Near Infrared Spectroscopy (NIRS): a tool for on-line monitoring of beverage quality

PRADES Alexia[1], ASSA Rebecca Rachel[2], DORNIER Manuel[1], PAIN Jean-Pierre[3]

[1]CIRAD, UMR Qualisud, 73 rue JF Breton, Montpellier, F-34398 France.
[2]CNRA, Programme Cocotier, 07 BP 13 Abidjan 07, Côte d'Ivoire.
[3]UM2, UMR Qualisud, Place E. Bataillon, Montpellier, F-34095 France

www.cirad.fr

CONTACT: alexia.prades@cirad.fr

Coconut water (CW) is a tropical drink known for its refreshing and isotonic properties[1]. It is a fragile liquid subjected to rapid deterioration[2]. As a consequence, assessing its quality during processing and storage still remains a challenge.

Among other food quality control methods, Near Infrared Spectroscopy (NIRS), a simple and non destructive analytical tool, should be a good challenger[3]. This study set out to determine if NIRS could monitor coconut water quality during storage at tropical ambient temperature.

Material and Methods

Immature coconut fruits (Guinea Equatorial Green Dwarf variety from Côte d'Ivoire) were harvested at two grades of maturity (7 and 9 months old). Aseptically collected CW was homogenised and stored into a 2 litres glass reactor (Fig1). The liquid temperature was maintained at 30±0.5°C using a double jacket water circulation. Data processing was performed using descriptive statistics and principal component analysis (PCA) with The Unscrambler® (Camo Process AS., Norway).

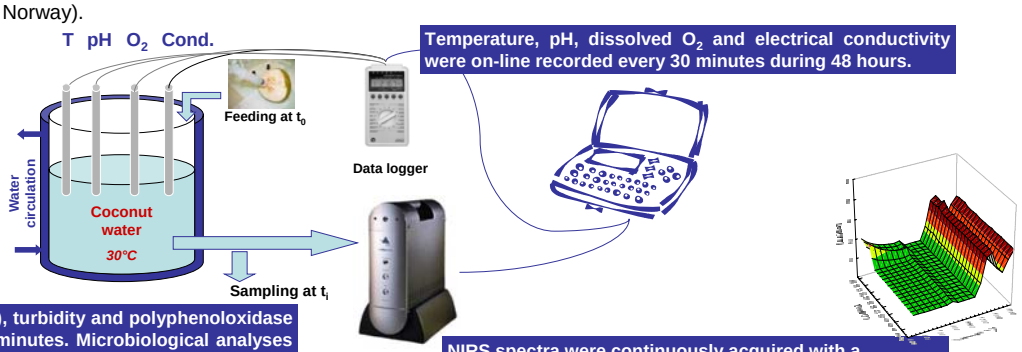
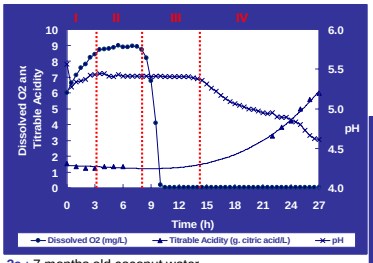


Figure 1: Experimental setup

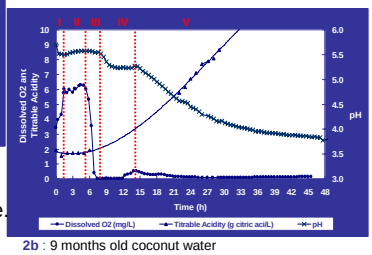
Results and discussion

The monitoring of physicochemical parameters showed that CW deterioration encountered at least four stages for both grades of maturity:

(I) a first stage where dissolved O_2 increased by 3 mgL^{-1} whereas pH and TA showed a slight decrease,
(II) a second stable stage,
(III) a third stage where dissolved O_2 fall down to 0 mgL^{-1} whereas TA began to rise,
(IV) a fourth stage where pH and TA showed clear antagonistic trends,
(V) a fifth stage (observed only on 9 months old nuts) where pH tend to stabilize around 3.8 and TA rose until 15 g citric acid.L^{-1}.



2a : 7 months old coconut water



2b : 9 months old coconut water

Figures 2a & 2b: Evolution of dissolved O_2, Titrable Acidity (TA) and pH of coconut water (7 and 9 months old) during storage at 30°C under atmospheric pressure

Main changes occurred during the first day (0 to 21hours) and especially during the first 10 hours of CW storage.

7 months old coconut water

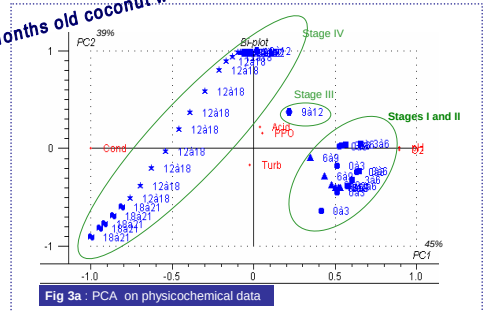


Fig 3a : PCA on physicochemical data

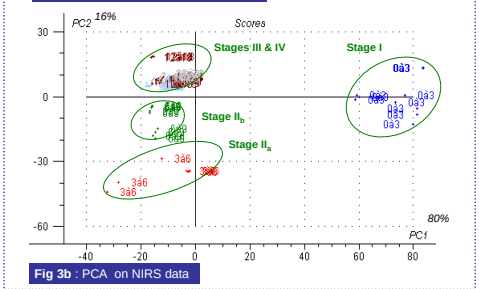


Fig 3b : PCA on NIRS data

The previous stages were highlighted by PCA performed on physicochemical and NIR spectral data.

The first two principal components of the PCA performed on physicochemical data of the 7 and 9 months old CW (Fig. 3a and 4a) explained respectively 75% and 73% of the total variance. However those from PCA performed on spectral data explained 96% and 99% (Fig. 3b and 4b).

For 7 months old coconut water, PCA performed on NIR spectral data distinguished two phases during Stage II (Fig 3b) suggesting that NIRS monitoring was more sensitive than physicochemical monitoring.

For 9 months old coconut water, although Stages I and II were not separated (Fig 4b), other stages were more clearly identified by spectral than by physicochemical monitoring.

Microbiological analyses confirmed the sterility of CW at initial time and later showed the prevalence of bacteria (over yeasts and moulds) due to environmental contamination.

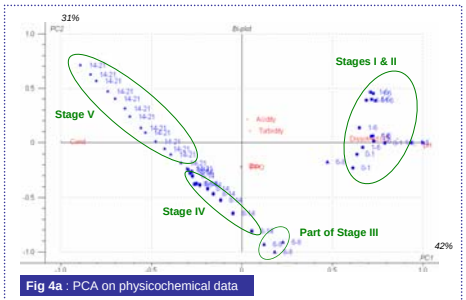


Fig 4a : PCA on physicochemical data

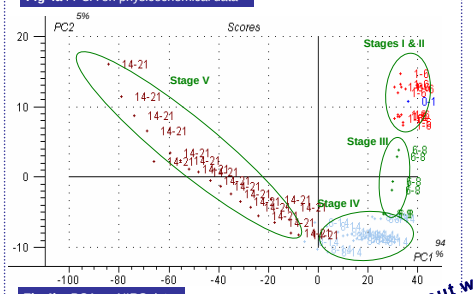


Fig 4b : PCA on NIRS data

9 months old coconut water

Conclusion and perspectives

- **The potential of NIRS for on-line monitoring of coconut water quality was demonstrated : 1 NIRS "fingerprint" is equivalent to 7 measurements of physicochemical parameters**
- **Further chemometric analyses and experiments may correlate spectral and chemical data to predict CW quality during storage**

References

[1]Rethinam P. and Kumar T. B. N. (2001). Tender coconut - an overview. Indian Coconut Journal 32(1): 2-22.
[2]Matsui K. N., Granado L. M., de Oliveira P.V., Tadini C.C (2007). Peroxidase and polyphenol oxidase thermal inactivation by microwaves in green coconut water simulated solutions. LWT - Food Science and Technology 40(5): 852-859.
[3]Davrieux F., Prades A. *et al.* (2005). Physico-chemical changes in the fruits of two coconut *(Cocos nucifera* L.) hybrids during ripening : A NIRS-boosted study. *In* : FRUTIC 05, 7th Fruit, nut and vegetable production engineering Symposium: Information and technology for sustainable fruit and vegetable production , Montpellier, France, 12-16 September 2005.