Comparison of benchtop and handheld NIR devices to determine fruit wine fermenting parameters

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INTRODUCTION

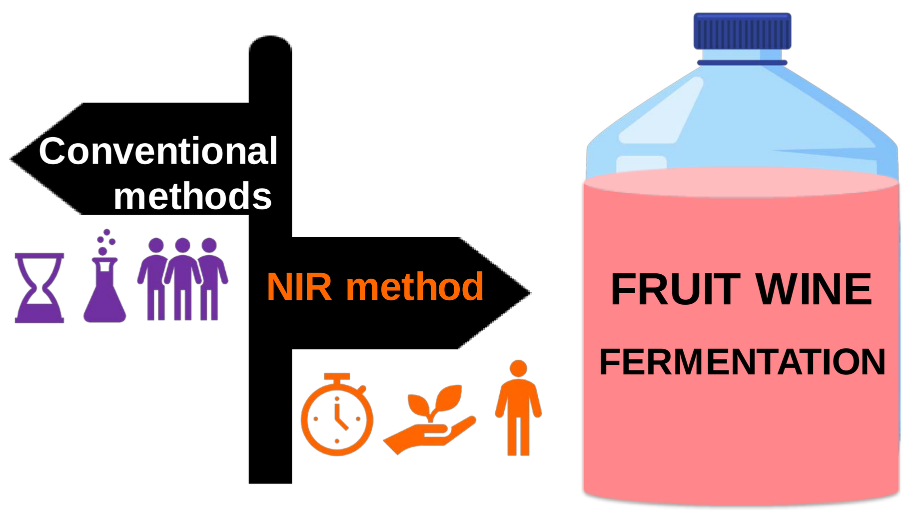
Unbalanced production and market conditions have resulted in farmers suffering from falling prices of pineapple and dragon fruit due to oversupply. This leads to an increase in low-grade and waste fruits. Accordingly, the production of fruit wine using these low-grade fruits is an interesting approach in terms of using alternative resources and adding value to them.

Fig. 1 Background of the research

OBJECTIVE

Sixth parameters of alcohol, reducing sugar, total acidity, total soluble solid, total yeast cell, and volatile acidity are required to inspect these samples throughout the fermentation process to maintain the consistency of wine quality, causing the alternative NIR analysis to enjoy this application (Kasemsumran et al., 2022).

The objective of this study was to develop NIR models and compare predictions using a benchtop type with a liquid probe and a handheld device to predict values of the sixth parameter of mixed pineapple and dragon fruit wine during fermentation.



Sixth parameters

1. Ethanol
2. Reducing sugar (RS)
3. Total acidity (TA)
4. Total soluble solid (TSS)
5. Total yeast cell (TYC)
6. Volatile acidity (VA)

NIR INSTRUMENTS

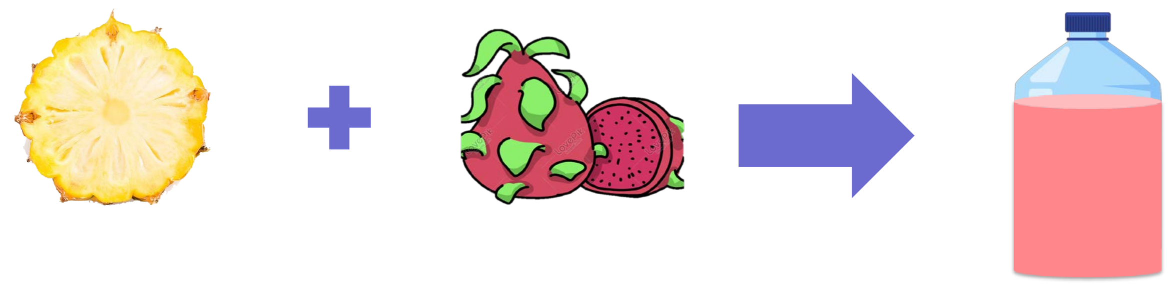
Fig. 2 FT-NIR benchtop type with a liquid probe

Fig. 3 A handheld NIR device

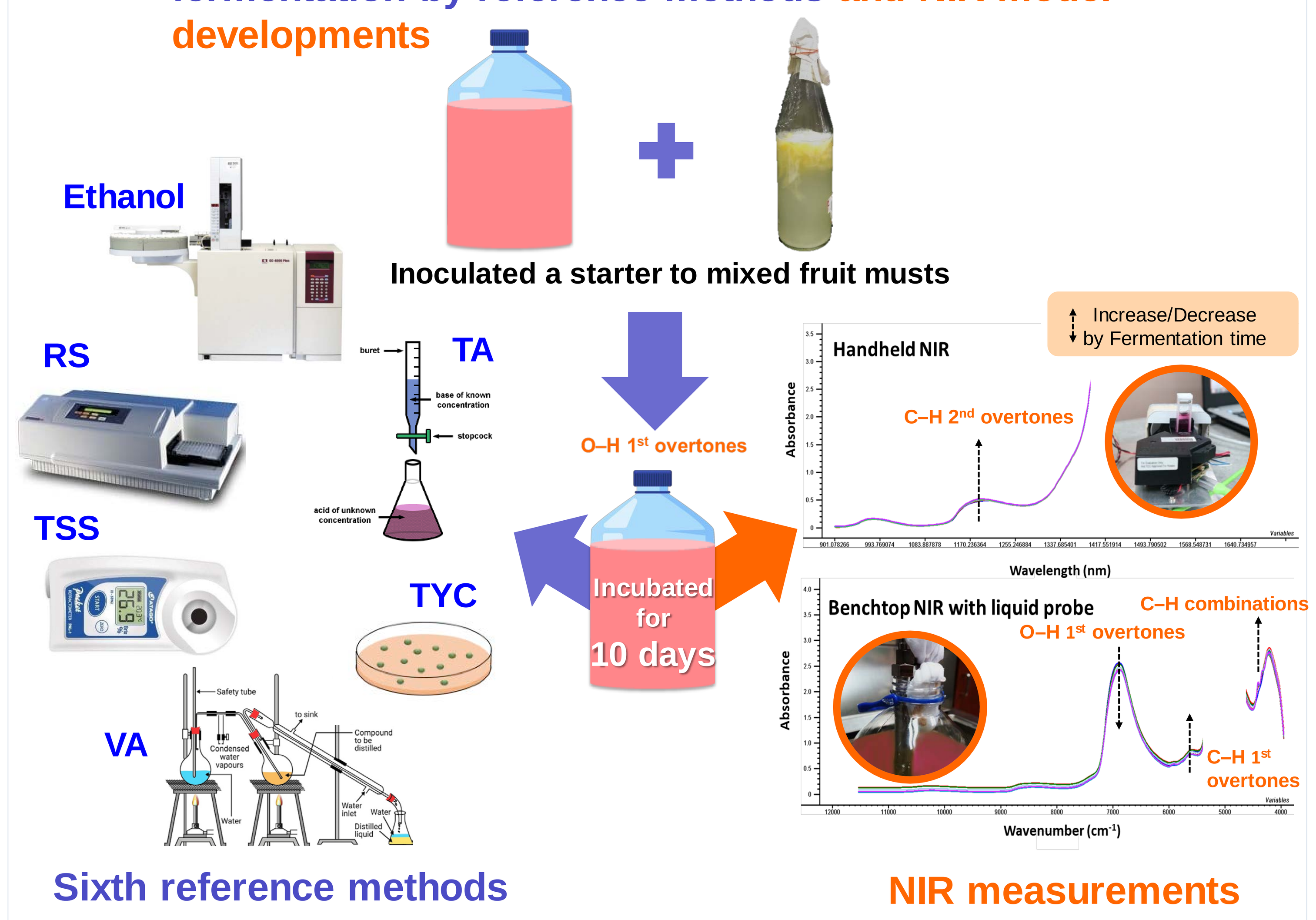
METHODS

1. Yeast culture preparation

2. Preparation of mixed pineapple and red dragon fruit musts



3. Wine fermentation & Evolution of sixth parameters during fermentation by reference methods and NIR model developments



RESULTS

A liquid probe with a length of 14 cm and a slit of 1 mm (IN271P-02) was connected to an FT-NIR spectrometer (MPA II, Bruker Optik GmbH, Germany) to collect the spectral data between 11,536–3952 cm^{-1} by immersion into samples (Fig. 2).

The competitive device was a handheld type (Transmissive DLP NIRscan Nano EVM, Texas Instruments, USA) using a quartz cell (pathlength 10 mm) for spectral collection of samples from 901–1700 nm (Fig. 3). The obtained spectra were shown in the METHODS 3. and the over abs. regions were cut off for calculation. All parameters were monitored during fermentation processing and employed as the reference chemical data for NIR model development (Table 1).

Table 1. Content distribution of sixth parameters in calibration set determined by the reference methods.

Analysts	Min	Mean	Max	SD
Ethanol (%)	0.457	6.733	10.221	2.946
Reducing sugar (g/L)	24.36	87.10	184.76	52.39
Total acidity (%)	0.169	0.248	0.297	0.036
Total soluble solid (°Brix)	8.07	13.78	25.00	4.99
Total yeast cell (CFU/mL)	5.90x10^5	1.31x10^7	3.40x10^7	9.58x10^6
Volatile acidity (%)	0.0011	0.0017	0.0024	0.0004

RESULTS

PLS-1 (Unscrambler software) was applied to the spectral regions (11,536–5408, 4592–3952 cm^{-1} for benchtop device and 901–1390 nm for handheld device) with no or pretreated data (2nd derivative (SD) or standard normal variate (SNV) methods) to develop the calibration models for the quantitative determination sixth parameters in samples, simultaneously. The benchtop device provides the NIR prediction models for ethanol, reducing sugar, total soluble solid, and total yeast cell with the highest R^2 and lowest RMSEP values; however, the predictive power of a handheld NIR device was better for the NIR prediction models of total acidity and volatile acidity (Fig. 4 and Fig. 5).

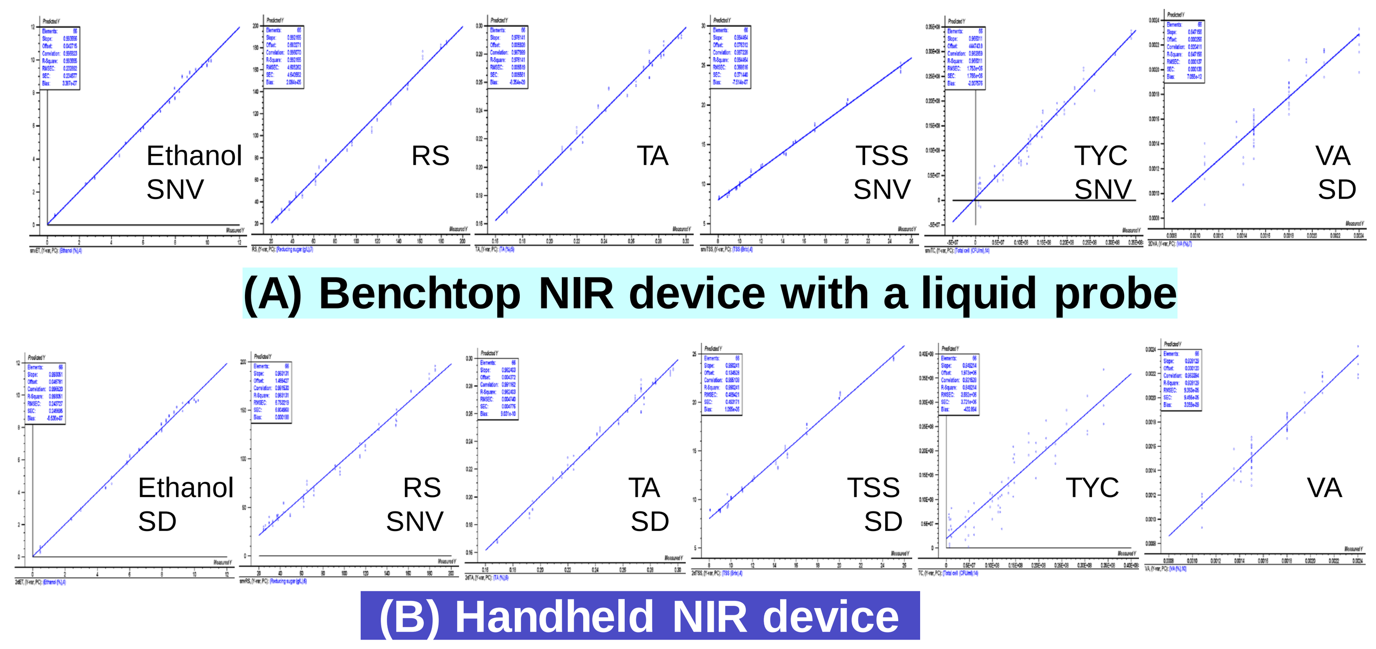


Fig. 4 Scatter plots for PLS calibration models of sixth parameters in fermented mix fruit wine samples obtained from the (A) benchtop with liquid probe and (B) handheld NIR devices.

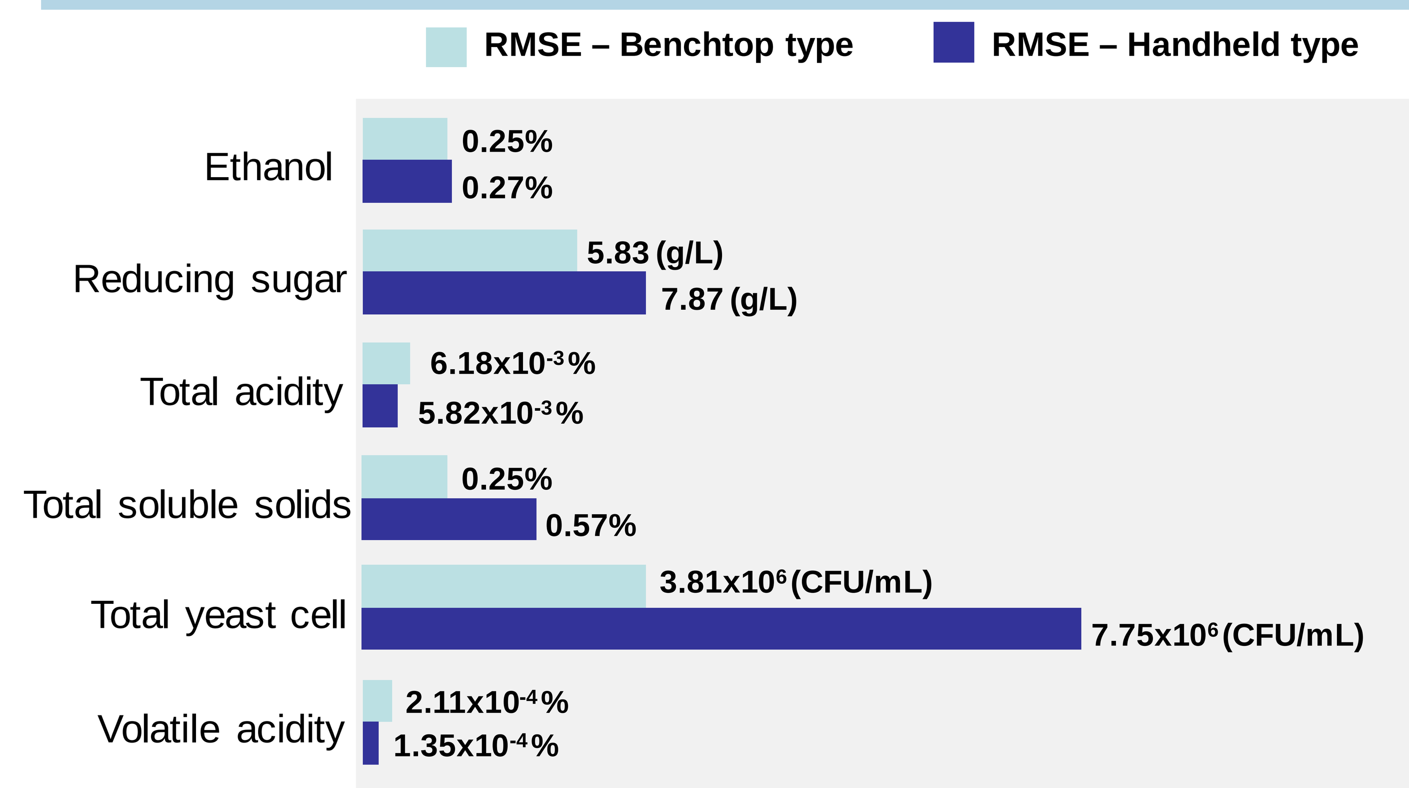


Fig. 5 Comparison of RMSEP values between the obtained PLS models of sixth parameters in these fermented mix fruit wine samples with the benchtop NIR equipped a liquid probe and the handheld NIR devices.

CONCLUSIONS

The results demonstrated the performance NIR method as alternative way for simultaneous monitoring of the chemical in the fermentation process. Moreover, using of low-grade fruits in wine-making was possible to get the new product with value-adding.

REFERENCE

Kasemsumran, S.; Boondaeng, A.; Ngowsuwan, K.; Jungtheerapanich, S.; Apiwatanapiwat, W.;Janchai, P.; Meelaksana, J.; Vaithanomsat, P.Simultaneous Monitoring of the Evolution of Chemical Parameters in the Fermentation Process of Pineapple Fruit Wine Using the Liquid Probe for Near-Infrared Coupled with Chemometrics. *Foods*, **2022**, 11, 377.

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