Innovative Approaches for Rapid Quality Assessment of Insect-Derived Products

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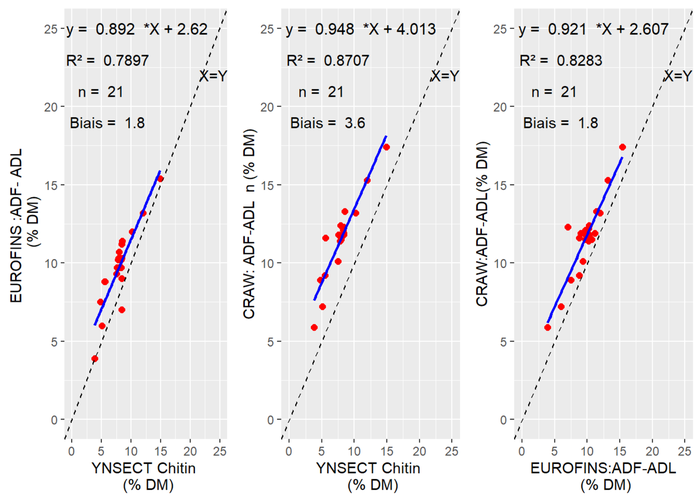
Insects can serve as an alternative source of protein in the current economic and environmental context of European livestock. The WP6 of the FARMYNG project (FlAgship demonstration of industrial scale production of nutrient Resources from Mealworms to develop a bioeconomY New Generation) aims, among others, to develop methods for testing the nutritional quality of insects-derived products.

Evaluation of the chitin content

The primary advantage of insect meals is their high protein content. Caution is necessary when estimating this parameter, as the exoskeleton of insects is made of chitin, which contains nitrogen that could be mistakenly included in the protein content calculation.

Within the FARMYNG project, two alternative methods to the traditional chitin extraction/purification process (which takes 4-5 days) were tested, the ADF-ADL method and the cellulose (Crude Fiber) method.

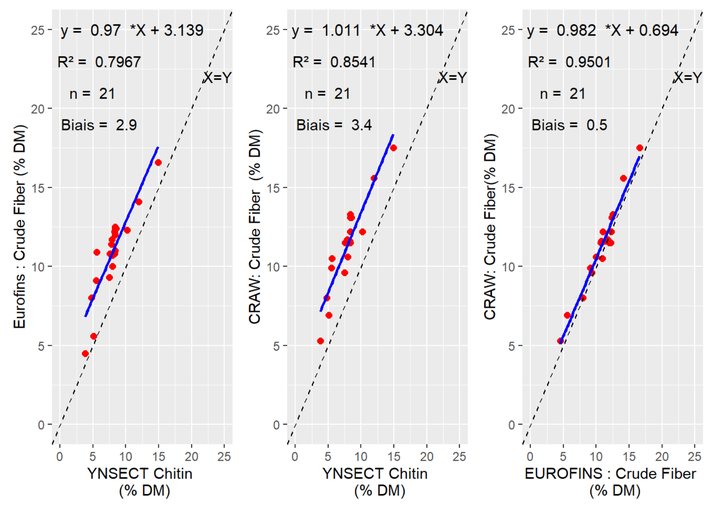
• ADF-ADL



Comparison to the reference method on 21 samples

- Good correlation between compared methods ($0.79<R^2<0.87$) and labs performing the same methods : $R^2 = 0.83$ (ADF-ADL) and $R^2 = 0.95$ (Crude Fiber).
- Known and constant bias between methods and labs allows values correction (Internal or external quality control).

• Crude Fiber (cellulose)



Although less precise, the ADF-ADL method (2-3 days) and the cellulose method (1.5 days) could be used for a quicker estimation of chitin content.

Rapid evaluation by Near Infrared (NIR) spectroscopy

The analysis time can be significantly reduced with the development of Near Infrared (NIR) spectroscopy approaches and the creation of appropriate models. NIR can also predict other parameters related to the quality of insect-derived products. Two approaches were tested: the "specific" approach, which was based solely on insect products (70 samples related to 11 insect species), and the "global" approach, which included 4 other animal proteins (bovine, pig, poultry and fish) in the database to increase the variability of the values.

• Specific approach (PLS)

(% as_is)	N Val	SEP	RSQ
HUM	17	0.27	0.97
CRUDE_PROTEIN	17	2.76	0.89
FAT	17	1.16	0.97
CRUDE_FIBER	17	1.06	0.90
ADF-ADL	17	1.68	0.75

N Val= number of samples in the validation;
SEP= Standard Error of Prediction; RSQ=coefficient of determination.

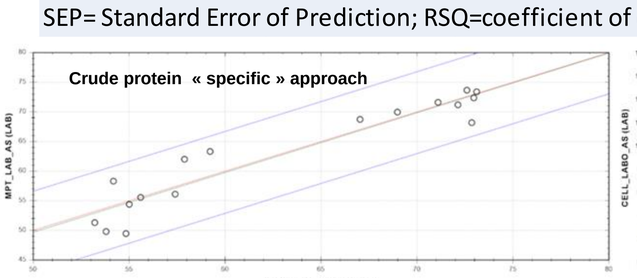
Model assessment

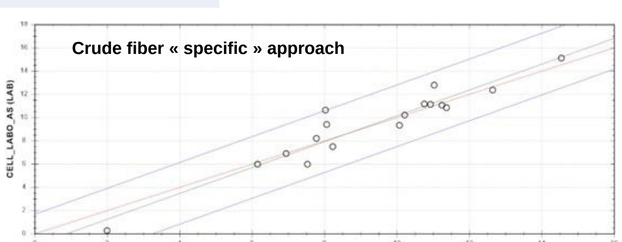
- Local model and PLS models, are good tools to predict ; humidity, crude protein, fat, chitin (ADF-ADL or crude fiber method).

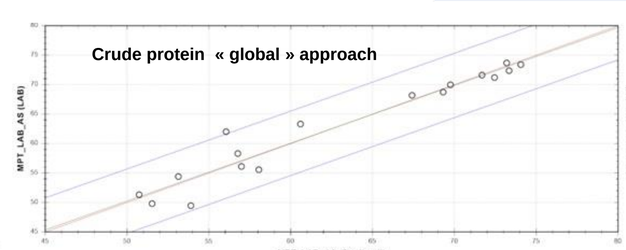
• Global approach (local mode)

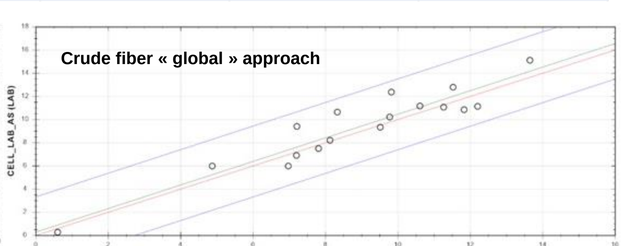
(% as_is)	N Val	SEP	RSQ
HUM	17	0.32	0.96
CRUDE_PROTEIN	17	2.21	0.91
FAT	17	2.97	0.93
CRUDE_FIBER	17	1.22	0.87
ADF-ADL	17	1.15	0.89

N Val= number of samples in the validation;
SEP= Standard Error of Prediction; RSQ=coefficient of determination.









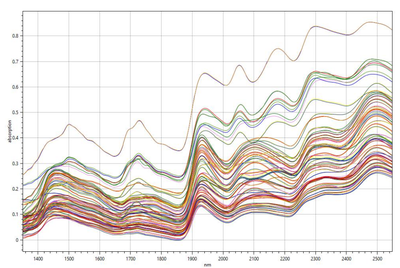
Specific and global approaches showed similar performance. It can be concluded that NIR-based methods are a valuable tool for predicting moisture, protein, fat, cellulose, and chitin content with relatively low prediction errors.

Implementation of NIR characterization in industry

The implementation of NIR calibrations in an industrial setting can be achieved by transferring the models. For this purpose, a methodical approach is proposed by CRA-W to verify that the instruments are compatible and to transfer successfully calibration models

To perform this standardization, a representative set of samples, known as the "standardization box", is transferred. These samples are scanned by both instruments: the original and the new one, under identical measurement conditions. Then, spectra alignment is performed using statistical methods.

(A) Standardization box sent by CRA-W to laboratories. The box contains 40 samples (30 samples used for standardization and 10 wheat samples used for validation). The samples are presented as sealed cups and contain different feed samples/ingredients. They are characterized by various spectral signatures.



(B) Spectra obtained at CRA-W on the samples of the standardization box.

Conclusions

- Faster methods were developed for chitin analysis
- NIR models were developed for a fast characterization of insect-derived products
- Methods can be transferred to other laboratories and industries
- Similar approaches could be developed for other types of components derived from various protein sources

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