MONITORING MOISTURE CONTENT OF HOUSE CRICKETS DURING THE DRYING PROCESS USING NEAR-INFRARED SPECTROSCOPY

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INTRODUCTION

House crickets are one of the edible insects that are considered a novel food source of protein and micronutrients. As a growing consumer concern is healthy nutrition, the food industry focuses on designing foods with high protein content. Cricket powder is cheap, easy to produce, and attractive as a protein-rich additive. The demand for drying process monitoring has required fast and non-destructive methods such as near-infrared spectroscopy (NIRs) in the cricket powder production process.

OBJECTIVE

This research aimed to evaluate the NIRs as an alternative analytical method to predict the moisture content of crickets during the drying process.

METHODOLOGY

1. CRICKET SAMPLE PREPARATION

The boiled crickets were dried at 50, 60, and 70 °C in a drying oven for 12 h. For each drying temperature, the cricket samples were taken from the oven at intervals of 60 min and subsequently scanned with a NIR instrument and then analyzed for moisture content.

2. NIR SPECTRAL ACQUISITION

NIR spectra of samples were collected in transflectance mode in a wavelength region of 950-1650 nm at 25°C using a NIR instrument (DA7250 NIR analyzer, Perten Instruments AB, Sweden) with a transflectance cup (Fig.2).

Two types of sample presentation forms (intact and ground cricket) were measured for each sample as follows: firstly, NIR spectra of intact samples were collected. Secondly, the sample was comminuted using a blender, and then NIR spectra of the ground sample were collected.

3. MOISTURE ANALYSIS

The moisture content of samples was analyzed by drying the sample in an oven according to the AOAC method.

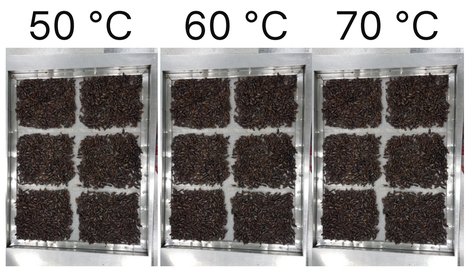

Fig.1. Dried cricket sample preparation.

Fig.2. Intact (a) and ground (b) cricket sample presentation.

Fig.3. Moisture analysis of cricket samples.

4. MODEL ANALYSIS

All of the samples for modeling were split into a calibration set (n = 95) and a prediction set (n = 22).

Statistical characteristics of the calibration and the prediction sample sets are shown in Table 1. The results showed that the moisture content of samples (n=117) ranged between 2.06 and 71.61%.

X VARIABLES

Partial least square (PLS) regression with full cross-validation was applied to develop the calibration models, using the Unscrambler software (version 9.2: CAMO AS, Trondheim, Norway).

Y VARIABLE

RESULTS AND DISCUSSION

Fig.4 shows that different sample presentation forms influence NIR absorption. Predominant differences in the spectra between the intact and ground samples come from the density of samples. The absorbance intensity at 1450 nm depends on the amount of water, which was affected by the drying time and temperature.

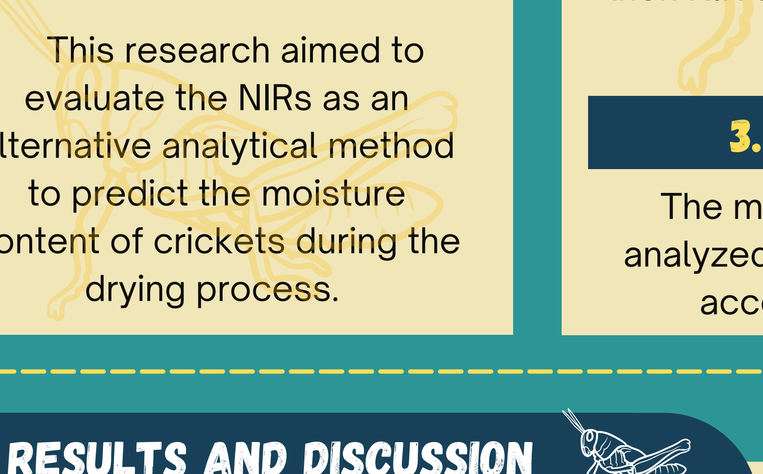

Fig.4. Average NIR spectra of intact and ground cricket samples.

Without the aid of the spectral pretreatment method, the PLS models yielded an excellent prediction of moisture content with the ratio of prediction to deviation (RPD) values of 6.71 for intact spectra and 13.86 for ground spectra, respectively. No statistically significant difference ($p>0.5$) was found between the measured and NIR predicted values.

Table 1. Statistical characteristics of the calibration and the prediction sample sets.

Sample sets	N	Min (%)	Max (%)	Mean (%)	SD(%)
Calibration	95	2.06	71.71	30.82	24.35
Prediction	22	2.06	71.61	31.30	25.35

Table 2. PLS calibration results for moisture content of intact and ground samples.

Sample Forms	F	R	RMSEC (%)	RMSECV (%)	RMSEP (%)	RPD
Intact	3	0.986	3.957	4.238	3.775	6.71
Ground	2	0.998	1.313	1.370	1.829	13.86

F: Number of PLS factors; R: Correlation coefficient in calibration; RMSEC: Root mean square error of calibration, RMSECV: Root mean square error of cross-validation; RMSEP: Root mean square error of prediction; RPD: Ratio of prediction to deviation (RPD=SD/RMSEP)

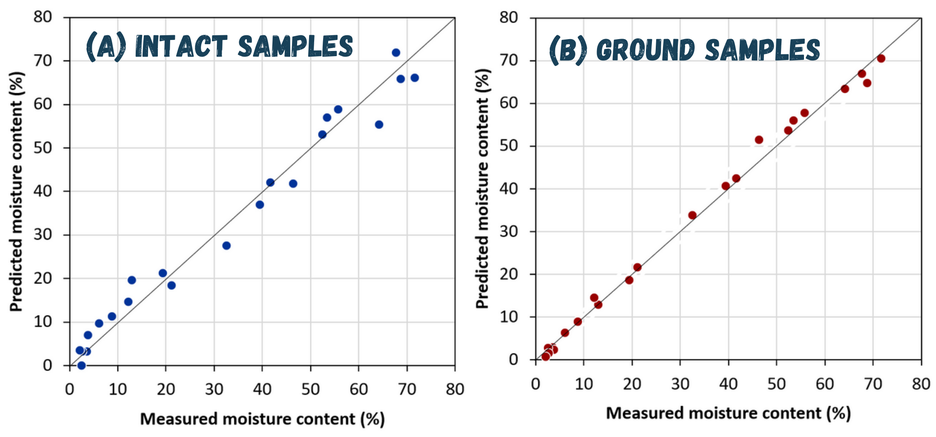

Fig 5. Comparison of the actual values with the values predicted by calibration PLS models of moisture content; (A) intact samples, (B) ground samples.

CONCLUSION

This study proved that both NIR calibration models based on intact and ground spectra are feasible and can be used to determine moisture content during the cricket drying process rapidly. However, the moisture content was better predicted by NIRs when the samples were in the ground form.

REFERENCES

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2. Y. Ozaki, W. F. McClure and A. A. Christy (Eds.), Near-infrared spectroscopy in food science and technology. Hoboken: John Wiley & Sons, UK (2007).