Article

Fresco Microwave

A non-destructive method to measure the quality parameters of avocados

Version 1

Researcher: Yatao Lu, 685748

Study year: The 4th year

Education: Horticulture & Agribusiness

Organization: Hogeschool Inholladn Deft

Food Waste Reduction and Food Quality Living Lab (FORQLAB)

Process Adviser: Caicheng Huang

Commissioner: Woody Maijers

Process Evaluator: Elfferich, Caroline

Target Group: Avocado traders

Trade Journal: Postharvest Biology and Technology

Date: 24/06/2023

Fresco Microwave Technology

A non-destructive measurement to measure quality parameters of avocados

Fresco Microwave Technology sensor which is obtained from Vertigo-Technologies.

Summary

Before storing fruits for a long period, it is important to monitor their quality and ripeness to predict how they will react to storage conditions. To accurately and quickly assess fruit quality, it is crucial to develop non-destructive methods. Vertigo Technologies, a startup located in TU Delft, has created a handheld sensor called the Fresco Microwave Sensor. This sensor emits low-energy microwaves that penetrate deep inside the fruit. The aim of the study was to create enough variation among avocados to train a model based on the frequency data acquired through the microwave sensor. Results showed that the Fresco Microwave Sensor was effective in predicting the dry matter content and firmness of avocados.

Introduction

Food quality and waste reduction in the industry are equally crucial to the growing avocado import and export industry (Vega Díaz et al., 2021). Fruit quality measurements are therefore essential, as they are both an excellent way to reduce waste and check fruit quality, and a necessary component of food testing. The Fresco Microwave sensor, developed by Vertigo-

Technologies, emits microwaves deep inside the fruit to assess the internal quality of the avocado. Hence, the objective of this project is to investigate whether the destructive measurements of testing avocados can be replaced by Fresco Microwave Technology by doing lab research.

The approach of the research

The frequency data were collected using one handheld Fresco prototype (Figure 1) from Vertigo-Technologies. The sunny side of each avocado was selected to measure different quality parameters. The areas where three points on the equatorial region of each whole fruit should be measured.

Fig 1. The Fresco microwave sensor from Vertigo-Technology

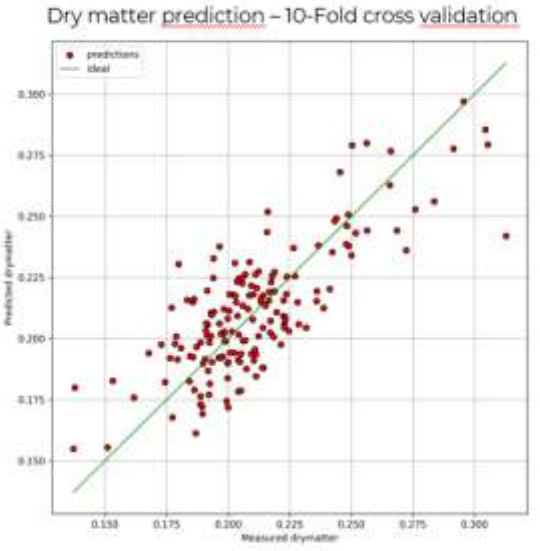
Regarding the destructive approach, dry matter content of avocados were collected by drying them in the air-force oven. Moreover, the firmness of avocados was collected by Texture Analyser XT Plus.

To test the ability of the Fresco Microwave sensor's prediction of avocados. The Partial Least Square (PLS) will be performed by using Python. And all the datasets (the DM content, firmness and spectral data) will undergo K-Cross Validation with K equal to 10.

The key findings

The Partial Least Square (PLS) calibration models were built using data from destructive (DM and firmness) and non-destructive data analysis. The red dots represent the test predictive data’s expected values in these models. The ideal without an error line is green.

Regarding the PLS regression model (Figure 2) of DM in avocados, R^2 (coefficient of determination) = 0.605: which indicates that the model explains 60.5% of the variability in the data. This is a moderate R^2 value, indicating that the model has an excellent fitting effect for the data. RMSE (Root Mean Square Error) = 0.018: the root mean square error is small, indicating that the average gap between the predicted and actual values is small and the prediction accuracy is high. MAE (Mean Absolute Error) = 0.015 represents the mean absolute error between the predicted and actual values. A small value indicates a high prediction accuracy. MAPE (Mean Absolute Percentage Error) = 0.072: This means that the average error of the model's predictions is 7.2% of the actual value, a relatively small percentage error, indicating high accuracy of the model's predictions.

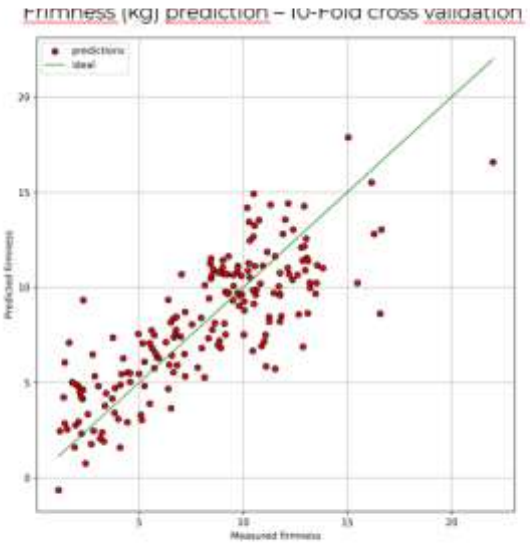


Parameter	r^2	RMSE	MAE	MAPE
Dry matter	0.605	0.018	0.015	0.072

Fig 2. PLS regression model of dry matter (%)

In terms of the PLS regression model of firmness in avocados, R^2 = 0.656: This indicates that the model explains 65.6% of the data variability, which is a better fit than the dry matter prediction. RMSE = 2.303: This is a relatively large error value, indicating that the average difference between the predicted and actual values is large and the prediction accuracy is low. MAE = 1.841: This value is also relatively large, indicating low prediction accuracy. MAPE = 0.338: This indicates that the mean error of the forecast is 33.8% of the actual value, which is a relatively large percentage error and indicates that the model's prediction accuracy is low.

From the results, models perform well in predicting dry matter and firmness. However, the dry matter prediction model performed better than the firmness prediction model.



Parameter	r^2	RMSE	MAE	MAPE
Firmness (kg)	0.656	2.303	1.841	0.338

Fig 3. PLS regression model of firmness (kg)

Discussion

The efficiency of PLS models was recorded due to the wide variation of firmness and DM in avocados. It is important to note that the Texture Analyser's firmness data for avocados has not been verified. Uarrota and Pedreschi's (2022) report indicates that the relationship between limited compression measured by Texture Analyser and actual firmness measured be penetrometer of avocados is not a direct 1:1 correlation, which suggests the use of T.A. in the experiment. Therefore, the T.A. measurements of avocado firmness may differ slightly from their actual firmness. Moreover. dry matter dataset is quite unbalanced, most of the observations are around 0.2. This is mostly due to the limited duration of the experiment.

Conclusion

Fresco Microwave Technology's capacity to measure avocado quality parameters, particularly dry matter and firmness, was extensively explored based on the experiments. The findings indicate that this technology has the potential to supplant conventional manual methods, yielding precise and consistent results.

The next steps

This report can provide a reference for future experiments and development direction in this field. In addition to the issues highlighted and addressed in this study, future research can focus on:

- Measure avocado firmness using T.A., which specializes in measuring fruit firmness.
- Although this study has demonstrated the potential of Fresco Microwave Technology, some issues still need further investigation. For example, how well does this technology predict the oil content and internal defects of avocados (other important quality parameters of avocados)? How does this technology perform in a real-world environment? More field testing and research are recommended for these problems.

Reference

Uarrota, V. G., & Pedreschi, R. (2022). Mathematical modelling of Hass avocado firmness by using destructive and non-destructive devices at different maturity stages and under two storage conditions. *Folia Horticulturae*,

Vega Díaz, J. J., Sandoval Aldana, A. P., & Reina Zuluaga, D. V. (2021). Prediction of dry matter content of recently harvested 'Hass' avocado fruits using hyperspectral imaging. *Journal of the Science of Food and Agriculture, 101*(3), 897-906. https://10.1002/jsfa.10697