

## Non-destructive measurement of mandarin orange quality parameters with visible - near infrared spectroscopy

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### Introduction

The development of sensors to measure fruit internal quality variables is one of the challenges of post-harvest technology. Visible-near infrared spectroscopy (Vis/NIRS) has been a promisable technique for non-destructive fruit quality assessment. This study was focused to evaluate the use of Vis/NIRS in measuring the quality parameters of intact mandarin orange fruit (*Citrus clementina*).

### Material and Methods

- Vis/NIRS - Spectra were collected with a contact probe (ASD Labspec 4.0 NIR)
- Fruit colour, L\*, a\* and b\* (Minolta CR-400)
- Firmness (TA.XT Plus, Stable Microsystems) Compression until 5 % deformation
- Soluble solids content, SSC (Atago PR32α)
- Titratable acidity, TA (Titromatic 2S -Crison)

### Results

Parameter	L*	a*	b*	peel thickness (mm)
Minimum	45.77	-10.24	33.62	1.6
Maximum	71.82	41.99	69.74	5.8

Parameter	SSC (%)	pH	TA (mEq. 100 g <sup>-1</sup> )	Firmness (N)
Minimum	8.20	3.2	9.47	4.84
Maximum	11.6	3.9	17.5	14.29

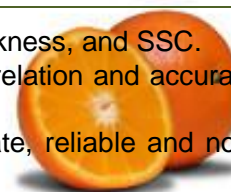


Parameter	Calibration				
	preprocess	Rank	r <sup>2</sup>	RMSEC	Bias
L*	Min-max	3	0.923	0.876	-4.54e-8
a*	Min-max	4	0.963	1.780	8.51e-7
b*	SNV	4	0.852	1.580	-4.09e-7
peel thickness	SNV	7	0.909	0.382	-1.56e-8
SSC	SNV	7	0.749	0.314	-2.72e-7
pH	Min-max	7	0.535	0.095	-7.95e-8
TA	1der+SNV	7	0.629	1.101	-4.77e-7
Firmness	2der	5	0.650	1.030	1.14e-7
Parameter	Validation				
	preprocess	Rank	r <sup>2</sup>	RMSEP	Bias
L*	Min-max	3	0.939	0.871	-0.066
a*	Min-max	4	0.971	1.803	0.192
b*	SNV	4	0.893	1.536	-0.218
peel thickness	SNV	7	0.791	0.625	0.082
SSC	SNV	7	0.747	0.312	-0.019
TA	1der+SNV	7	0.648	1.073	0.044
pH	Min-max	7	0.517	0.094	0.016
Firmness	2der	5	0.516	1.536	-0.136

Rank, number of factors used in prediction models; r<sup>2</sup>, coefficient of determination; RMSEC, root mean square error of calibration; RMSEP, root mean square error of prediction; Bias, estimate of the test error at that same value of the tuning parameter; 1der, first derivative; 2der, second derivative; SNV, vector normalization; Min-max, minimum-maximum normalization.

### Conclusions

- ✓ The models presented a good prediction for color parameters, peel thickness, and SSC.
- ✓ pH and acidity showed low variability in the samples reducing the correlation and accuracy of the model.
- ✓ The results indicate that Vis/NIRS technique could provide an accurate, reliable and non-destructive method for assessing the internal quality indices.



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