WORKSHOP: CHARACTERIZATION OF FRESH AND PROCESSED FRUIT QUALITY
Research Institute of Biotechnology and Environment (RIBE), Nong Lam University (NLU), Ho Chi Minh City, Vietnam, July 23rd--25th, 2012.

The workshop is funded under the Project "International network on preserving safety and nutrition of indigenous fruits and their derivatives", by The Leverhulme Trust, UK.

NIRS and Its Applications In Assessment of Fruit and Vegetable Quality

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UMR QualiSud CITAA CIRAD HarvestPlus

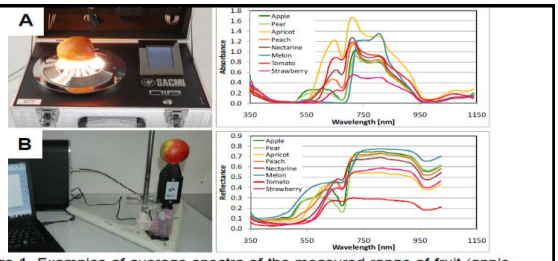


Figure 1. Examples of average spectra of the measured range of fruit (apple, pear, apricot, peach, nectarine, melon, tomato, strawberry) obtained with: **A**: NIR Case (interactance) and **B**: QualitySpec® Pro (reflectance).

	Number of samples	R^2 NC	R^2 QS	RMSECV NC	RMSECV QS	RPD NC	RPD QS
Apple	80	0.92	0.83	0.48	0.67	3.5	2.5
Pear	96	0.90	0.88	0.43	0.47	3.2	2.9
Peach	100	0.87	0.82	0.44	0.51	2.7	2.3
Nectarine	85	0.94	0.86	0.25	0.39	4.1	2.6
Tomato	94	0.90	0.79	0.26	0.39	3.2	2.4
Apricot	205	0.90	0.88	0.58	0.71	3.5	2.8
Melon	56	0.89	0.84	0.70	0.87	3.0	2.4
Strawberry	78	0.94	0.88	0.32	0.44	3.9	2.8

Cross-validations of the NIR calibrations for (°Brix) obtained for the measured range of fruit. NC: NIR Case, QS:QualitySpec® Pro, R2: coefficient, of determination, RMSECV: root mean square error of cross-validation, RPD: residual predictive deviation.

The NIR Case instrument based on *interactance mode* **more accurate for measuring TSS of fruit** than the QualitySpec® Pro instrument based on *reflectance mode*.

What is NIRS?

A technique based on the *correlation* between **chemical properties**, as determined by defined reference methods, and **absorption of light** at different wavelengthe in the near infrared region.

The colour of an apple in the visible spectrum gives us information on a variety of pigments

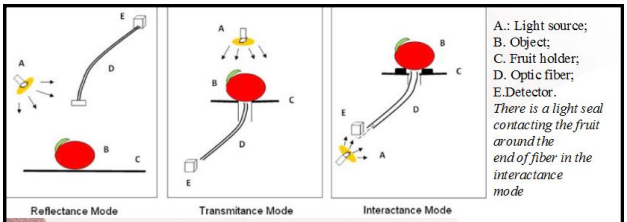
BUT

We can not see things that do not absorb visible light. e.g.water, sugar, acids and other organic substances which absorb near infra-red in proportion to their concentration.

To start using NIRS

It is required to develop a calibration with reference laboratory values (chemical analysis) and NIRS spectras of a minimum of 80-100 samples.

- NIRS estimates the concentration of the nutrient of interest by comparing the sample spectra with the developed calibration
- NIRS gives multi-analyte information

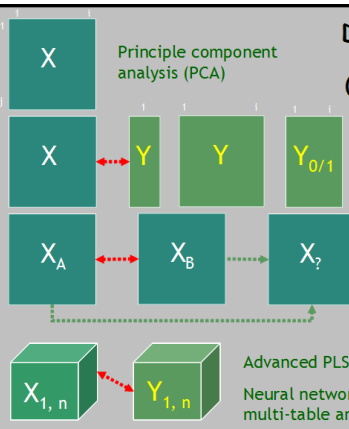


A.: Light source;
B. Object;
C. Fruit holder;
D. Optic fiber;
E.Detector.
There is a light seal contacting the fruit around the end of fiber in the interactance mode

Since instruments based on different measurement modes are commercially available, it needs assessed which one is the most suitable for each particular situation.

S. Gabioud Rebeaud et al 2011, NIR measurements (350-1100 nm) using (1) NIR Case (SACMI, Italy) and (2) QualitySpec® Pro (ASD, USA). Same fruit batches were measured on both instruments.

Data analysis tools: multivariate statistics (chemometrics/pattern recognition)

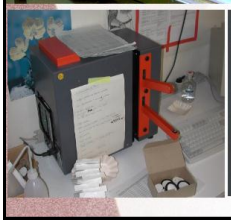


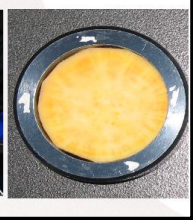
Rapid NIRS screening methods for beta-carotene determination

Burgos, G., zum Felde, T. and Grüneberg, W.

NIRS analysis

Samples were scanned as ground meal in a FOSS NIRS Systems 6500 scanning monochromator (400-2500 nm)





Chemical methods:
→ very accurate!

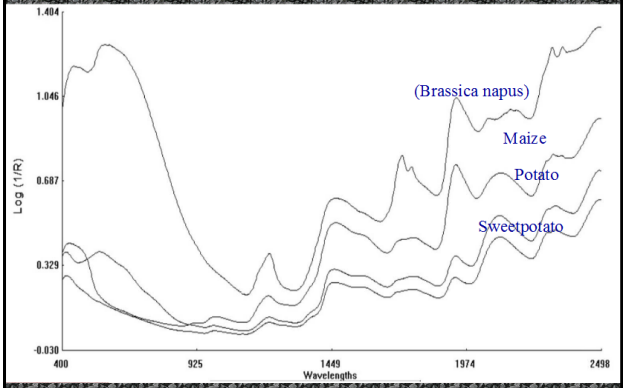
BUT
- **high costs**
- **time consumming.**
- **chemical waste disposal.**

➔ Costs to analyze 1 sweetpotato sample:

▪ Total Protein (Uni Agraria, La Molina):	8 US-$ per sample
▪ Total Carotenoids & ß-carotene (HPLC at CIP):	30 US-$ per sample
▪ Minerals (Iron & Zinc) by ICP (Waite, Adelaide):	10 US-$ per sample
▪ Total Starch & Individual Sugars (Uni Göttingen):	30 US-$ per sample

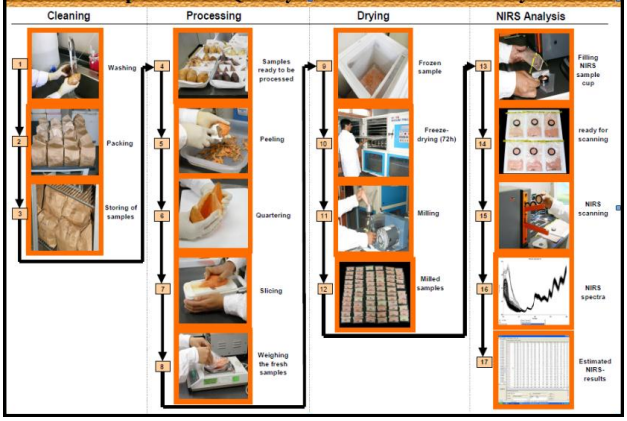
➔ ➔ ➔ Total cost: **78 US-$** per 1 sample!!!

Spectra of Sweetpotato and Maize



Calibration developmenta (Thomas zum Felde, 2011)

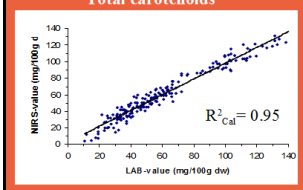
Workflow for sample preparation and NIRS analysis of sweetpotato samples at CIP Quality and Nutrition Laboratory!



RESULTS I – Sweetpotato carotenoids

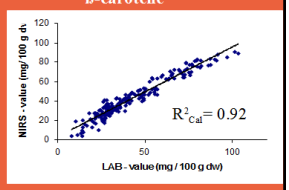
Trait (mg / 100g, DW)	Mean	Range	No. Samples	No. Used for calibration
Total - carotenoids	60.1	10.4 – 150.3	208	196
ß–carotene	43.4	7.9 – 101.5	208	197

Total carotenoids



R^2_{CV} = 0.92

ß-carotene

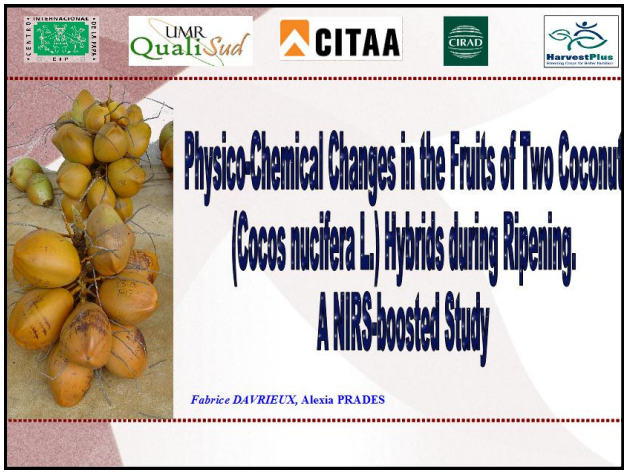


R^2_{CV} = 0.88

RESULTS I – Sweetpotato minerals

Minerals? Iron and Zinc by NIRS?!

- NIRS is mainly used for **organic components!**
- Minerals must be **linked with organic components!**
- In Sweetpotato iron and zinc concentrations are **correlated with the total protein content!**
- **Iron (N=422):** range in calibration dataset = 8–45ppm, mean = 20ppm, Standard error of NIRS prediction in external validation: 3-4ppm
- **Zinc (N=422):** range in calibration dataset = 5–31ppm, mean = 13ppm, Standard error of NIRS prediction in external validation: 3ppm



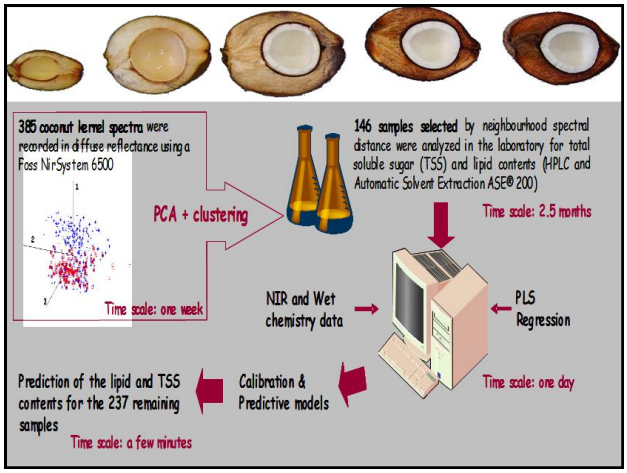
RESULTS I – Sweetpotato

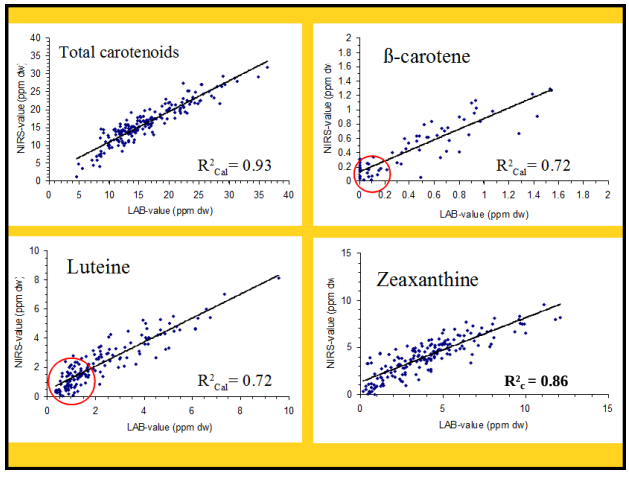
NIRS calibrations developed for freeze dried sweetpotato samples

Variation of concentrations as measured by reference methods, NIRS calibration and cross validation statistics for the content of protein, β-carotene, iron, zinc, starch and individual sugars concentrations.

Trait	Reference Values			Calibration		Cross Validation	
	Range [a,b]	Mean [a,b]	SD [a,b]	R^2_c	SEC [a,b]	R^2_{cv}	SECV [a,b]
Protein (N=216) [b]	1.7 – 9.1	4.1	1.7	0.97	0.30	0.95	0.36
β-carotene (N=320) [a]	0.0 – 157.2	33.7	37.9	0.98	4.25	0.97	5.69
Iron (N=422) [a]	0.8 – 4.5	2.0	0.7	0.81	0.26	0.80	0.27
Zinc (N=422) [a]	0.5 – 3.1	1.3	0.5	0.91	0.14	0.89	0.15

SD = standard deviation, R^2_c = coefficient of determination in calibration, SEC = standard error of calibration, R^2_{cv} = coefficient of determination in cross validation, SECV = standard error of cross validation, [a] = mg 100 g^{-1} in dry wt, [b] = % in dry wt.





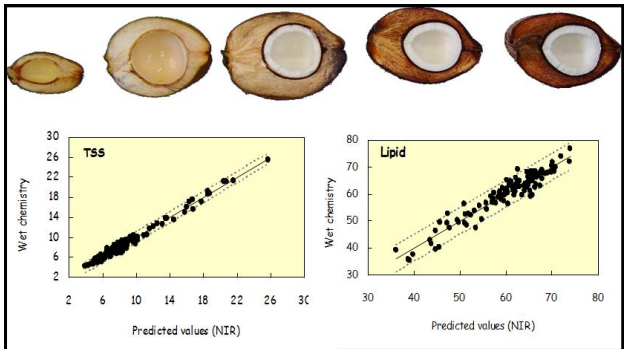


Figure 1: Correlation between wet chemistry and NIR predicted values for TSS and lipid contents (95% confidence interval)

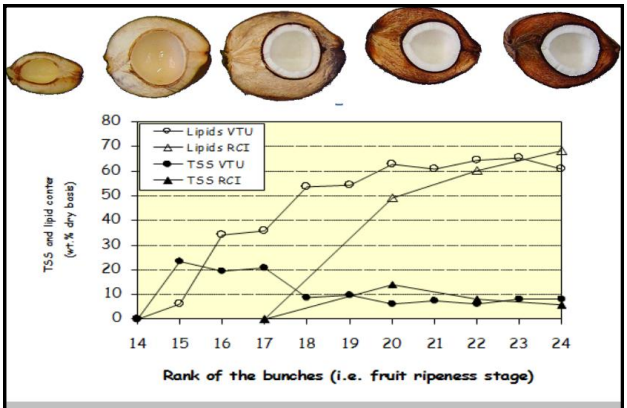


Figure 2: Total soluble sugar and lipid contents (% db) of the freez-dried of the coconut kernels according to ripening stage

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Thank you for your welcome and for your listening

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Table 1: Comparison of the time, volume of organic solvents and cost of the study according to the type of methodology used

	without NIRS without ASE®	with NIRS with ASE®	% reduction
Number of samples	n=385	n=151	
Time	40 weeks	10 weeks	75%
Organic solvents	109 litres	9 litres	92%
Cost	54 858 €	16 613 €	70%

CONCLUSIONS (to date)

It is possible to obtain very good estimations of the concentration of total carotenoids and ß-carotene in sweetpotato.

Low, medium and high values can be distinguished for total carotenoids and specific carotenoids in maize.

NIRS is demonstrated its feasibility to assess the quality of coconut fruits at different ripening stages. And obviously, it is time saving and enviroment protecting.