UNIVERSITÀ DI FOGGIA

MED

11th Workshop on

MANAGEMENT OF INNOVATION IN THE AGRICULTURAL & FOOD SYSTEMS OF THE MEDITERRANEAN REGION

(Gestione dell'Innovazione nei Sistemi Agroalimentari della Regione Mediterranea)

Giovedì 1 Giugno 2017

Dipartimento di Scienze Agrarie, degli Alimenti e dell'Ambiente (SAFE)

Via Napoli 25 Foggia – Aula Magna "Di Stefano"

UNIVERSITÀ DEGLI STUDI DELLA TUSCIA

WeDIBAF

CORE organic

SusOrganic

QUALITY AND DRYING BEHAVIOUR OF ORGANIC FRUIT PRODUCTS

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OUR RESEARCH GROUP AND COMPETENCES

RICCARDO MASSANTINI
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ROBERTO MOSCETTI
POST-DOC

FLAVIO RAPONI
PH.D. STUDENT
2ND YEAR

SERENA FERRI
PH.D STUDENT
1ST YEAR

1. Chemical, physical and physicochemical analysis on food
2. Image analysis and computer vision
3. Vis/NIR and SWIR single-point spectroscopy and hyperspectral imaging
4. Chemometrics and Machine Learning (e.g. Deep Learning and Transfer Learning)
5. Internet of Things and sensors
6. virtual development environment, 4GL software (i.e. R, Python and Matlab) and agnostic programming platforms

Drying of food consists of three steps…

Pre-drying processing

drying

Post-drying handling

1

Pre-drying processing

It depends on the physical state of the material subjected to drying

SOLID

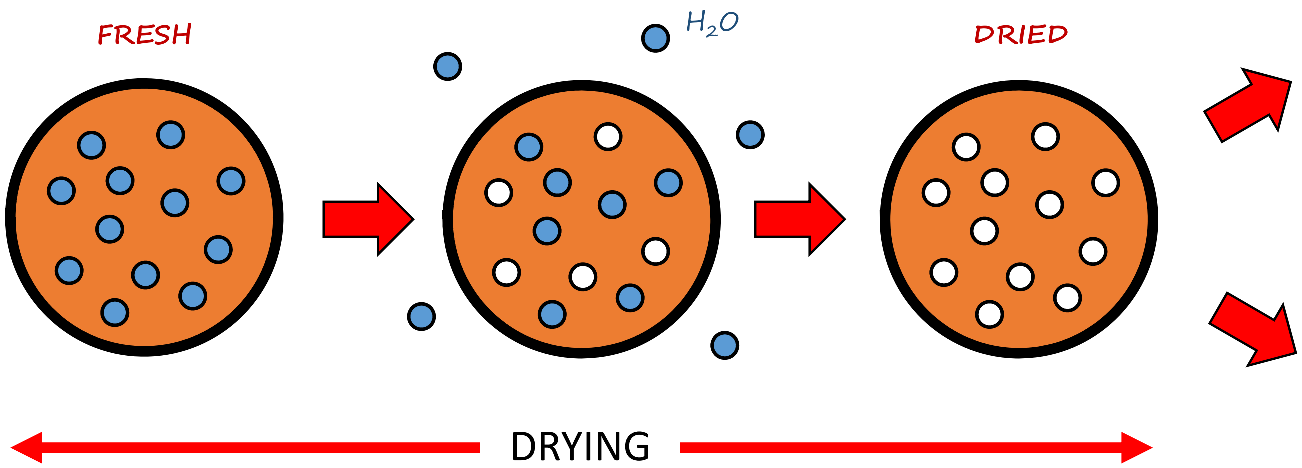
- SULFITED
- SOAKED
- DEWATERED
- BLANCHED
- FROZEN
- …

LIQUID

- VACUUM CONCENTRATED
- TREATED WITH ENZYMES
- FOAMED
- …

2

DRYING



READY-TO-EAT

QUALITY INDICES ASSESSED BY CONSUMERS

SEMI-PRODUCT

QUALITY INDICES IMPORTANT IN FURTHER PROCESSING AND AFFECTING PROPERTIES OF THE FINAL PRODUCT

3

POST-DRYING HANDLING

THE DRY PRODUCT IS NOT IN A THERMODYNAMIC EQUILIBRIUM STATE

- PRE-DRYING TREATMENTS AND DRYING AFFECT PRODUCT STORABILITY
- POST-DRYING TREATMENTS SHOULD MINIMIZE OR PROTECT THE MATERIAL FROM FURTHER CHANGES
- PRODUCT IS MORE STABLE WHEN IT IS IN A GLASSY STATE THAN IN RUBBERY STATE
- CONTACT WITH OXYGEN PROMOTES OXIDATION OF LIPID-LIKE SUBSTANCES (I.E. CAROTENOIDS)
- POST-DRYING PROCESSING IS ALSO INTENDED TO ADD VALUE TO THE FINAL PRODUCT

Physicochemical changes

- Moisture content and water activity
- Shape and size
- Firmness and texture
- Pigments content
- Enzymatic and non-enzymatic browning

Nutritional changes

- Vitamins content
- Carotenoids content
- Total polyphenolic content
- Antioxydant capacity

Sensorial characteristics

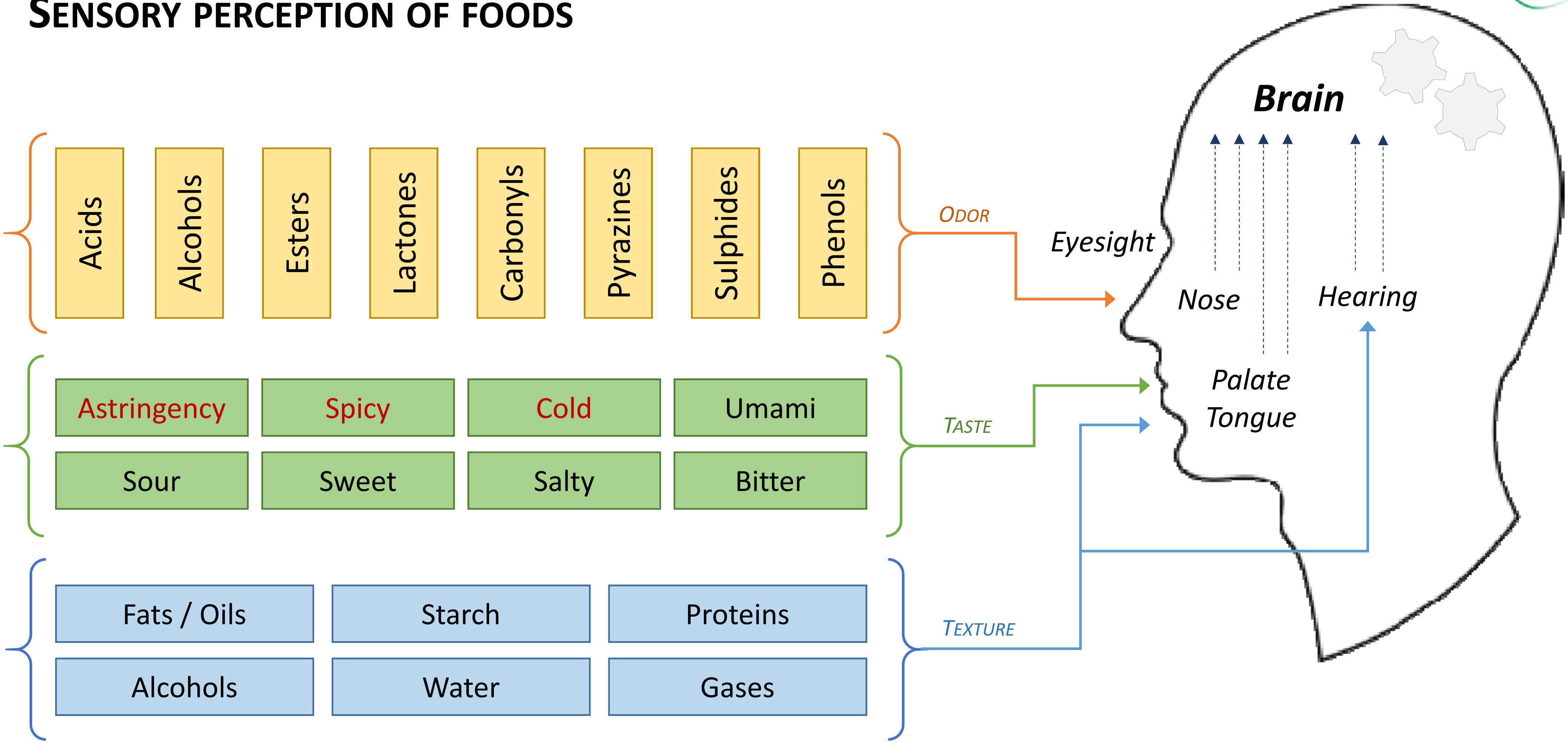
WHICH ARE THE MAIN INTERESTS OF AN ORGANIC CONSUMER?

HEALTH-RELATED ISSUES

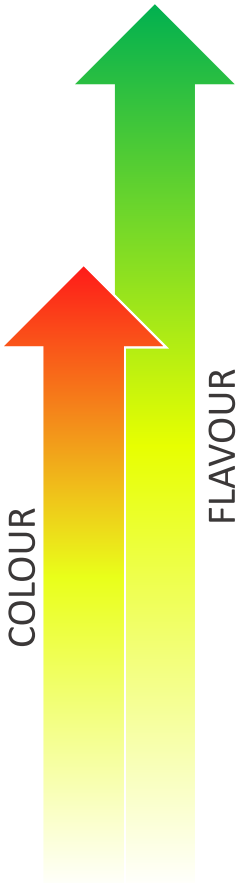
ENVIRONMENTAL CONCERN

FINALLY, YET IMPORTANTLY, DEMAND FOR ORGANIC FOODS IS DRIVEN PRIMARILY BY <u>CONSUMER PERCEPTIONS</u> OF THEIR QUALITY

SENSORY PERCEPTION OF FOODS



BIASED PERCEPTION OF FOOD QUALITY



RELATIONSHIP BETWEEN FLAVOUR AND COLOUR

RELATIONSHIP BETWEEN FLAVOUR AND SIZE, SHAPE, STRUCTURE AND PACKAGING

NUTRITIONAL VALUE OF ORGANIC AND CONVENTIONAL FOODS

AGRONOMIC VARIABLES	PRODUCTION METHODS	FARM LOCATION
Cultivar	*Duration*	*Geographical location*
Soil type	*Replication*	*Climate*
Organic matter	*Statistical design*	*Seasonal variations*
Planting date	*Sampling of plant*	*Storage conditions*
Harvest date	*Sample size*	*Post-harvest processing*
Trace elements	*Nutritional analyses*	*Plant disease*

OUR RESEARCH WORK

CARROT

Daucus carota L.
var. Romance

Shape and size
Slices of 3-mm thickness

Pretreatment
Hot-water blanching

Drying temperature
40°C (for 8 h)

APPLE

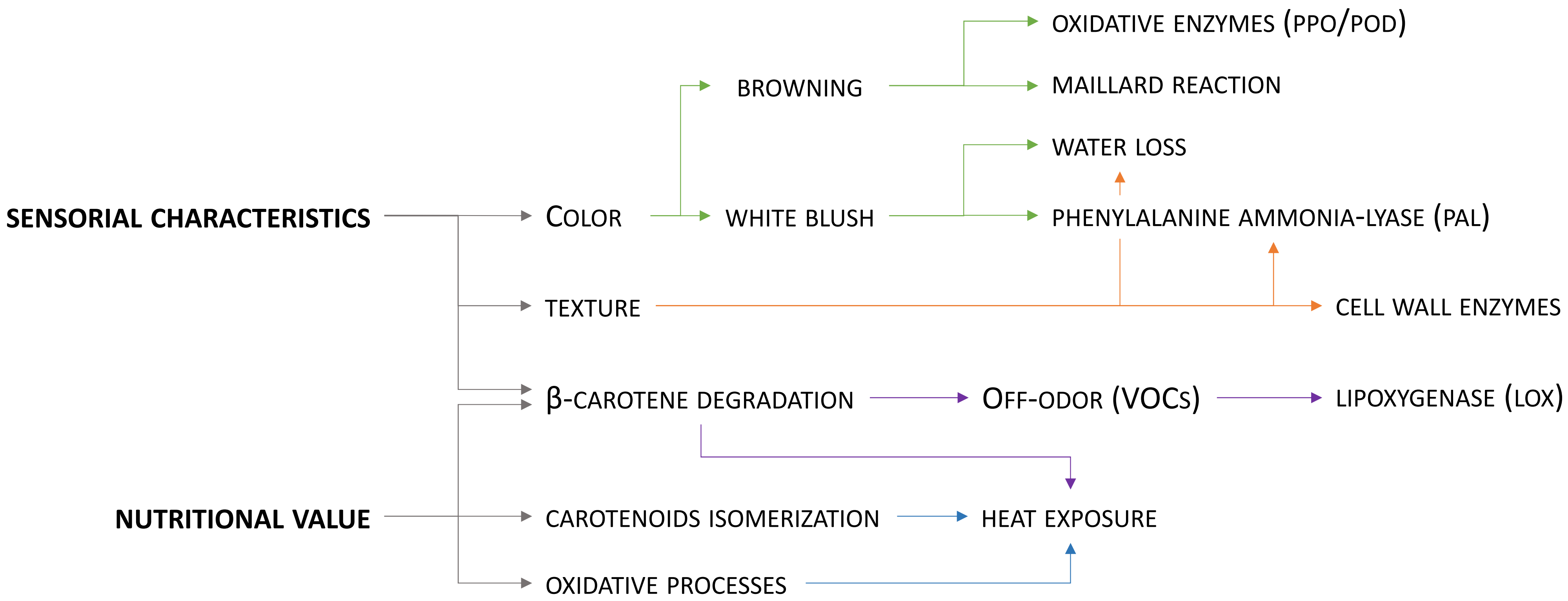
Malus domestica B.
var. Gala

Shape and size
Wedges of 3-mm thickness

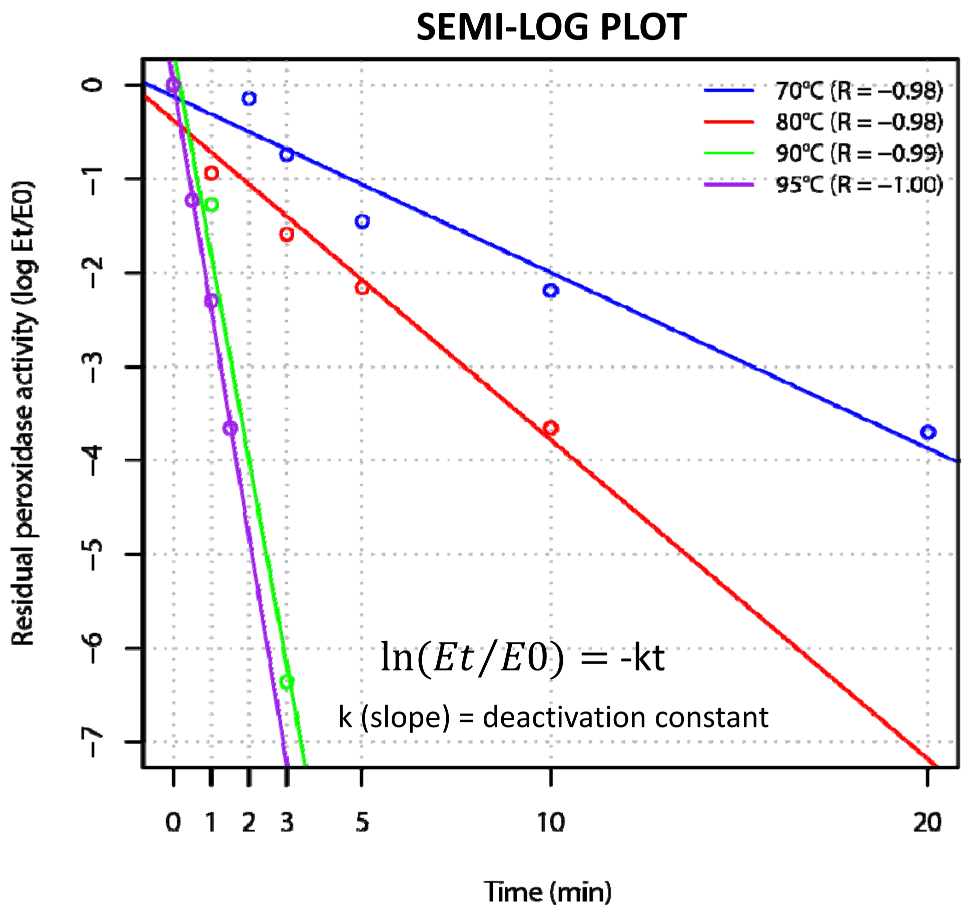
Pretreatment
Hot-water blanching

Drying temperature
60°C (for 8 h)

QUALITY PARAMETERS AFFECTED BY DRYING PROCESS

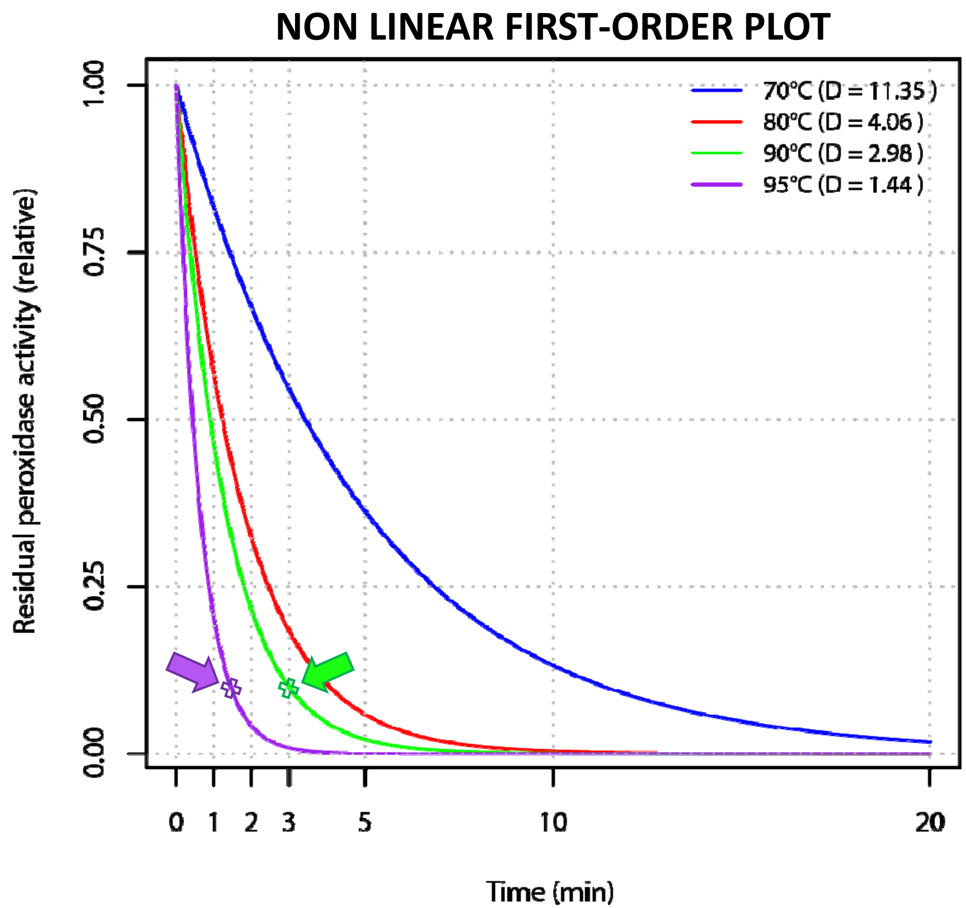


HOT-WATER BLANCHING - PEROXIDASE ACTIVITY -



$$\ln(Et/E0) = -kt$$

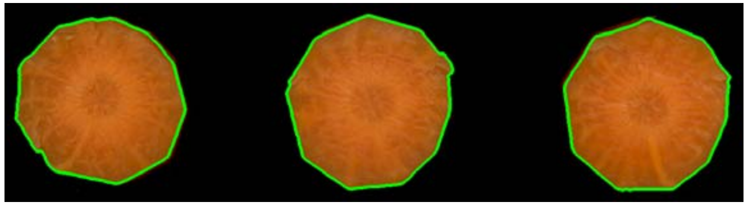
k (slope) = deactivation constant



HOT-WATER BLANCHING - COLOR ANALYSIS -

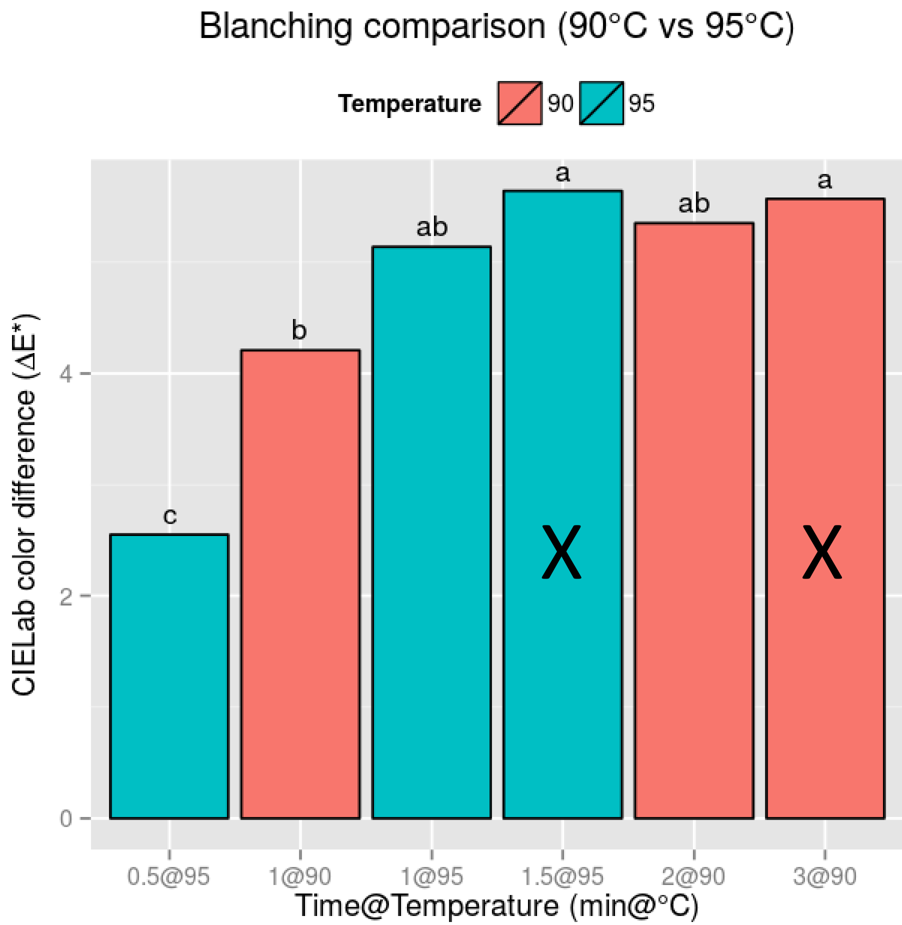
EXPERIMENTAL PROTOCOL

- Product: carrot slices
- Slice thickness: 5 mm
- Blanching temperature: 90, 95°C
- Blanching time at 90°C: 0.0, 1.0, 2.0, 3.0 min
- Blanching time at 95°C: 0.0, 0.5, 1.0, 1.5 min



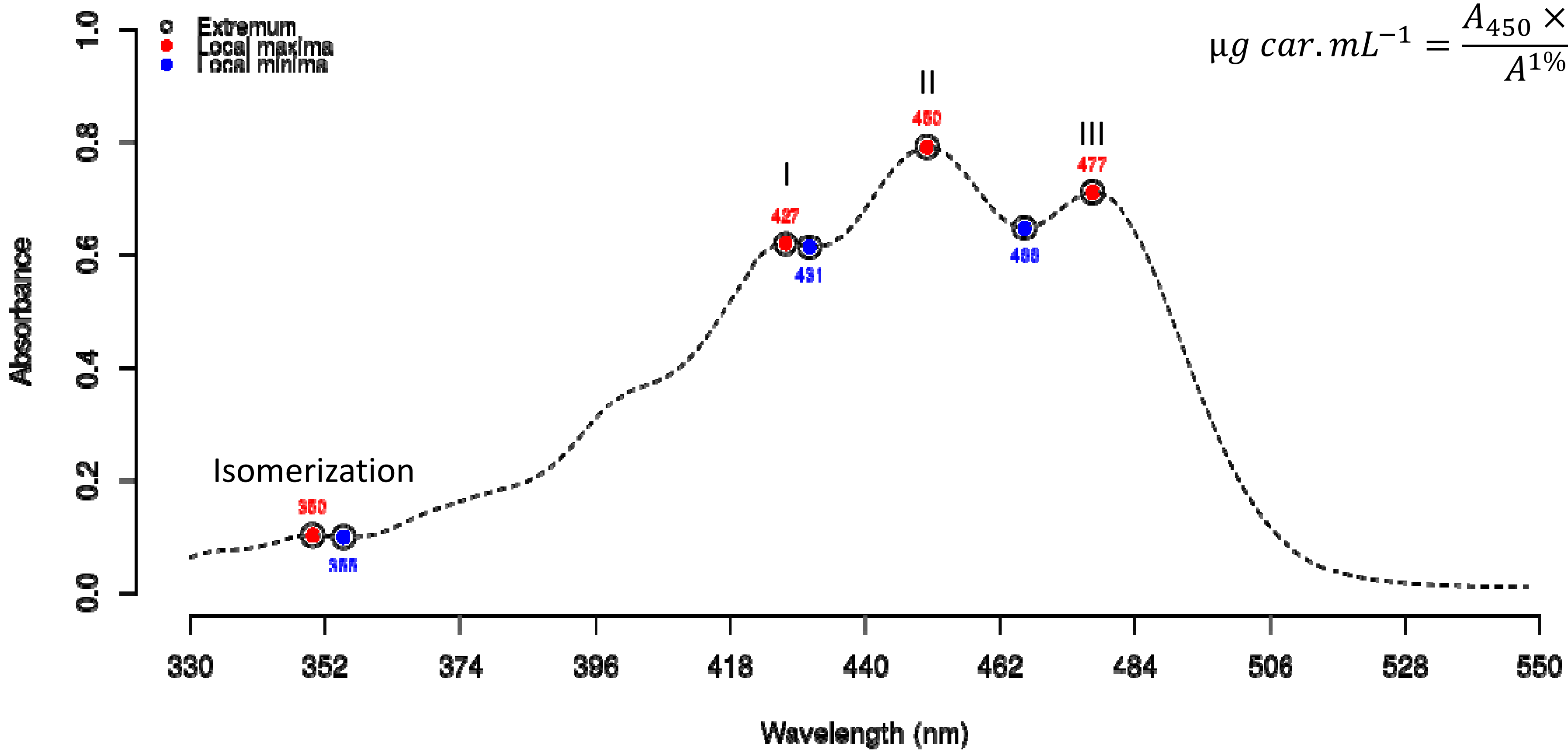
BLANCHING EFFECTS ON CARROT COLOR COORDINATES

- Decrease in Luminance (L*)
- Increase in Hue Angle (h)
- Decrease in Chroma (C*)
- Increase in ΔE* (>5, high difference between colors)



HOT-WATER BLANCHING - TOTAL CAROTENOIDS -

$$\mu g\ car.mL^{-1} = \frac{A_{450} \times V_1}{A^{1\%}} \times C^{1\%}$$



HOT-WATER BLANCHING - TOTAL CAROTENOIDS -

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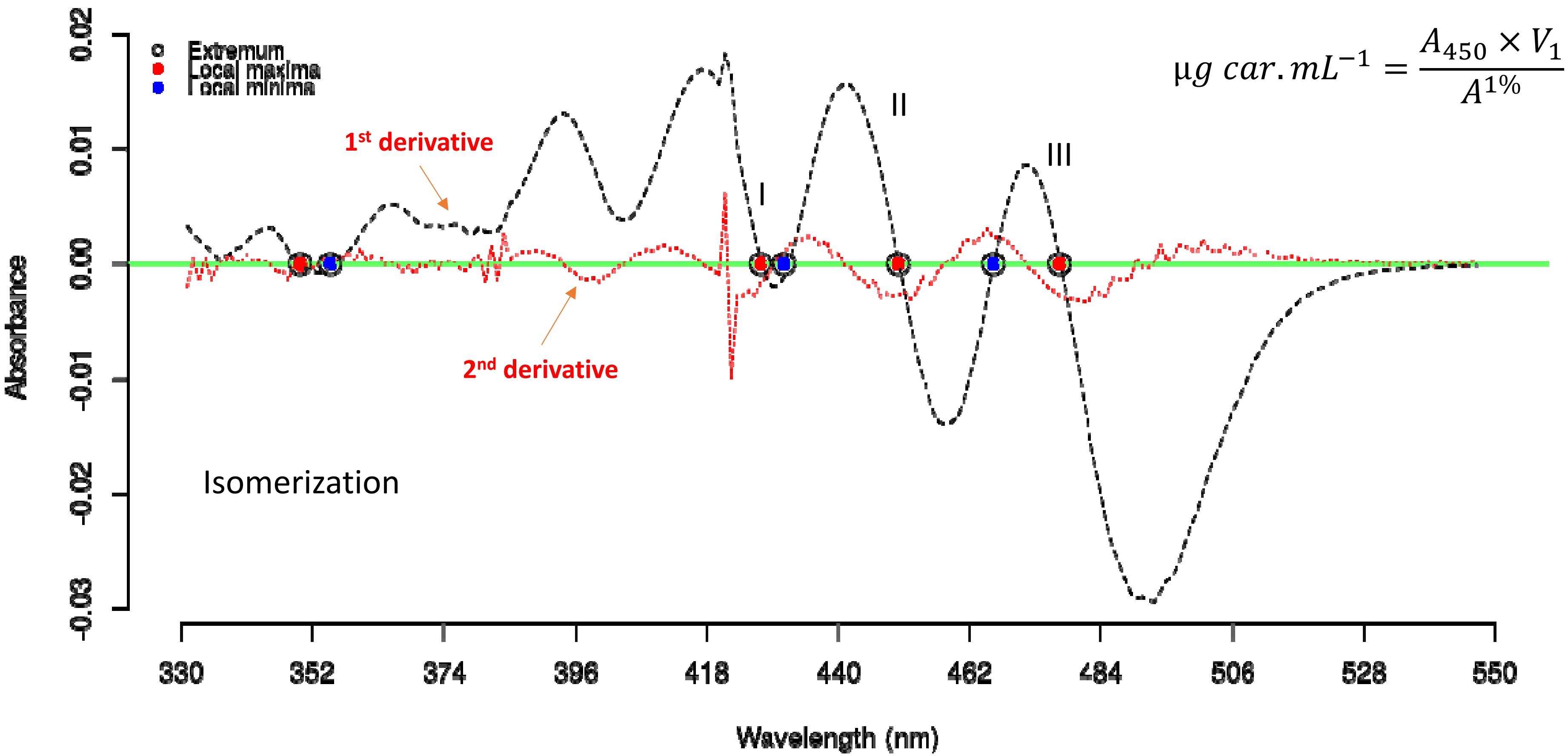
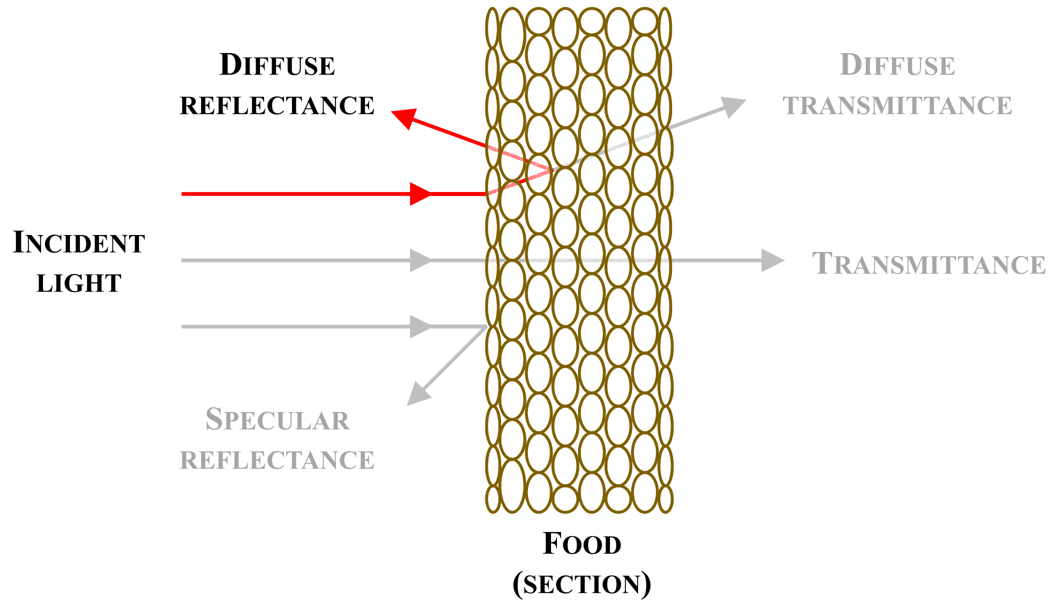
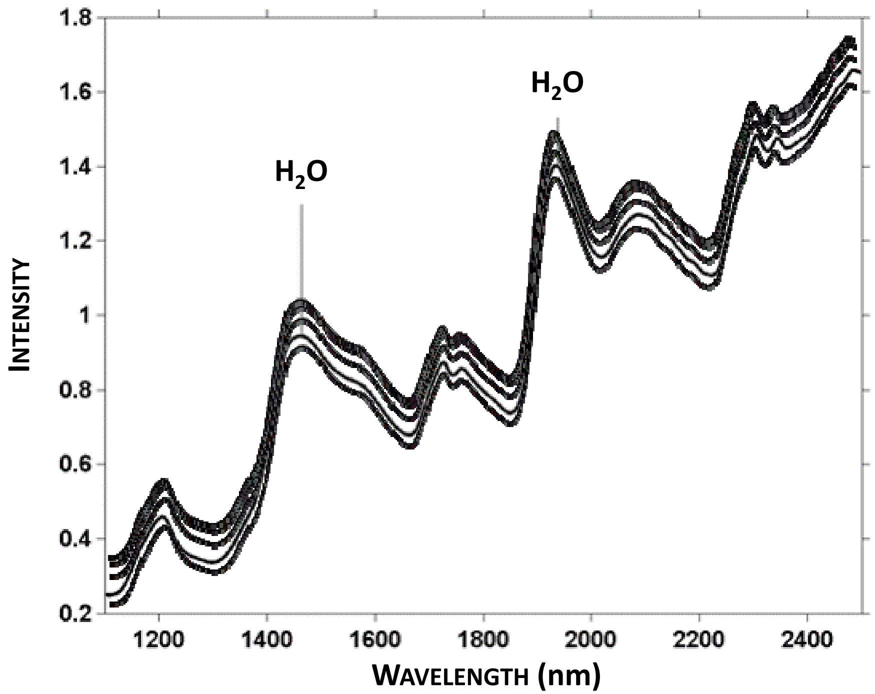


QUALITY PARAMETERS DURING 8-H DRYING

Treatment	Drying phase (K-means)	Drying time (hour)	Water activity (a_w)	Moisture (relative)	SSC (°Brix)	Lightness (L^*)	Hue angle (h)	Total carotenoids
Control		0	0.88 ± 0.04 a	0.90 ± 0.02 a	6.35 ± 1.43 f	53.61 ± 1.47 f	51.82 ± 0.37 bc	50.75 ± 3.05 d
	I	1	0.84 ± 0.04 ab	0.86 ± 0.01 ab	8.58 ± 0.99 ef	57.38 ± 1.36 e	53.43 ± 0.50 ab	52.90 ± 5.66 d
		2	0.82 ± 0.05 b	0.85 ± 0.01 ab	8.56 ± 1.27 ef	58.70 ± 1.60 de	53.32 ± 0.62 bc	66.26 ± 15.09 d
		3	0.64 ± 0.03 c	0.82 ± 0.03 b	10.57 ± 1.64 de	61.65 ± 4.28 bcd	50.40 ± 1.38 c	154.88 ± 37.01 c
	II	4	0.62 ± 0.03 c	0.67 ± 0.09 c	14.69 ± 3.15 bc	64.67 ± 2.14 ab	50.18 ± 0.95 c	205.63 ± 87.36 bc
		5	0.45 ± 0.03 d	0.72 ± 0.05 c	12.02 ± 3.54 cde	62.86 ± 2.68 abc	53.17 ± 1.93 bc	261.22 ± 81.76 ab
		6	0.46 ± 0.04 d	0.49 ± 0.15 d	14.09 ± 5.80 cd	65.12 ± 1.49 a	55.16 ± 2.32 ab	294.65 ± 61.04 a
	III	7	0.45 ± 0.04 d	0.45 ± 0.09 d	18.67 ± 5.25 ab	58.86 ± 2.69 de	51.89 ± 1.17 bc	297.32 ± 44.30 a
		8	0.42 ± 0.02 d	0.25 ± 0.07 e	20.02 ± 7.25 a	60.63 ± 2.23 de	50.52 ± 0.96 c	178.68 ± 29.63 c
		p value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
		HSD	0.04	0.06	3.99	2.72	1.84	71.30
Hot-water blanching		0	0.91 ± 0.03 a	0.91 ± 0.01 a	5.75 ± 0.51 c	49.00 ± 1.89 c	56.55 ± 1.98 a	35.74 ± 6.25 d
	I	1	0.90 ± 0.02 a	0.89 ± 0.01 a	5.35 ± 0.75 c	50.55 ± 2.33 c	56.12 ± 1.66 a	45.27 ± 11.11 d
		2	0.88 ± 0.03 a	0.86 ± 0.02 a	7.13 ± 2.21 c	51.42 ± 1.84 bc	55.00 ± 1.41 a	65.18 ± 17.70 cd
		3	0.77 ± 0.03 b	0.63 ± 0.07 b	7.40 ± 1.69 c	59.91 ± 2.72 a	51.86 ± 1.36 b	89.97 ± 24.46 cd
	II	4	0.70 ± 0.08 c	0.44 ± 0.14 c	15.96 ± 6.14 b	60.13 ± 2.33 a	49.77 ± 2.30 cd	239.58 ± 47.43 b
		5	0.68 ± 0.07 c	0.49 ± 0.08 c	19.55 ± 7.37 b	60.96 ± 2.25 a	50.61 ± 2.01 bc	234.04 ± 78.81 b
		6	0.50 ± 0.07 d	0.20 ± 0.07 d	35.79 ± 8.08 a	54.82 ± 7.16 b	48.79 ± 1.89 de	292.47 ± 69.77 a
	III	7	0.49 ± 0.08 d	0.19 ± 0.03 d	31.68 ± 6.09 a	52.63 ± 3.47 bc	47.50 ± 1.38 e	275.45 ± 27.87 ab
		8	0.40 ± 0.02 e	0.17 ± 0.02 d	32.71 ± 8.72 a	54.72 ± 6.27 c	47.66 ± 1.08 e	304.57 ± 31.62 a
		p value	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
		HSD	0.05	0.06	5.53	3.83	1.71	42.54

NIR spectroscopy to monitor the drying process





QUALITY AND DRYING BEHAVIOUR OF ORGANIC FRUIT PRODUCTS

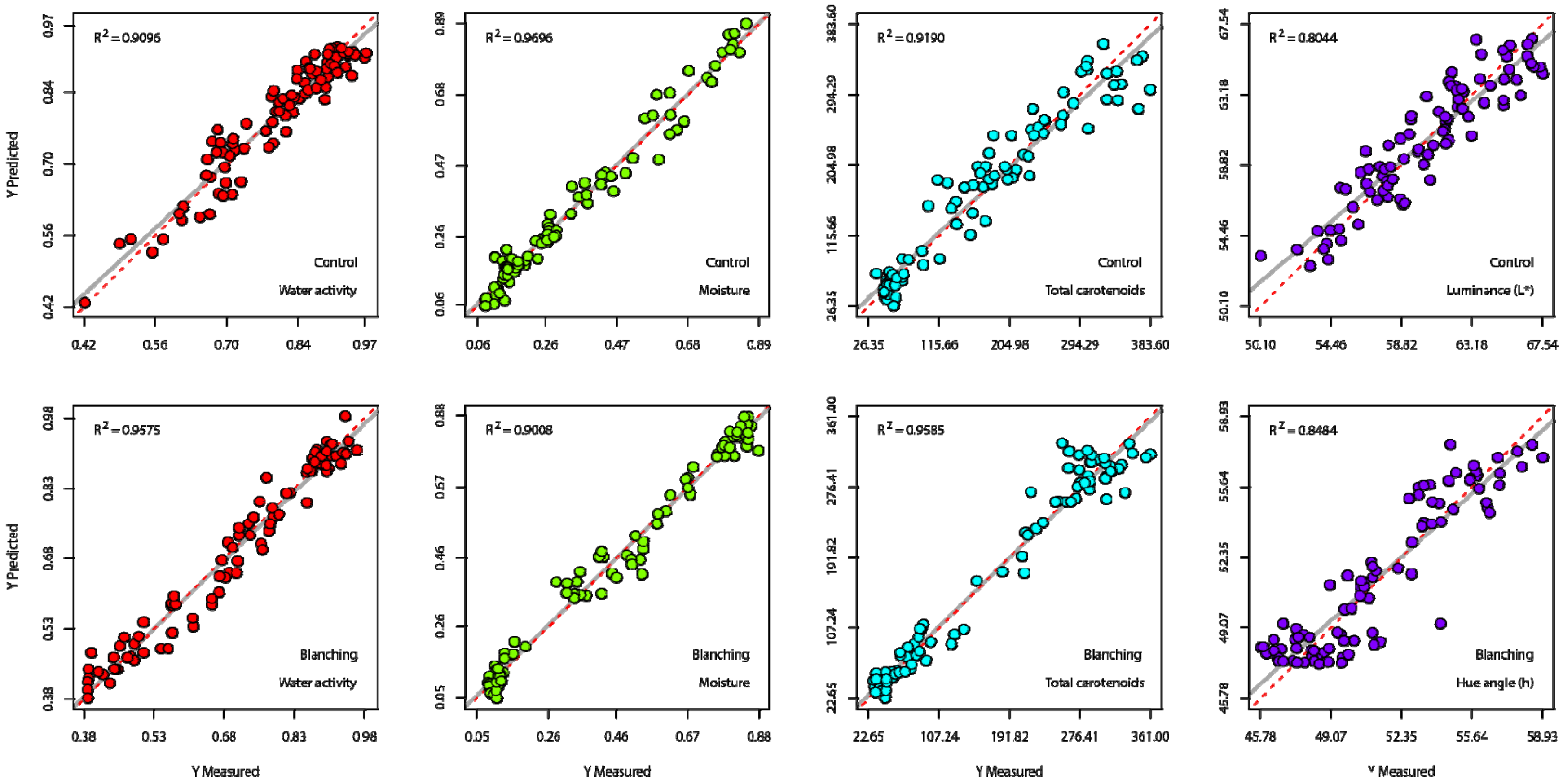
11TH WORKSHOP ON MANAGEMENT OF INNOVATION IN THE AGRICULTURAL AND FOOD SYSTEMS OF THE MEDITERRANEAN REGION – JUNE 1, FOGGIA, ITALY

PARTIAL LEAST SQUARES (PLS) REGRESSION MODELS

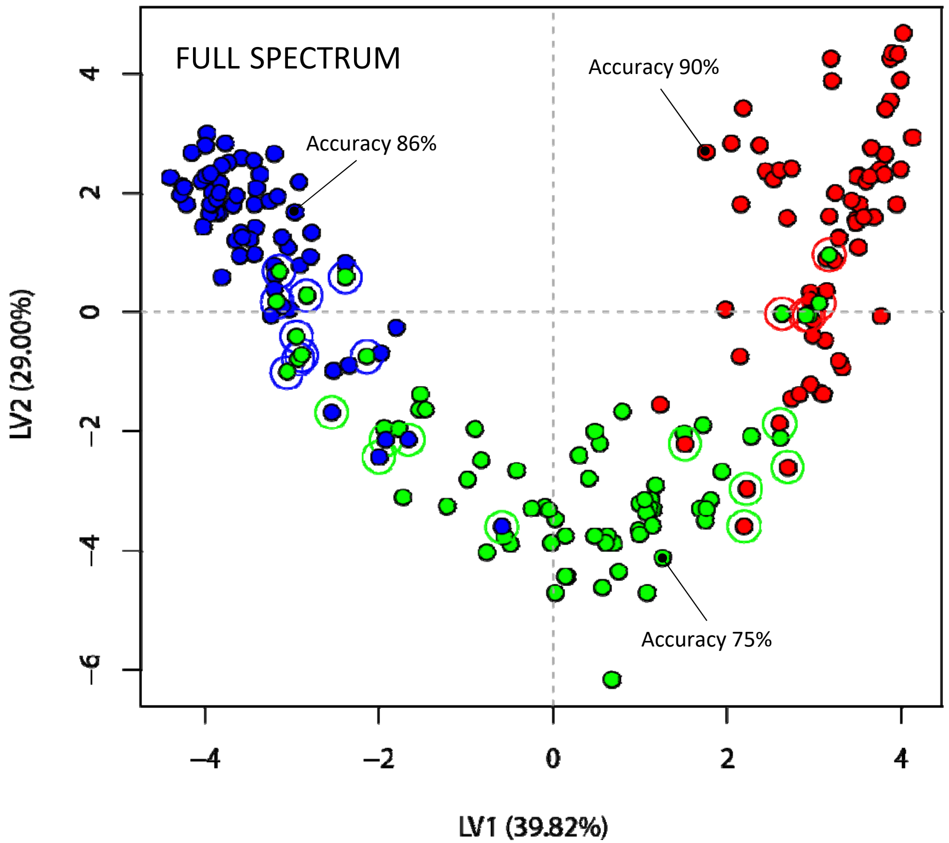
WATER ACTIVITY | MOISTURE RATIO | CAROTENOIDS | COLOUR

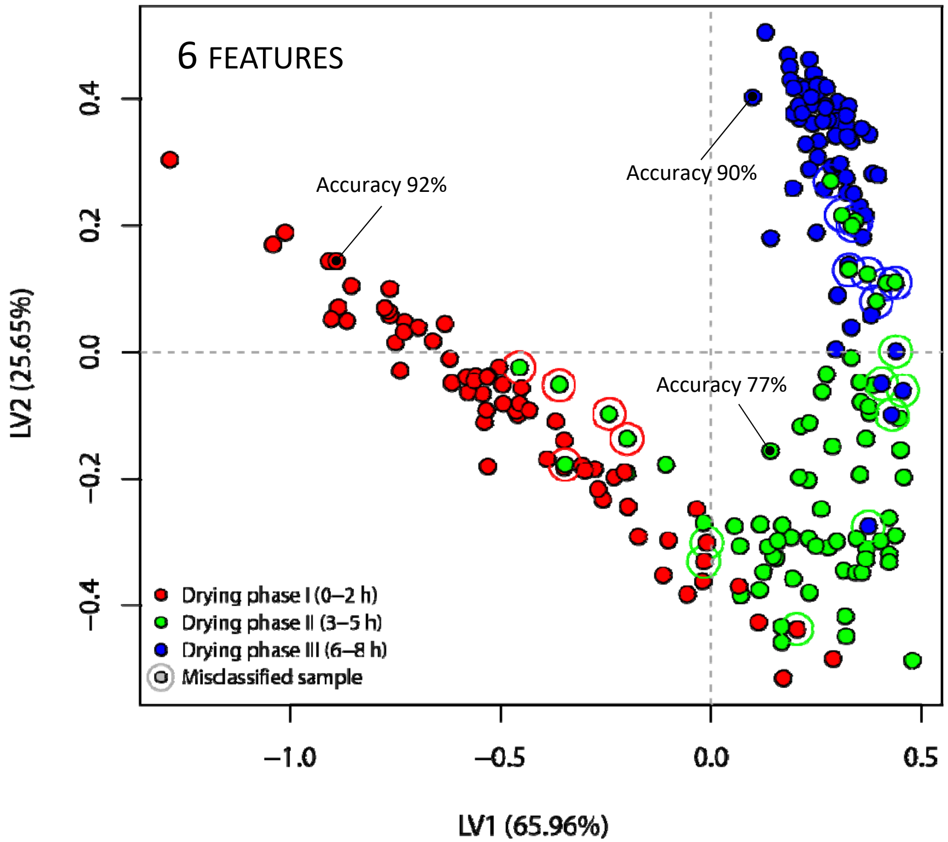
CONTROL

HOT-WATER BLANCHING



PLS Discriminant Analysis - classification models





CONCLUSIONS

1. *PPO (**apple**) and POD (**carrot**) activities were monitored as markers for enzyme inactivation*
2. *Hot-water blanching for 1.5 min at 95°C was selected as the best feasible pre-treatment on **carrot***
3. *Results showed advantages of NIR spectroscopy for online monitoring of moisture ratio, water activity, colour and nutrients in both **apple** and **carrot***
4. *NIR spectral profiles allowed recognition of drying phases in both **apple** and **carrot***
5. *Prediction models based on few wavelengths showed metrics comparable to models obtained from full spectra*

THANK YOU FOR YOUR ATTENTION