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Exploring South African Dealcoholized Wine:

Comparative Analysis of Volatile and Aroma Composition

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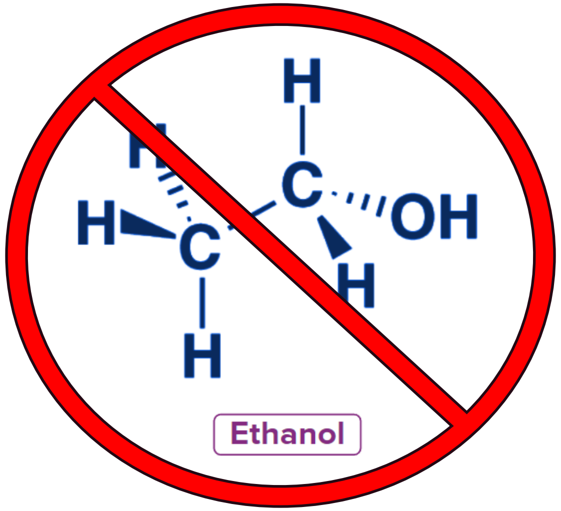
SASEV
South African Society for Enology & Viticulture

Introduction

- A finished wine from which alcohol has been removed post-fermentation, resulting in < 0.5 % ABV while retaining typical wine characteristics (OIV, 2021).
- Global low/no-alcohol beverage market growing ~7% annually.
- Health, lifestyle & legal factors driving consumer demand.
- Wine industry challenge: maintain flavour & aroma when removing alcohol.
- SA market still developing; opportunity for innovation.
- Lack of research in this field



Esteras-Saz, de la Iglesia, et al. 2024, Motta, Guaita, et al. 2017, OIV, 2021

Should it be sold as wine, or as a “wine-based” product?

Wine

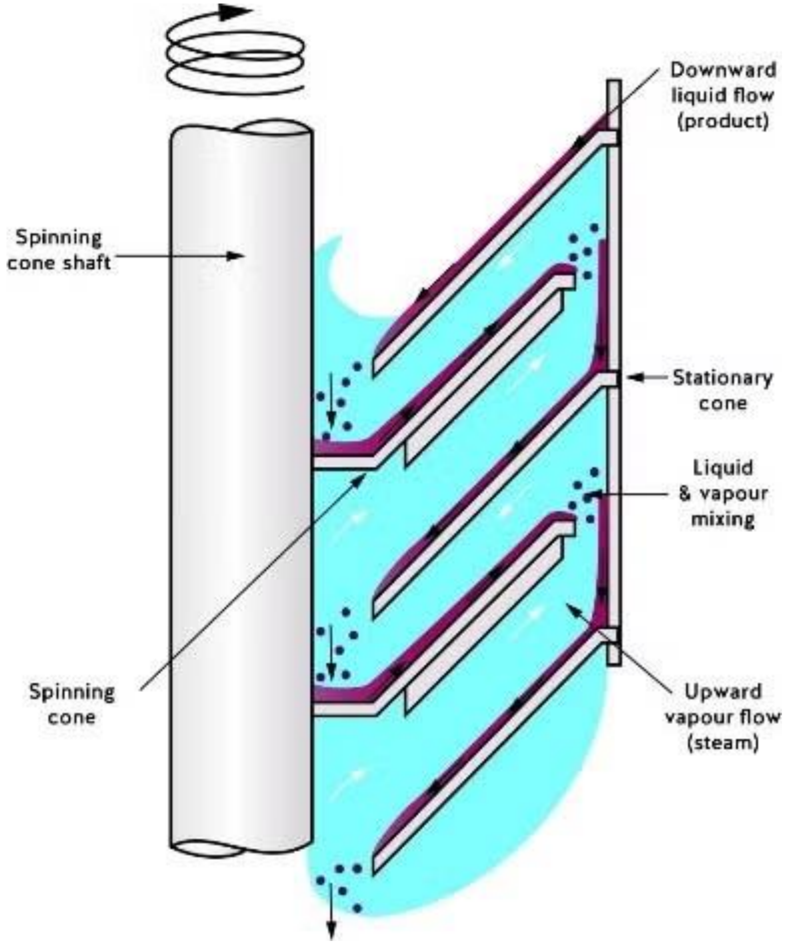
Dealcoholised Wine

Coca-cola

Coke Zero

- Consumer expectations
- Sparkling wine faced the same challenges
- Price considerations

Spinning Cone Column



SCC Mechanism:
- Rotating cones stack.
- Wine flows down, steam up.
- Increases surface area for mass transfer.

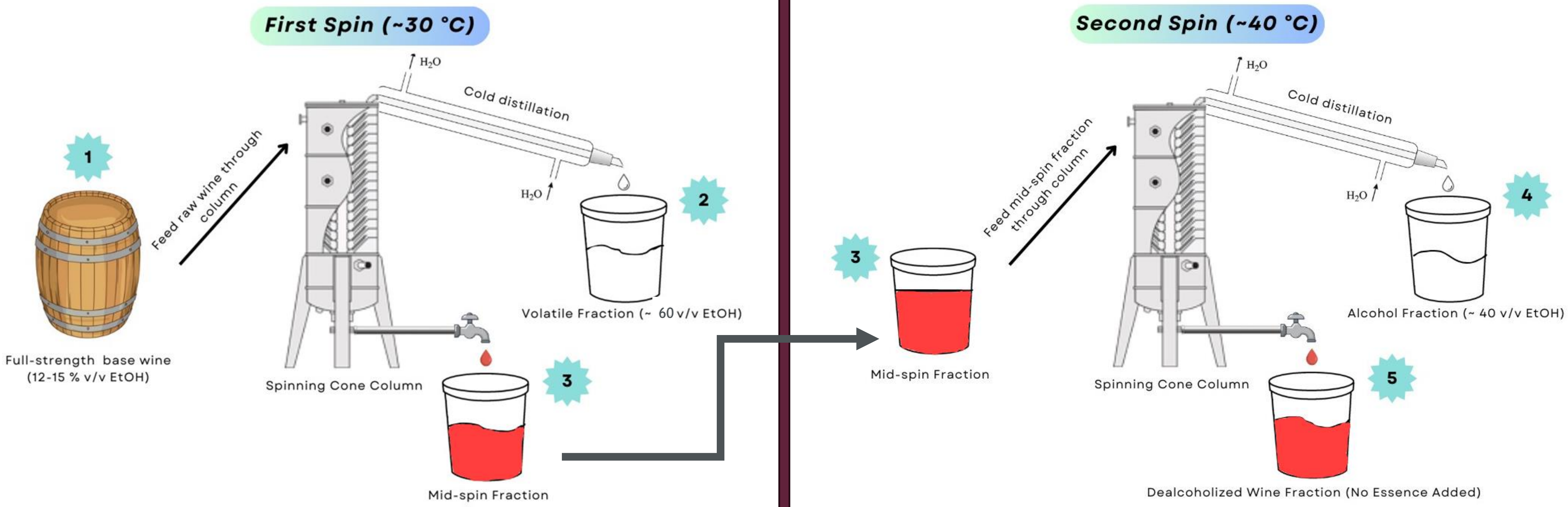
Evaporation:
- Wine forms film, steam carries compounds.
- Alcohol removed while preserving flavours.

Preservation:
- SCC operates at low temp, vacuum.
- Alcohol has lower boiling point.
- Protects aroma compounds.

Separation:
- Enriched steam condensed.
- Alcohol separated via distillation.

Saha et al., 2013; Ozturk and Anli, 2014

Dealcoholisation Fractions:



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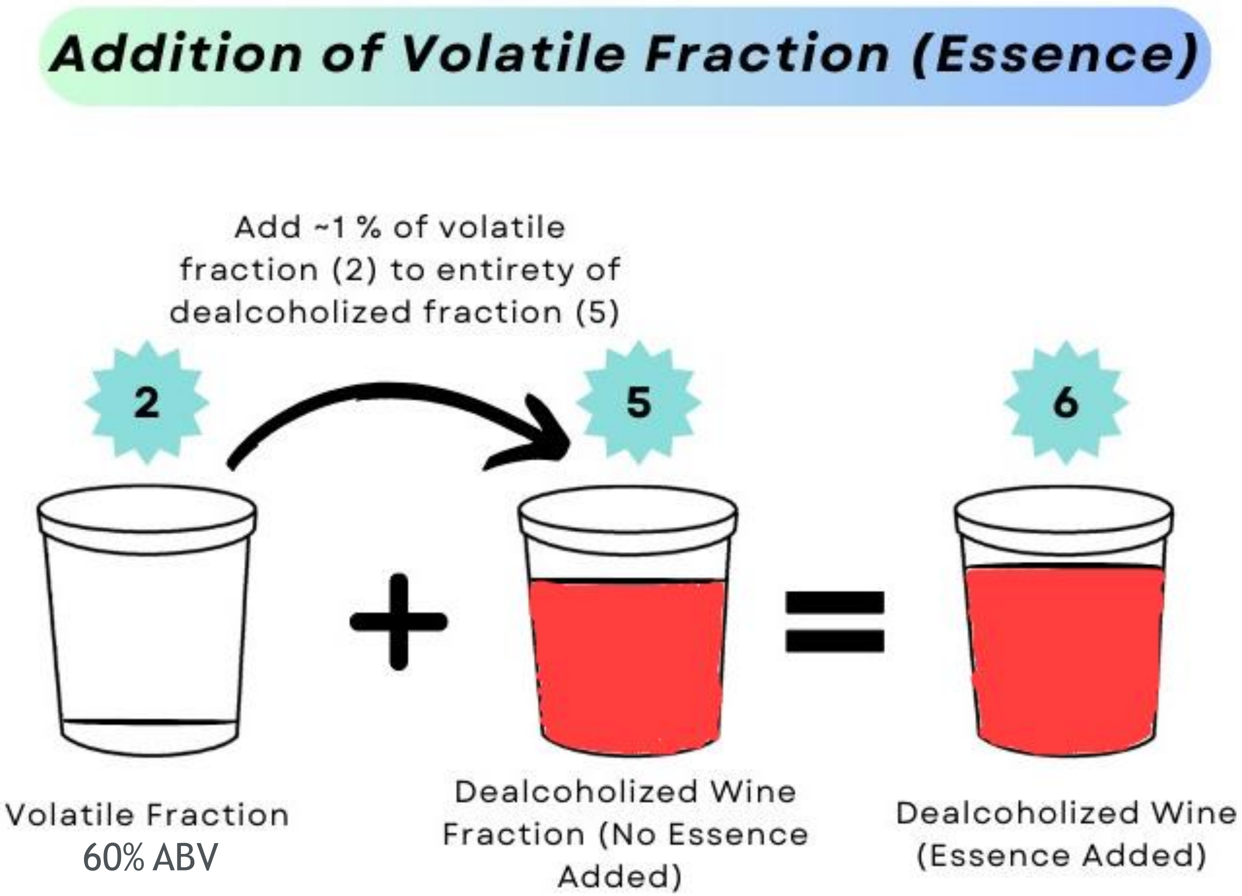

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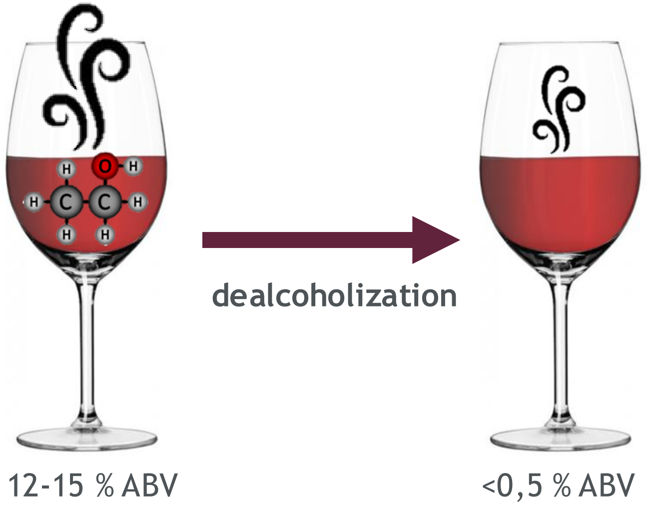
Aims & Objectives

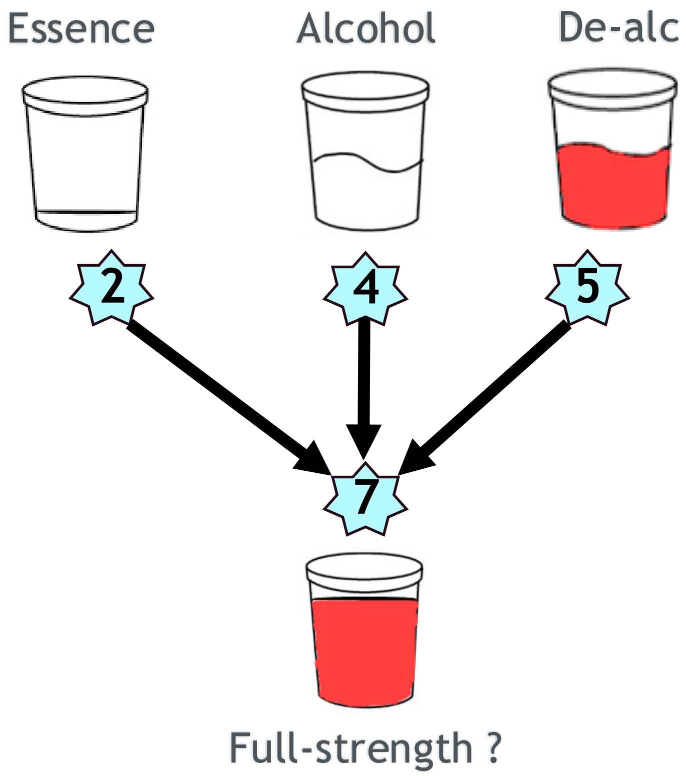
Compare RSA dealcoholised wine with international counterparts

1



Assess the aromatic profile of full-strength base wine, separate fractions and the final dealcoholized wine

2



Recombination of wine fractions to measure aroma molecule retention

3

First Objective:

Compare RSA dealcoholised wine with international counterparts

1

Comparative Experiment:

1

Table Discussion

2

International sourcing

3

Comparative aroma testing by panelists

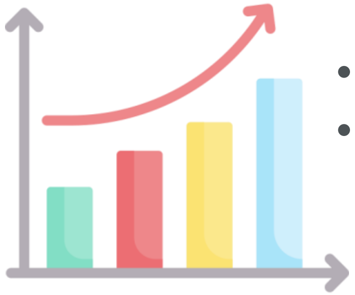
- Free-description
- Quality score
- Wine-like score
- Compusense

4

Chemical profiling

- Major Volatiles
- VOC's
- Thiols

5



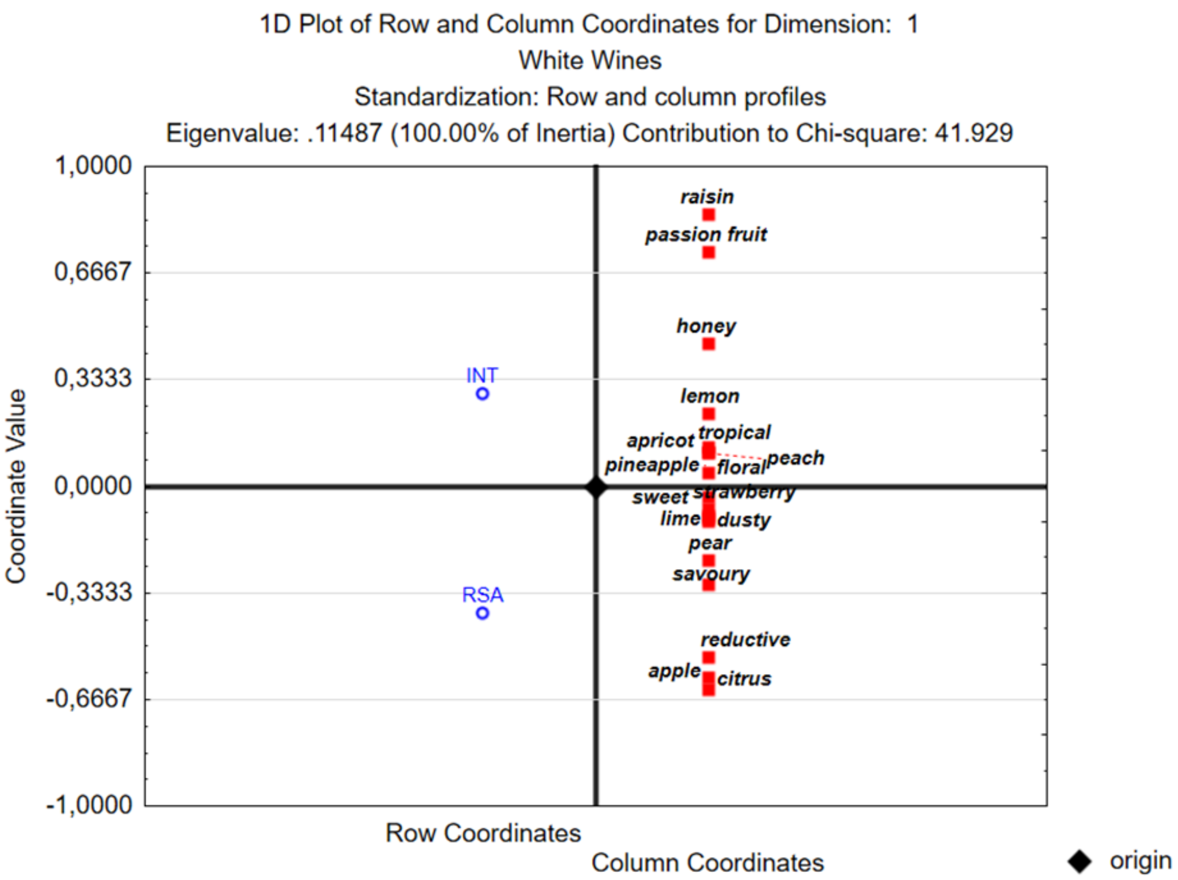
Statistical analysis

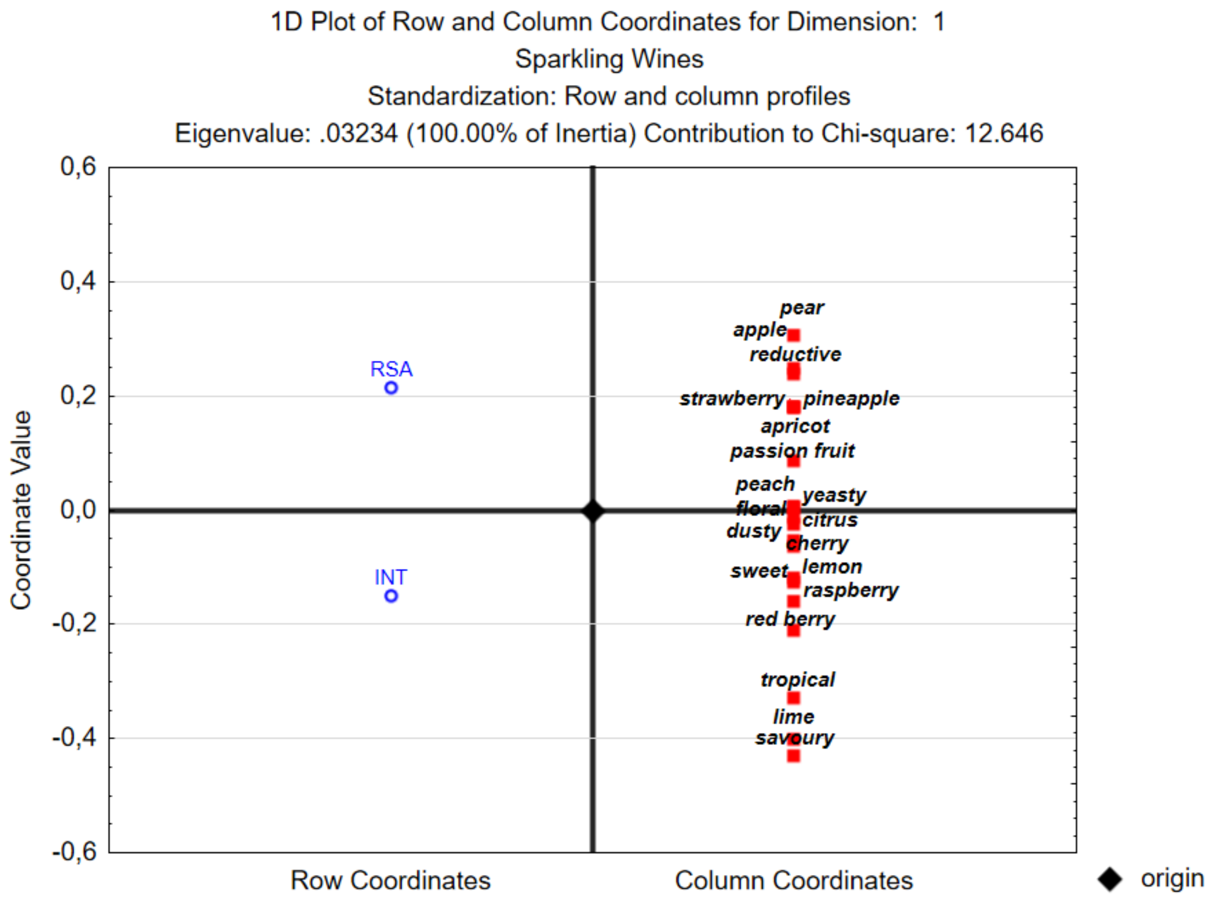
- Statistica
- XLSTAT

Dealcoholised wines by style and country of origin:

Country of origin	Sparkling (10)	White (10)	Rosé (5)	Red (12)	Total wines
South Africa (SA)	5	4	2	4	15
United States (USA)	3	2	2	3	10
Spain (SPN)	1	2	-	2	5
France (FRA)	2	-	-	2	4
New Zealand (NZ)	-	1	-	-	1
Australia (AUS)	-	1	1	1	3

Results: Int vs RSA





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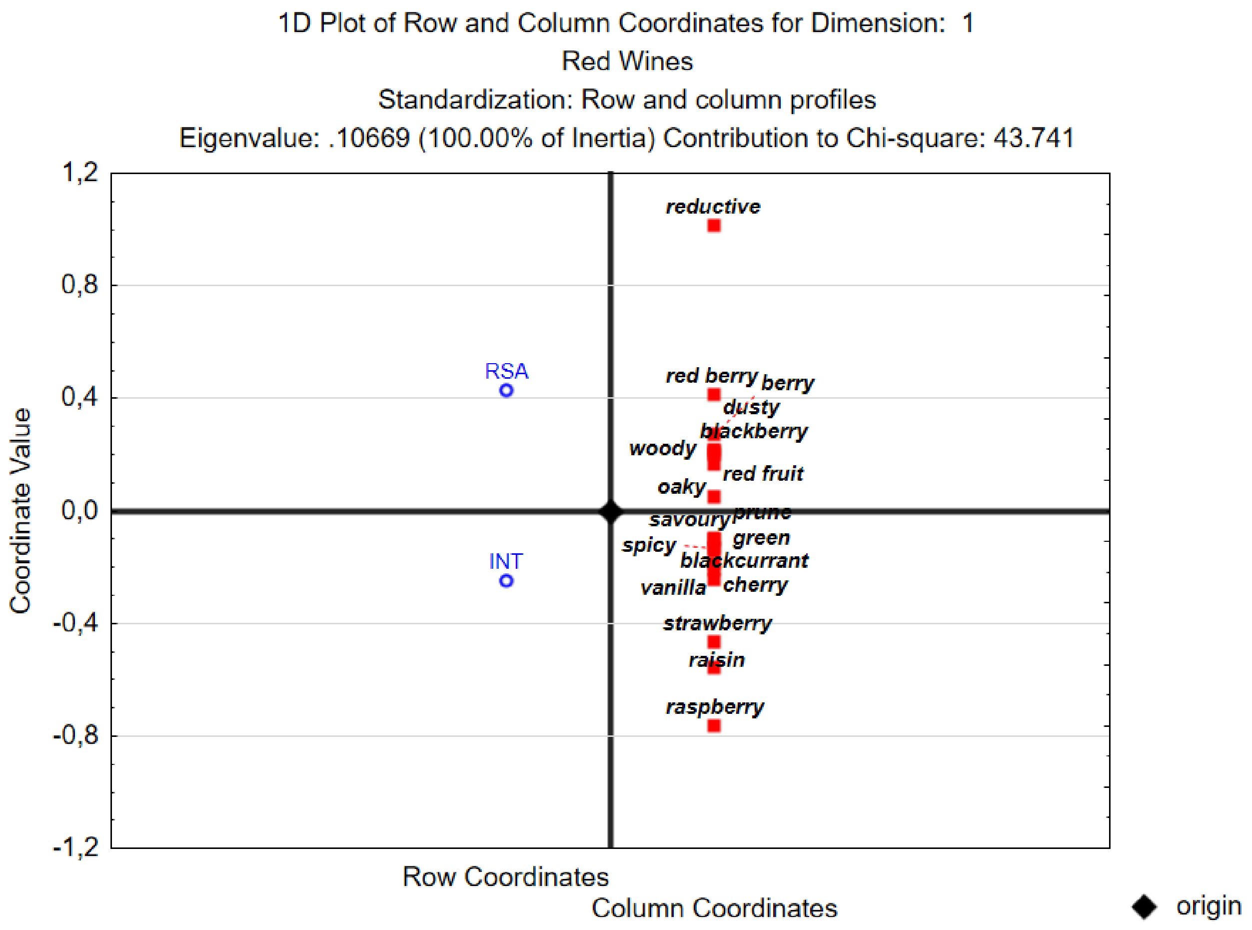

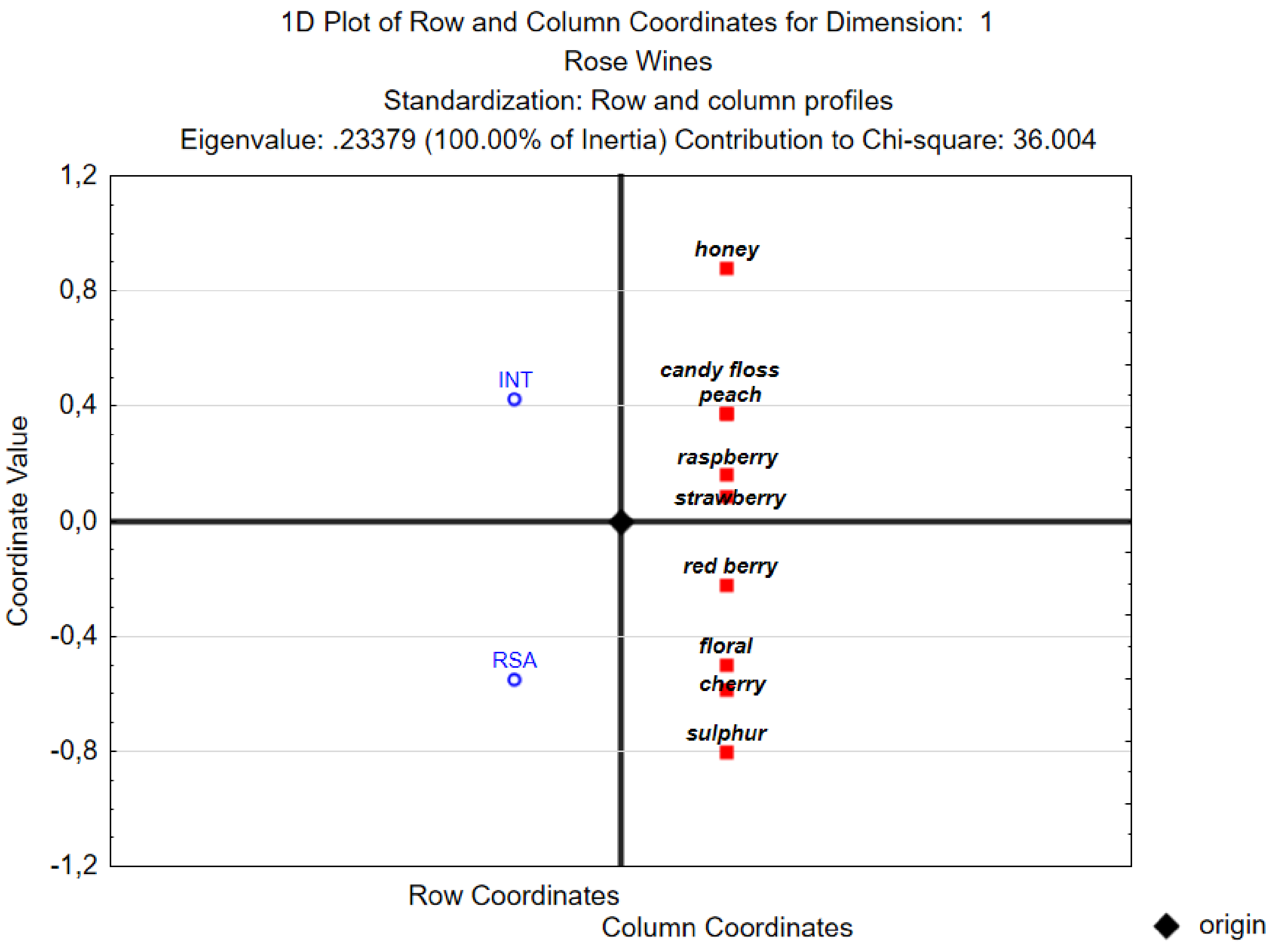

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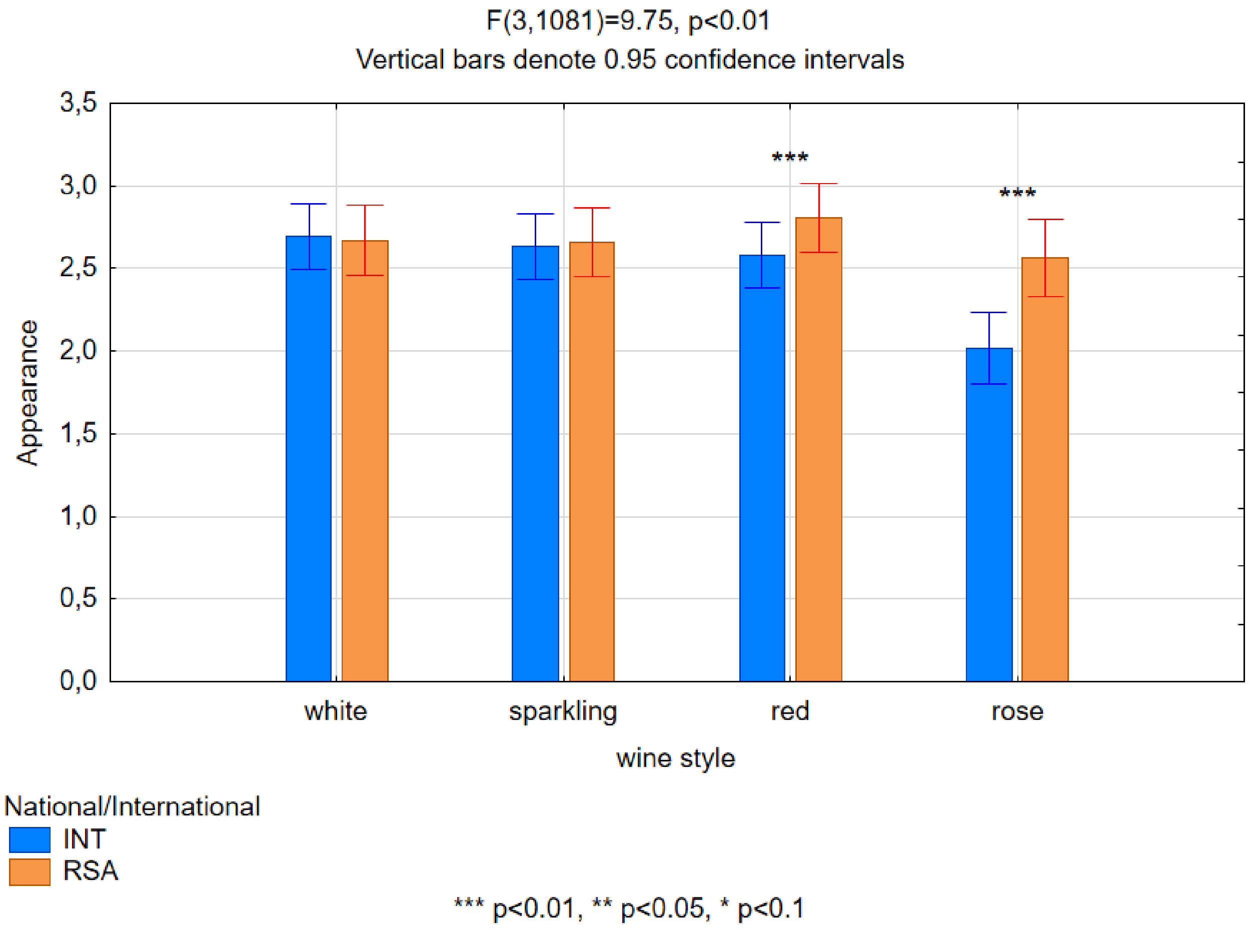
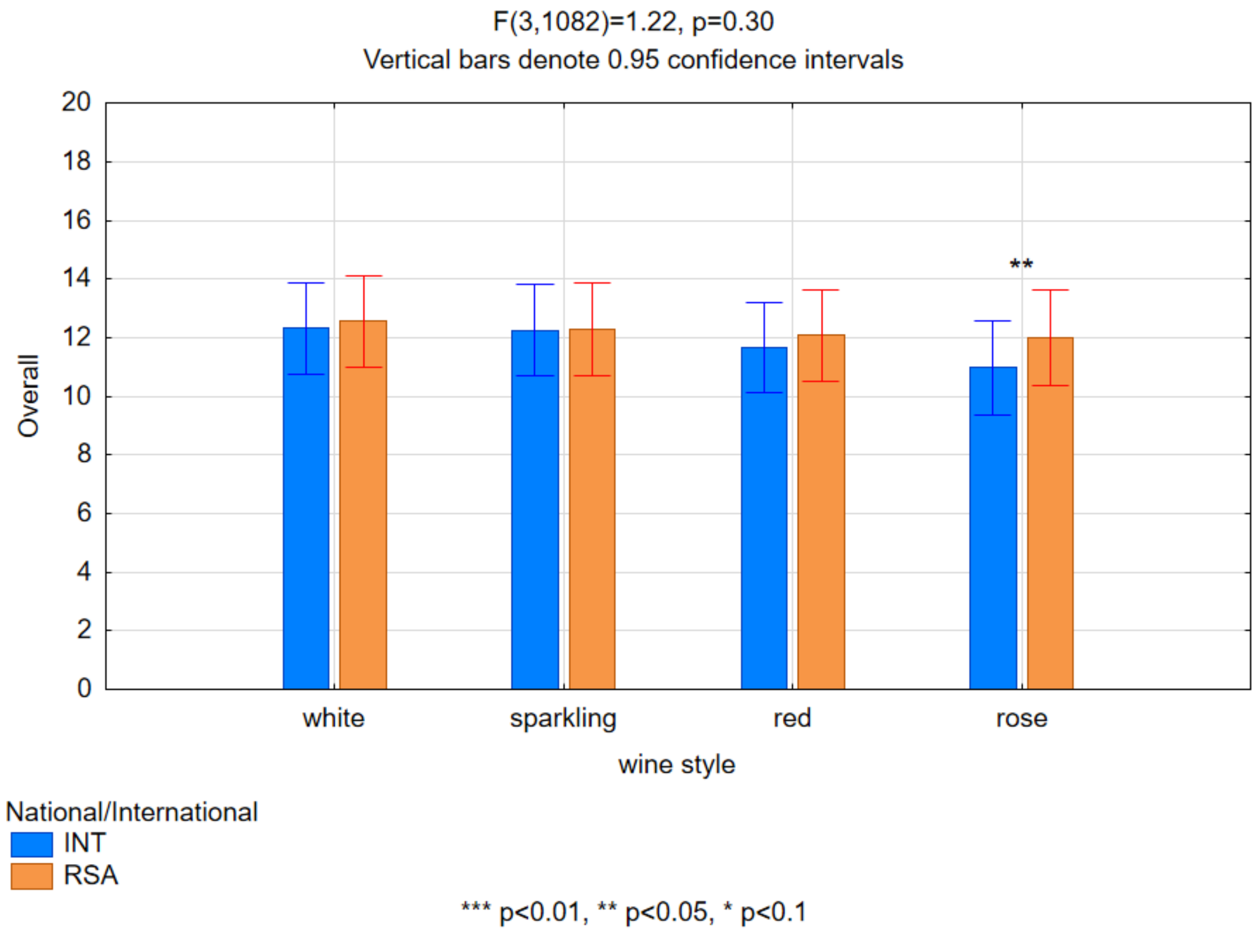
Results: Int vs RSA “appearance” and “overall quality”





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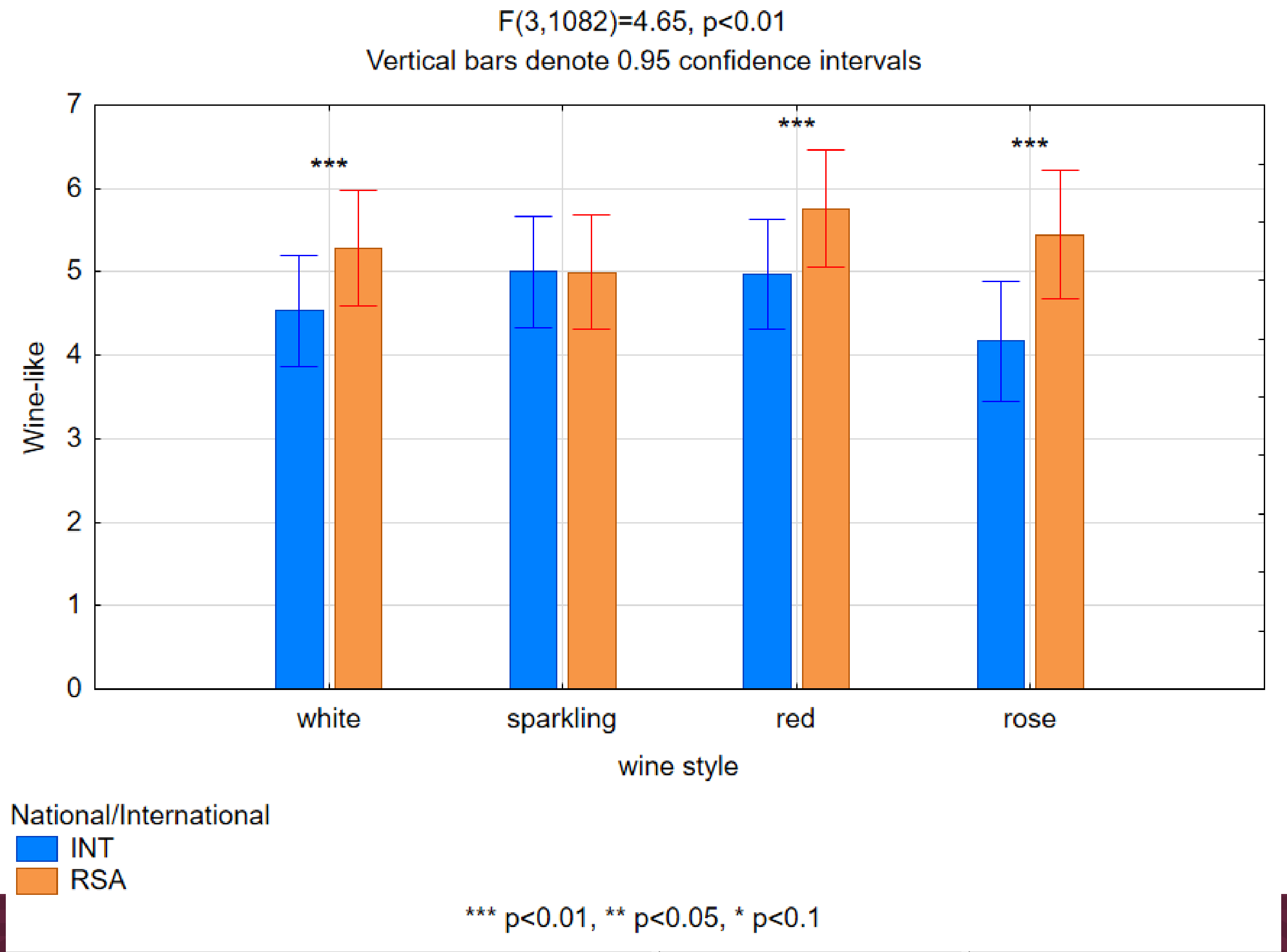
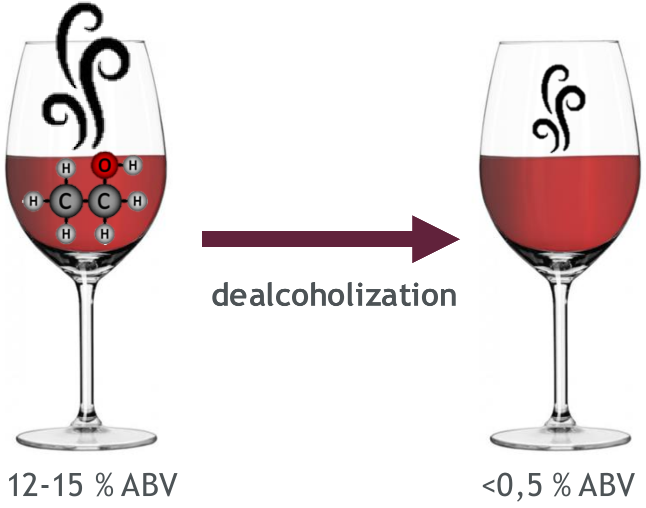
Results: Int vs RSA "wine-like"



Second Objective:

Style	Count	
Whites	4	
Rosés	2	
Reds	3	

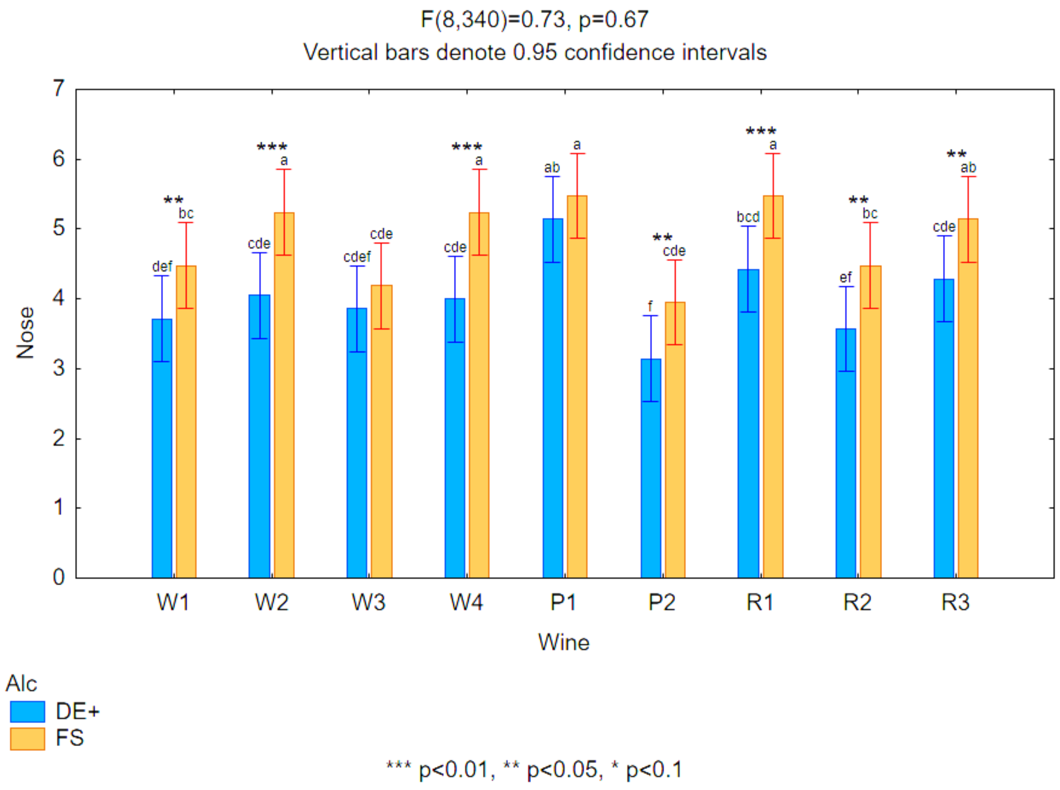


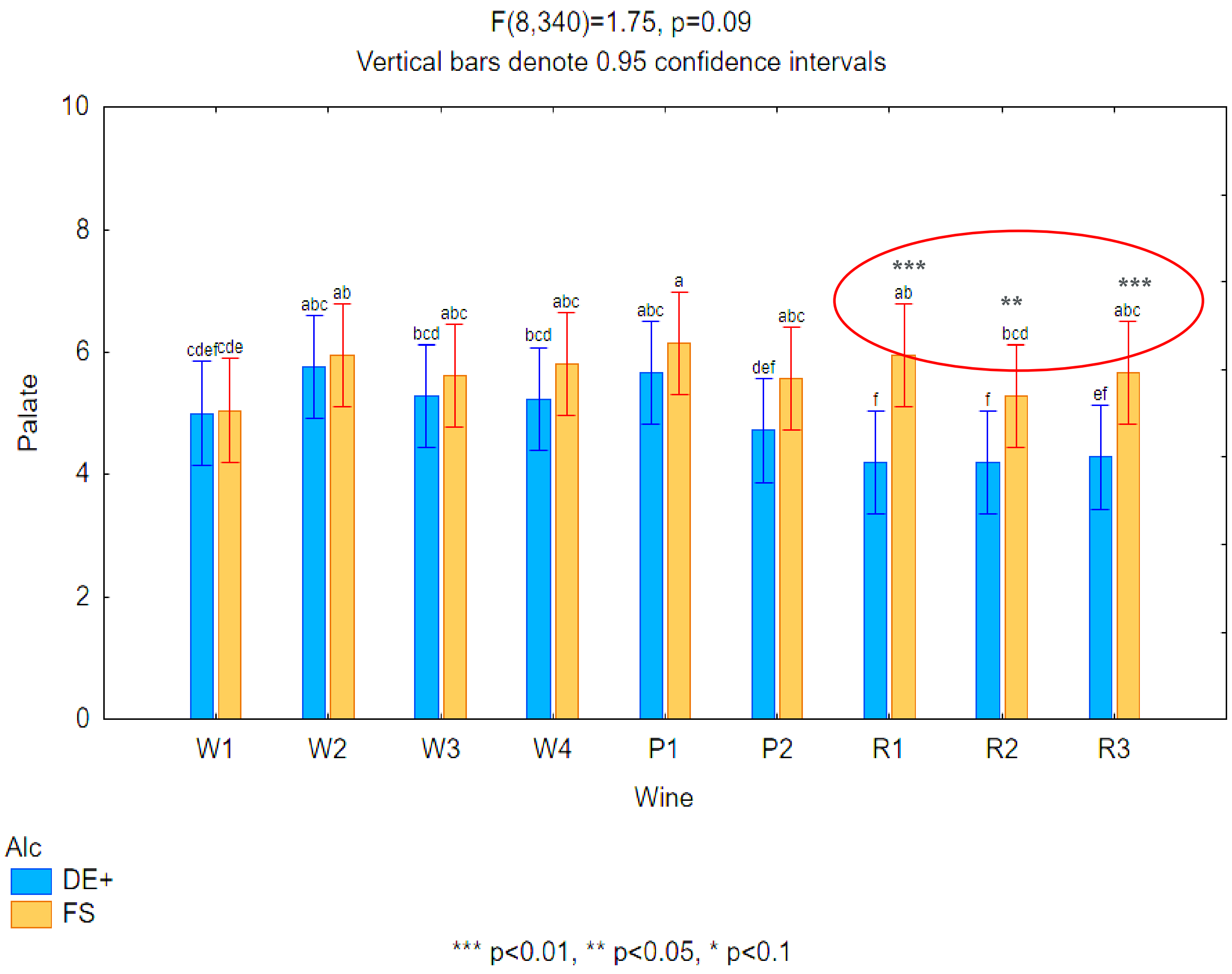
FS vs DE+: Comparison of quality drivers by assessing full-strength with de-alc counterpart

2

- Trained panellists smelled, taste and visually observed each sample
- Original full-strength wine quality scoring using 20-point scale
- Corresponding dealcoholised wine quality scoring using 20-point scale
- Scores were compared to determine how dealcoholisation affect sensory quality

Obj 2: FS vs Dealc Results





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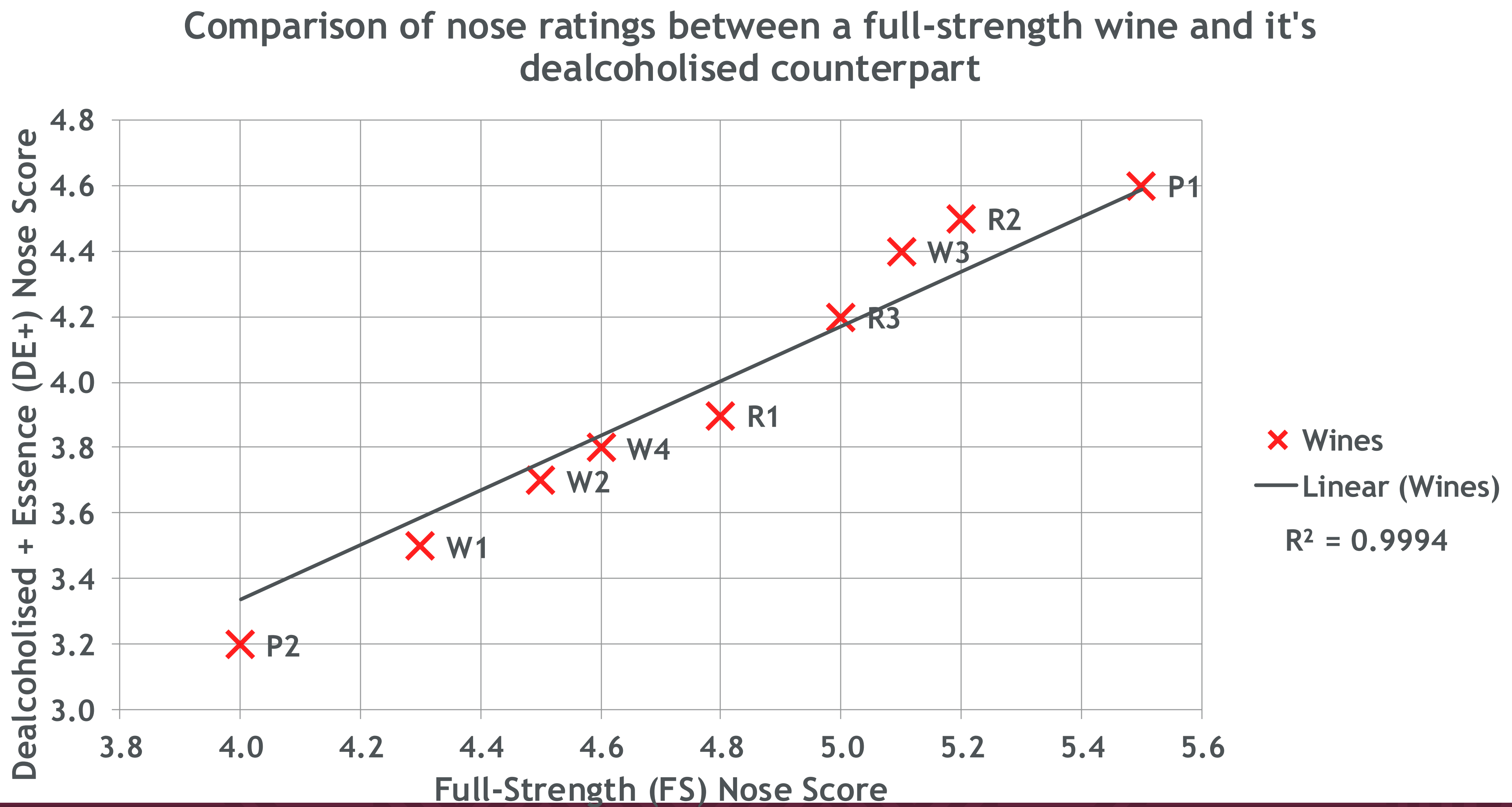
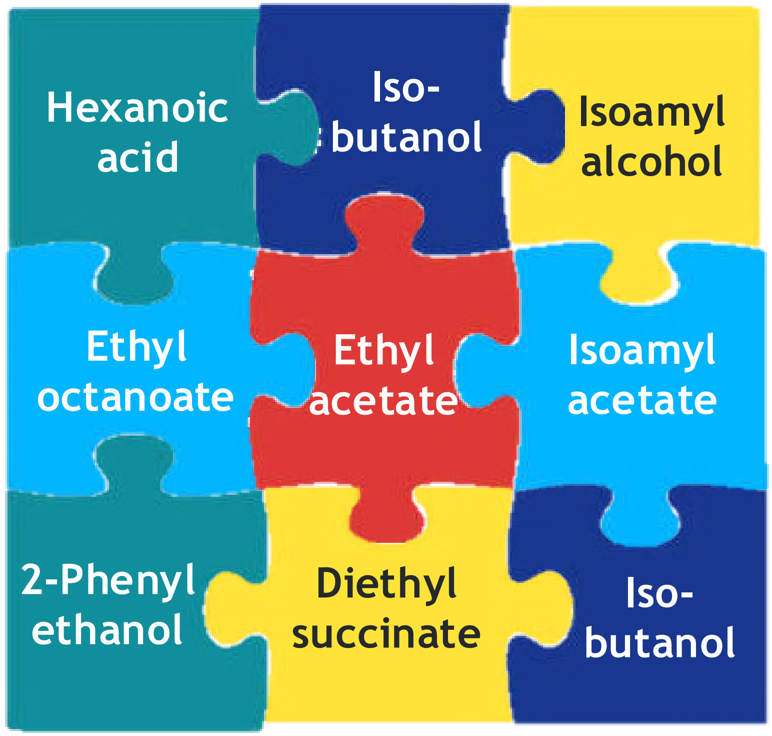


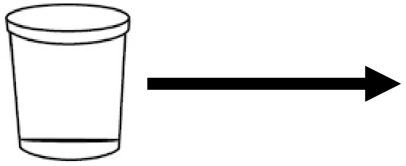
Third Objective:

Full-strength:

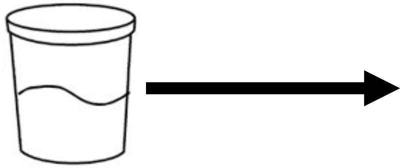


Reconstitution to mimic the full-strength counterpart:

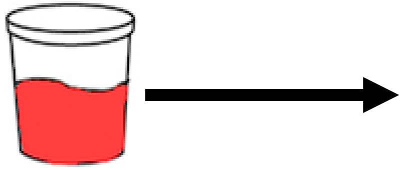
Essence:



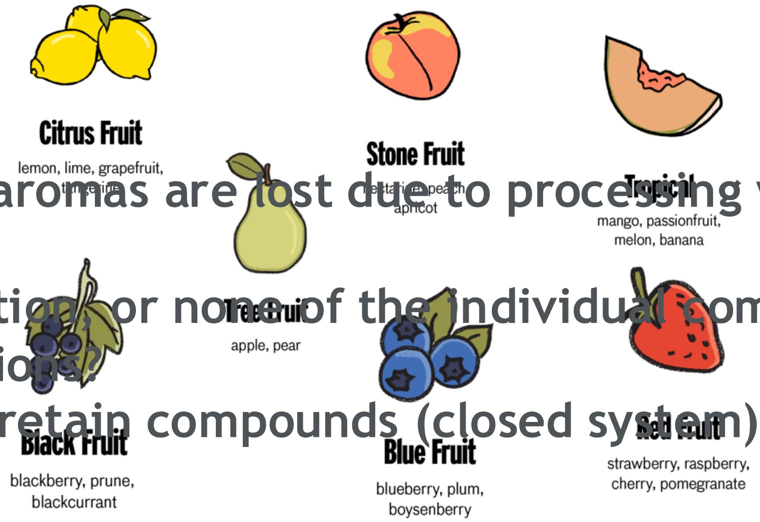
Alcohol:



De-alcoholised:



Third Objective:



- What compounds/aromas are lost due to processing when utilizing SCC?
- Are all, only a portion, or none of the individual compounds captured in any of the fractions?
- SCC's potential to retain compounds (closed system)?

More:

No difference:

Less:

Reconstitution Results (Sensory):

Reconstitution of white wines:

Attribute	Mean	Std.Dv	N	t-value	p
Fruity	0,08	1,02	52	0,39	**0,70**
Floral	-0,11	1,05	18	-0,32	**0,76**
Tropical	0,38	0,96	26	1,44	**0,17**
Muscat	0,00	1,15	8	0,00	**1,00**
Fresh	0,25	1,04	16	0,68	**0,52**
Green	-0,50	1,00	8	-1,00	**0,39**
Dusty	0,00	1,15	8	0,00	**1,00**
Overall aroma	-0,33	1,15	6	-0,50	**0,67**
Citrus	-0,60	0,89	10	-1,50	**0,21**
Lemon	0,33	1,03	12	0,79	**0,47**
Perfume	0,33	1,15	6	0,50	**0,67**
Passion Fruit	0,20	1,10	10	0,41	**0,70**
Pineapple	0,60	0,89	10	1,50	**0,21**
Guava	-0,60	0,89	10	-1,50	**0,21**

Reconstitution of red wines:

Attribute	Mean	Std.Dv	N	t-value	p
Alcohol	0,67	0,82	12	2,00	**0,10**
Floral	0,14	1,07	14	0,35	**0,74**
Sweet	-0,14	1,07	14	-0,35	**0,74**
Fresh	0,00	1,15	8	0,00	**1,00**
Green	0,67	0,82	12	2,00	**0,10**
Dusty	0,33	1,03	12	0,79	**0,47**
Spice	-0,11	1,05	18	-0,32	**0,76**
Oak	0,25	1,04	16	0,68	**0,52**
Vanilla	-0,67	0,82	12	-2,00	**0,10**
Red berries	-0,67	0,82	12	-2,00	**0,10**
Strawberry	0,50	1,00	8	1,00	**0,39**
Meaty	0,67	0,82	12	2,00	**0,10**
Red fruit	-0,60	0,89	10	-1,50	**0,21**
Reductive	0,00	1,41	4	0,00	**1,00**

Reconstitution Results (Chemistry): One white wine as example

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Ethyl esters

Compound	FS mg/L	RC mg/L	%diff
Ethyl acetate	51,15	48,98	4,20
Ethyl butyrate	0,10	0,09	-
Ethyl hexanoate	0,48	0,46	4,20
Ethyl lactate	3,18	2,87	9,70
Ethyl octanoate/caprylate	1,41	1,29	8,50
Ethyl-3-hydroxybutanoate	0,30	0,29	3,30
Ethyl decanoate	0,17	0,16	5,90
Diethyl succinate	0,07	0,07	0,00
Ethyl phenylacetate	0,26	0,21	19,20

Acetate esters

Compound	FS mg/L	RC mg/L	%diff
Isoamyl acetate	2,04	1,88	7,80
Hexyl acetate	0,08	0,07	-
2-Phenethyl acetate	0,14	0,13	7,10

Reconstitution Results (Chemistry): One white wine as example

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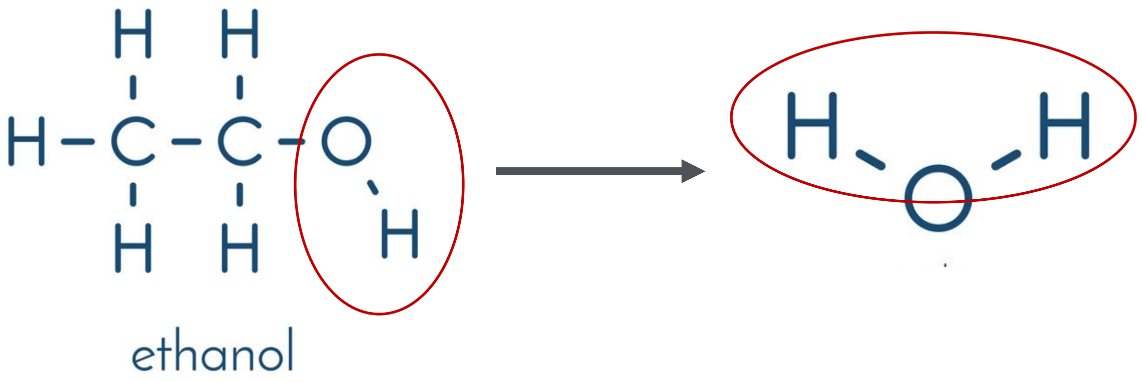
Acids

Compound	FS mg/L	RC mg/L	%diff
Acetic acid	610,30	549,27	10,00
Isobutyric acid	0,87	0,78	10,30
Isovaleric acid	0,69	0,63	8,70
n-Valeric acid	0,29	0,28	3,40
Hexanoic acid	1,90	1,76	7,40
Octanoic acid	1,91	1,76	7,90
Decanoic acid	0,83	0,81	2,40
Propionic acid	2,72	2,52	7,40

Higher Alcohols

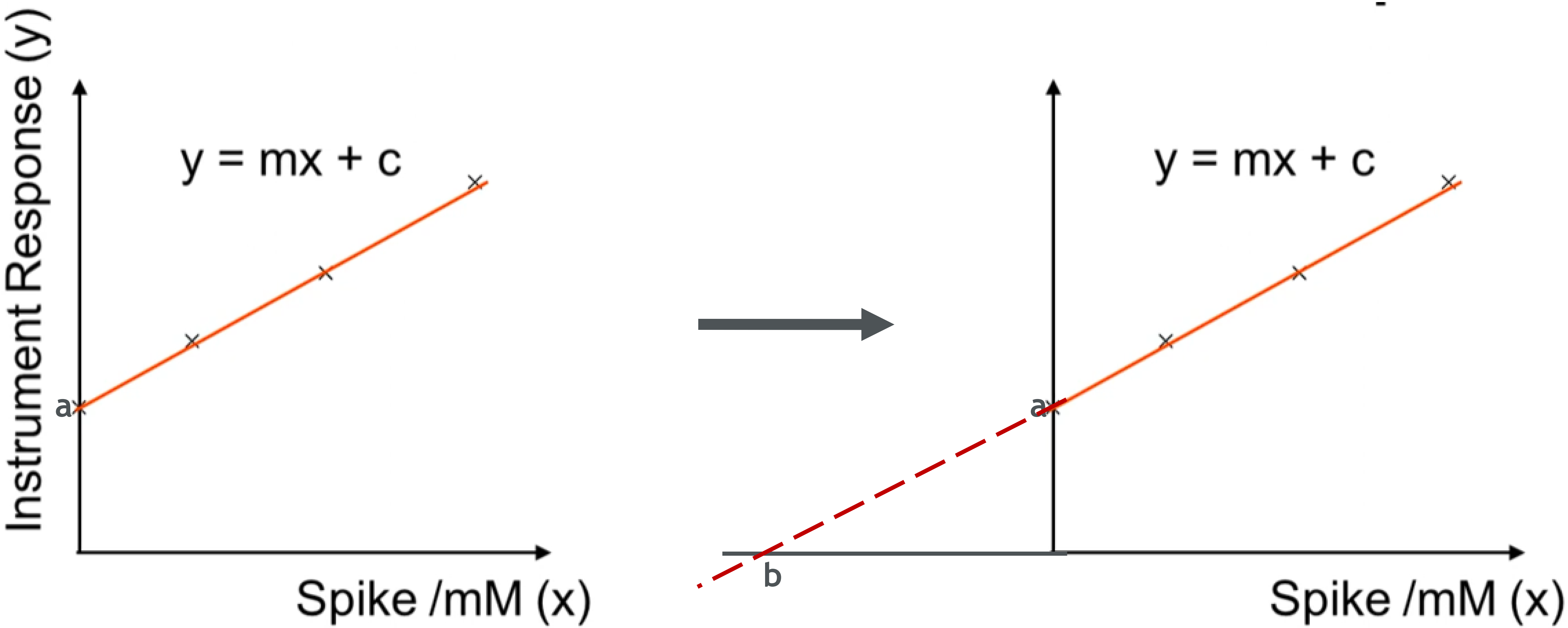
Compound	FS mg/L	RC mg/L	%diff
Methanol*	132,71	126,07	5,00
n-Propanol	44,30	39,36	11,10
Isobutanol	13,68	12,50	8,60
n-Butanol	1,21	1,09	9,90
Isoamyl alcohol	83,94	79,74	5,00
3-Ethoxy-1-propanol	3,54	3,26	7,90
Hexanol	0,50	0,45	10,00
Pentanol	0,10	0,09	10,00
2-Phenylethanol	4,50	4,15	7,80

Polarity Considerations:



- Removing 12% of ethanol – much more polar matrix
- Interaction of particles start to behave different in analysis
- Calibration curves need a fix
- Standard addition:
  - Compensates for matrix effects
  - Works well at low analyte concentrations

Calibration Considerations:



Limitations & Challenges

1 Dependent on commercial producers to provide wine for project

2 Limited number of tasting professionals = limited number of wines that can be analysed

3 Different standards for international wines.

Scientific- and industry contributions:

- Develop liquid-liquid calibration to effectively analyze volatile compounds in a wine matrix containing < 0.5 % ABV
- Understand the implications of using SCC on the aroma profile of dealcoholized wine
- Provide information for further research to possibly enhance dealcoholized wine quality

- Provide knowledge/insight to South African winemakers to better compete with international peers
- Wine producing companies will have a deeper understanding of the changes in aroma profile during the dealcoholization process.
- Understanding the importance of base wine selection

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Conclusion

- **Across RSA and international sets, patterns were similar:**
  - **- White & rosé** retained **appearance** better than **reds**.
  - **- International (INT) wines:** more **sweet-leaning notes** — raisin, passion fruit, honey.
- **South African (RSA) wines:** more **fresh descriptors** — citrus, apple.
- **Aroma (“nose”)** remains a **primary driver of perceived quality**.
- **Olfactory impact drops in dealcoholised wines**, even with essence added, vs full-strength controls.
- **Base-wine aroma intensity/quality is a key driver** of final dealcoholised wine quality.
- **SCC dealcoholisation + fraction recombination** produced **minimal sensory and chemical change** overall.

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Thank you
Enkosi
Dankie