]Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of a reference solution with the reported mean as follows: dextrins (g/100mL), 0.4.

Table S2: Concentrations of acetaldehyde, higher alcohols, and esters (mg/L) as well as the concentration of 3-MBT (ng/L).

Samples	Treatment	Acetaldehyde	Ethyl acetate	1-Propanol	Isobutanol	Isoamyl acetate	2-Methyl-1-Butanol	3-Methyl-1-Butanol	Phenethyl acetate	Phenyl ethanol	3-methyl-2-butene-1-thiol
		A1	A2	A3	A4	A5	A6	A7	A8	A9	3MBT
C1	COM	1.75	4.11	0.17	0.33	2.27	3.50	31.80	1.12	19.64	9.80
C2	COM	0.33	0.17	0.17	0.33	0.17	0.33	1.09	0.03	0.33	7.50
C3	COM	1.41	0.17	0.17	0.33	0.17	0.33	0.33	0.03	7.39	7.00
C4	COM	2.32	0.60	2.15	1.18	0.17	0.33	3.71	0.03	1.57	4.50
C5	COM	1.78	0.43	1.69	1.93	0.17	0.33	3.49	0.03	1.55	4.90
C6	COM	1.38	1.02	1.64	1.47	0.17	1.70	7.23	0.03	4.32	4.60
C7	COM	1.37	0.17	0.58	0.33	0.17	0.33	1.13	0.03	10.43	2.30
C8	COM	1.18	0.55	1.47	0.68	0.17	0.33	3.63	0.03	10.92	3.80
C9	COM	0.33	0.55	24.29	1.78	0.17	1.32	3.87	0.03	3.55	2.70
M1	M	0.33	1.21	0.85	2.35	0.17	3.52	18.13	0.16	7.81	4.40
MI1	MI	1.93	0.46	1.59	1.85	0.17	0.33	5.69	0.03	4.92	4.30
MI2	MI	0.33	0.17	4.56	1.34	0.17	1.02	5.61	0.03	1.36	5.60
RF1	RF	1.94	0.51	1.28	0.33	0.17	0.33	5.12	0.03	0.33	5.00
RF2	RF	1.38	0.17	0.75	0.33	0.17	0.33	1.10	0.03	0.33	12.40
RF3	RF	2.95	0.65	0.69	0.33	0.17	0.33	1.75	0.03	1.04	3.80
RF4	RF	1.77	0.17	1.77	0.33	0.17	0.33	4.93	0.03	1.36	2.40
V1	VAC	1.48	0.17	0.82	0.33	0.17	0.33	0.33	0.11	61.90	8.00
V2	VAC	0.33	0.17	0.17	0.33	0.17	0.33	0.33	0.03	7.74	4.30
V3	VAC	0.33	5.01	0.88	0.33	0.61	1.11	5.36	0.03	27.07	23.80
V4	VAC	3.31	0.79	0.57	0.33	0.17	0.33	1.94	0.03	21.78	4.40
	%RSD	11.4 ^{\$}	11.3 ^{\$}	2.9 ^{\$}	3.2 ^{\$}	10.8 ^{\$}	5.9 ^{\$}	3.6 ^{\$}	12.7 ^{\$}	8.6 ^{\$}	10.7 ^{\$}

Analytes that were present below LOQ were replaced by using 1/3 of the LOQ for statistical analysis. In this table, these values appear in grey. Concentrations are the calculated means of duplicate measurements and not rounded.

^{\$}Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of a reference lager beer with calculated mean concentrations (mg/L) as follows: Acetaldehyde, 3.25; Ethyl acetate, 10.78; Propanol, 2.93; Isobutanol, 14.45; Isoamylacetate, 0.66; 2-Methyl-1-Butanol, 10.86; 3-Methyl-1-Butanol, 46.80; Phenethyl acetate, 0.32; Phenyl ethanol, 45.06.

^{\$}Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of sample C8

Table S3: Concentration of staling aldehydes and ethyl nicotinate (µg/L)

Samples	Treatment	2-Methylpropanal	Ethyl nicotinate	2-Methylbutanal	3-Methylbutanal	Pentanal	Hexanal	2-Furfural	Heptanal	Methional	Octanal	Benzaldehyde	Phenylacetaldehyde	Nonanal	E-2-Nonenal	Decanal	E,E-2,4-Decadienal
		SAI1	SAI2	SAI3	SAI4	SAI5	SAI6	SAI7	SAI8	SAI9	SAI10	SAI11	SAI12	SAI13	SAI14	SAI15	SAI16
C1	COM	35.64	5.26	5.08	62.32	0.36	0.74	70.53	0.16	4.29	0.10	0.96	12.82	0.25	0.05	0.34	0.02
C2	COM	31.11	0.08	6.79	17.60	0.26	0.50	78.73	0.11	22.42	0.05	0.70	16.75	0.10	0.06	0.16	0.02
C3	COM	21.48	0.78	4.71	9.84	0.26	0.59	94.34	0.12	3.71	0.07	0.66	9.17	0.17	0.07	0.17	0.02
C4	COM	25.93	2.21	11.58	30.88	0.30	0.84	100.00	0.28	4.50	0.13	1.50	22.87	0.61	0.32	0.42	0.05
C5	COM	14.91	1.09	6.73	16.69	0.14	0.29	60.48	0.25	2.72	0.13	1.12	15.97	0.66	0.19	0.33	0.02
C6	COM	15.20	1.46	4.65	12.89	0.21	0.52	101.77	0.12	6.88	0.12	2.45	23.06	0.37	0.20	0.56	0.03
C7	COM	24.87	1.22	8.45	21.86	0.42	1.04	101.26	0.21	9.95	0.24	2.79	31.14	0.55	0.25	0.26	0.03
C8	COM	24.21	2.59	4.41	13.84	0.22	0.49	73.07	0.09	6.43	0.09	1.87	23.41	0.29	0.09	0.31	0.02
C9	COM	54.34	0.90	7.02	10.26	0.44	0.75	89.71	0.40	16.94	0.18	5.79	13.03	0.65	0.08	0.81	0.01
M1	M	50.05	1.94	21.61	55.32	0.63	1.32	250.93	0.42	69.97	0.06	2.02	62.98	0.15	0.06	0.17	0.02
MI1	MI	53.66	1.76	4.62	9.59	0.18	0.40	121.00	0.11	5.15	0.12	1.95	29.25	0.31	0.12	0.20	0.02
MI2	MI	48.02	2.35	17.72	25.63	0.42	0.71	84.67	0.27	15.92	0.12	1.56	25.11	0.43	0.05	0.37	0.01
RF1	RF	14.08	0.42	6.85	15.97	0.15	0.27	42.72	0.15	5.83	0.05	1.21	12.53	0.17	0.05	0.23	0.01
RF2	RF	47.96	0.26	18.49	50.89	0.59	1.47	33.52	0.19	29.43	0.07	1.60	20.68	0.22	0.09	0.27	0.02
RF3	RF	40.84	2.29	15.22	29.35	0.57	1.34	64.40	0.14	20.58	0.05	4.15	40.11	0.10	0.13	0.14	0.02
RF4	RF	34.30	1.04	14.90	48.77	0.36	0.77	173.49	0.17	14.21	0.14	2.18	49.72	0.45	0.37	0.31	0.03
V1	VAC	20.35	3.03	2.92	9.53	0.21	0.38	74.69	0.12	2.04	0.09	0.70	7.14	0.22	0.05	0.21	0.01
V2	VAC	36.55	0.38	11.71	22.75	0.44	0.99	35.22	0.13	24.50	0.05	1.48	23.77	0.13	0.08	0.17	0.02
V3	VAC	24.13	3.85	4.26	12.98	0.25	0.55	149.69	0.18	4.24	0.11	2.33	22.39	0.35	0.23	0.49	0.03
V4	VAC	71.16	5.07	4.90	19.37	0.20	0.42	31.31	0.14	4.74	0.09	1.00	15.60	0.22	0.04	0.29	0.01
	%RSD	2.4*	9.2 [§]	2.3*	2.3*	4.5*	4.0*	5.5*	3.9*	9.2*	4.9*	4.9*	1.6*	7.0*	5.1*	8.3*	2.6*

Concentrations are the calculated means of duplicate measurements and not rounded.

*Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis as previously published (<https://doi.org/10.1080/03610470.2020.1795478>).

[§]Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of a reference lager beer with calculated mean concentrations (µg/L) as follows: Ethyl nicotinate, 7.99.

Table S4: Concentrations of hop derived aroma compounds, ethyl esters and DMS (µg/L)

Samples	Treatment	α -Pinene	Myrcene	2-Methylbutyl isobutyrate	Limonene	cis-Linalool oxide	trans-Linalool oxide	Linalool	Terpineol	Citronellol	Nerol	Geraniol	Humulene	Ethyl butyrate	Ethyl hexanoate	Ethyl octanoate	DMS
		Hop1	Hop2	Hop3	Hop4	Hop5	Hop6	Hop7	Hop8	Hop9	Hop10	Hop11	Hop12	EST1	EST2	EST3	DMS
C1	COM	0.33	2.21	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	14.75	61.59	14.07	10.00
C2	COM	0.33	3.75	0.33	0.33	1.14	0.33	4.57	2.53	1.10	0.33	1.47	0.33	1.67	1.67	12.92	39.00
C3	COM	0.33	2.54	0.33	0.33	0.33	0.33	1.29	0.33	1.95	0.33	1.17	0.33	1.67	1.67	7.16	29.00
C4	COM	0.33	56.61	116.46	4.32	0.33	0.33	37.37	11.99	5.80	7.86	20.85	0.33	1.67	5.42	10.87	22.00
C5	COM	0.33	48.17	307.31	6.30	1.21	1.05	48.21	66.66	6.81	5.59	17.60	0.33	1.67	5.52	10.26	25.00
C6	COM	0.33	3.79	0.33	0.33	0.33	0.33	6.13	2.44	1.44	0.33	1.70	0.33	1.67	13.63	27.13	37.00
C7	COM	0.33	3.63	0.33	1.13	0.33	0.33	3.82	1.67	1.06	0.33	0.33	0.33	1.67	1.67	7.38	30.00
C8	COM	0.33	2.25	0.33	1.15	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.67	5.63	12.45	10.00
C9	COM	0.33	104.55	64.30	25.71	75.90	65.83	540.45	55.10	3.98	21.95	132.74	1.64	1.67	1.67	8.96	31.00
M1	M	5.05	4.04	0.33	1.88	0.33	0.33	2.30	1.33	1.86	0.33	2.46	0.33	18.90	26.33	23.13	29.00
MI1	MI	0.33	2.73	0.33	0.33	0.33	0.33	1.71	2.38	0.33	1.00	0.33	0.33	1.67	1.67	7.34	26.00
MI2	MI	0.33	124.99	89.67	21.84	7.55	6.72	260.71	40.95	38.87	45.62	312.81	1.82	1.67	1.67	9.12	26.00
RF1	RF	0.33	5.44	33.98	2.07	1.11	0.33	23.20	25.50	6.51	6.94	7.14	0.33	1.67	1.67	8.39	54.00
RF2	RF	0.33	10.03	1.62	2.06	1.32	0.99	32.69	10.66	2.17	3.97	14.95	0.33	1.67	1.67	8.52	34.00
RF3	RF	0.33	2.41	0.33	0.33	0.33	0.33	1.05	0.33	1.51	0.33	0.33	0.33	1.67	6.96	6.94	31.00
RF4	RF	0.33	7.89	1.90	1.31	1.30	0.98	25.53	6.02	1.57	2.07	3.25	0.33	1.67	1.67	8.35	33.00
V1	VAC	0.33	2.22	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.67	1.67	26.81	10.00
V2	VAC	0.33	2.13	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.67	1.67	6.63	10.00
V3	VAC	0.33	2.29	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	32.51	75.42	60.10	10.00
V4	VAC	0.33	2.28	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.67	6.89	19.57	10.00
	%RSD	5.6*	5.3*	7.3*	6.6*	5.4*	7.5*	1.7*	5.2*	3.4*	5.4*	5.4*	8.1*	3.5 [§]	3.5 [§]	3.4 [§]	3.4 [§]

Analyses that were present below LOQ were replaced by using 1/3 of the LOQ for statistical analysis. In this table, these values appear in grey. Concentrations are the calculated means of duplicate measurements and not rounded.

*Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis as previously published (<https://doi.org/10.1080/03610470.2019.1668223>).

%Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of sample C8

[§]Measurement precision based on relative standard deviation (RSD or %RSD) from 6-fold repeat analysis of reference lager beers with calculated mean concentrations (µg/L) as follows: ethyl butyrate, 61.63; ethyl hexanoate, 100.72; ethyl octanoate, 196.47; dimethyl sulfide (DMS), 32.3.

Sample:

Date:

Name:

Subcategory	Intensity									Deskriptoren (bitte unterschreiben)
	1	2	3	4	5	6	7	8	9	
Quality of the smell	<input type="checkbox"/> very poor	<input type="checkbox"/>	<input type="checkbox"/> weak	<input type="checkbox"/>	<input type="checkbox"/> satisfactory	<input type="checkbox"/>	<input type="checkbox"/> good	<input type="checkbox"/>	<input type="checkbox"/> very good	Diacetyl, oxidation, metallic, DMS, sulfurous, solvent, dull, cheesy, etc.
Quality of taste	<input type="checkbox"/> very poor	<input type="checkbox"/>	<input type="checkbox"/> weak	<input type="checkbox"/>	<input type="checkbox"/> satisfactory	<input type="checkbox"/>	<input type="checkbox"/> good	<input type="checkbox"/>	<input type="checkbox"/> very good	Diacetyl, oxidation, metallic, DMS, sulfurous, solvent, dull, cheesy, etc.
Hop aroma	<input type="checkbox"/> not present	<input type="checkbox"/>	<input type="checkbox"/> slightly present	<input type="checkbox"/>	<input type="checkbox"/> present	<input type="checkbox"/>	<input type="checkbox"/> pronounced	<input type="checkbox"/>	<input type="checkbox"/> very pronounced	Citrus, floral, spices/herbs, tropical, pine/resinous, grassy
Sweetness	<input type="checkbox"/> dry	<input type="checkbox"/>	<input type="checkbox"/> semi-dry	<input type="checkbox"/>	<input type="checkbox"/> medium	<input type="checkbox"/>	<input type="checkbox"/> sweet	<input type="checkbox"/>	<input type="checkbox"/> very sweet	
Sourness	<input type="checkbox"/> none	<input type="checkbox"/>	<input type="checkbox"/> light	<input type="checkbox"/>	<input type="checkbox"/> moderate	<input type="checkbox"/>	<input type="checkbox"/> pronounced	<input type="checkbox"/>	<input type="checkbox"/> strong	
Bitterness Intensity	<input type="checkbox"/> very low	<input type="checkbox"/>	<input type="checkbox"/> low	<input type="checkbox"/>	<input type="checkbox"/> moderate	<input type="checkbox"/>	<input type="checkbox"/> pronounced	<input type="checkbox"/>	<input type="checkbox"/> very high	
Bitterness Quality	<input type="checkbox"/> very poor	<input type="checkbox"/>	<input type="checkbox"/> weak	<input type="checkbox"/>	<input type="checkbox"/> satisfactory	<input type="checkbox"/>	<input type="checkbox"/> good	<input type="checkbox"/>	<input type="checkbox"/> very good	astringent, lingering untypical
Estery	<input type="checkbox"/> not present	<input type="checkbox"/>	<input type="checkbox"/> slightly present	<input type="checkbox"/>	<input type="checkbox"/> present	<input type="checkbox"/>	<input type="checkbox"/> pronounced	<input type="checkbox"/>	<input type="checkbox"/> very pronounced	Ethyl acetate, isoamyl acetate, Acetaldehyde, Ethylhexanoate
Worty	<input type="checkbox"/> not present	<input type="checkbox"/>	<input type="checkbox"/> slightly present	<input type="checkbox"/>	<input type="checkbox"/> present	<input type="checkbox"/>	<input type="checkbox"/> pronounced	<input type="checkbox"/>	<input type="checkbox"/> very pronounced	
Mouthfeel	<input type="checkbox"/> watery	<input type="checkbox"/>	<input type="checkbox"/> empty	<input type="checkbox"/>	<input type="checkbox"/> light body	<input type="checkbox"/>	<input type="checkbox"/> round body	<input type="checkbox"/>	<input type="checkbox"/> heavy body	
Aftertaste duration	<input type="checkbox"/> none	<input type="checkbox"/>	<input type="checkbox"/> fast	<input type="checkbox"/>	<input type="checkbox"/> moderate	<input type="checkbox"/>	<input type="checkbox"/> slightly persistent	<input type="checkbox"/>	<input type="checkbox"/> persistent	
Overall Harmony	<input type="checkbox"/> very poor	<input type="checkbox"/>	<input type="checkbox"/> weak	<input type="checkbox"/>	<input type="checkbox"/> satisfactory	<input type="checkbox"/>	<input type="checkbox"/> good	<input type="checkbox"/>	<input type="checkbox"/> very good	

Extra comments

Description of the odor:

positive

negative

Description of the taste:

positive

negative

Figure S1. Ballot used for modified descriptive analysis.

Table S5. Mixed model analysis of variance on the sensory attributes

Source	Type	DF	Quality of smell		Quality of taste		Sweet		Sour		Bitterness Intensity		Bitterness Quality	
			F	P-value	F	P-value	F	P-value	F	P-value	F	P-value	F	P-value
Product	Fixed	19	1.690	0.047	1.967	0.015	6.024	<0.0001	3.068	0.000	1.701	0.045	1.796	0.031
Panelist	Random	11	1.320	0.222	1.575	0.115	0.980	0.469	2.459	0.008	3.668	0.000	2.318	0.013
Source	Type	DF	Hop aroma		Estery		Worty		Mouthfeel		Aftertaste duration		Overall Harmony	
			F	P-value	F	P-value	F	P-value	F	P-value	F	P-value	F	P-value
Product	Fixed	19	2.908	0.000	1.789	0.032	6.047	<0.0001	4.386	<0.0001	1.339	0.172	2.427	0.002
Panelist	Random	11	5.510	<0.0001	3.153	0.001	1.548	0.123	2.271	0.015	1.644	0.095	2.054	0.029

Values in bold indicate p-value < 0.05

Table S6: Least square mean values sensory terms sorted by overall harmony.

	Overall Harmony	Aftertaste	Mouthfeel	Worty*	Estery/ fruity*	Bitterness (quality)	Bitterness (Intensity)*	Sour*	Sweet*	Hop aroma*	Quality of Aroma	Quality of Taste
V1	4.14 g	6.00 bcd	4.00 g	2.57 i	2.29 cd	4.86 ef	7.00 a	5.57 a	2.14 h	3.00 fgh	4.14 f	4.29 g
RF3	4.43 g	6.57 abc	5.71 cde	7.43 a	2.00 d	5.50 abcdef	3.57 hi	2.71 d	5.14 bc	2.29 h	4.86 ef	5.29 bcdefg
RF1	4.57 fg	7.14 a	6.43 abcd	5.71 bcd	2.29 cd	4.14 f	6.86 ab	3.71 cd	4.43 cde	3.71 efgh	6.40 abcde	6.57 ab
V4	4.57 fg	5.86 bcd	4.71 efg	3.00 hi	2.57 cd	5.14 def	6.29 abcd	5.00 ab	3 fgh	3.00 fgh	5.14 def	4.43 fg
M1	4.67 efg	4.67 e	4.17 fg	3.33 ghi	3.50 abc	6.17 abcde	3.50 i	5.97 a	2.67 gh	3.17 fgh	5.50 bcdef	5.33 bcdefg
V2	4.86 efg	5.86 bcd	7.14 a	6.43 abc	2.57 cd	4.71 ef	5.00 defgh	2.86 d	7.14 a	2.57 gh	5.29 cdef	5.86 bcdef
RF2	4.89 efg	5.89 bcd	6.00 bcd	5.22 cdef	2.78 cd	5.33 cdef	6.44 abcd	3.00 d	5.33 bc	5.33 cd	5.25 cdef	4.78 efg
MI1	5.00 defg	5.43 de	5.29 def	4.14 efgh	2.71 cd	5.86 abcde	4.71 efghi	3.43 d	4.43 cde	3.86 efg	5.33 cdef	4.86 defg
V3	5.00 defg	5.29 de	4.29 fg	2.57 i	2.71 cd	6.00 abcde	6.43 abcd	4.71 abc	2.86 fgh	3.43 fgh	5.57 bcdef	5.29 bcdefg
C1	5.29 cdefg	5.29 de	4.71 efg	2.57 i	4.57 a	6.00 abcde	4.14 fghi	3.29 d	3.71 efg	3.33 fgh	5.29 cdef	5.00 cdefg
C2	5.43 bcdefg	6.00 bcd	7.00 ab	6.86 ab	2.43 cd	5.14 def	5.50 bcdef	2.71 d	5.57 b	2.71 gh	6.00 bcde	5.71 bcdefg
C7	5.44 bcdefg	5.56 cde	6.44 abc	5.89 bcd	3.11 bcd	6.56 abcd	5.67 abcde	2.89 d	5.33 bc	3.67 efgh	6.25 abcde	6.33 abc
C3	5.86 bcdef	5.43 de	6.14 abcd	5.57 bcde	2.57 cd	5.43 bcdef	5.00 defgh	3.14 d	5.00 bc	3.29 fgh	5.86 bcde	5.43 bcdefg
RF4	6.00 bcde	5.44 de	4.56 fg	4.67 defg	2.89 cd	6.00 abcde	5.00 defgh	2.78 d	5.00 bc	4.33 def	5.78 bcde	5.75 bcdef
C5	6.14 abcde	5.14 de	6.33 abcd	3.86 fghi	3.14 abcd	6.86 ab	6.29 abcd	3.86 bcd	4.86 bcd	5.86 bc	6.43 abcd	5.57 bcdefg
C9	6.22 abcd	5.67 cde	6.00 bcd	3.44 ghi	4.56 a	5.78 abcde	5.78 abcde	5.13 a	5.22 bc	7.00 b	6.44 abcd	6.11 bcd
C8	6.29 abcd	5.43 de	6.57 abc	5.43 bcde	2.71 cd	6.43 abcd	4.00 ghi	3.57 cd	5.29 bc	3.29 fgh	6.71 abc	6.71 ab
C6	6.57 abc	5.43 de	6.14 abcd	3.29 hi	2.86 cd	6.57 abcd	5.14 cdefg	2.71 d	3.00 fgh	3.50 efgh	7.00 ab	6.00 bcde
C4	6.71 ab	5.86 bcd	6.57 abc	3.29 hi	3.57 abc	6.71 abc	5.71 abcde	3.43 d	3.86 def	5.00 cde	6.67 abcd	6.43 abc
MI2	7.44 a	6.89 ab	6.56 abc	3.22 hi	4.33 ab	6.89 a	6.56 abc	3.33 d	5.33 bc	8.67 a	7.44 a	7.44 a
LSD-value:	1.26	1.02	1.02	1.28	1.3	1.36	1.33	1.06	0.92	1.34	1.34	1.3

* The scaling for the attributes relates to Figure S1

Letters represent the Fisher Least Significant Difference (LSD) means comparison results within each attribute (i.e. column) p-value < 0.05