An objective and easy-to-use NIR-based software for food quality control

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1. Introduction

In the food industry, **powdered products** are about **40%** of the human consumption. Moreover, pure ingredients and powdered blends are used by food companies in the production of their final recipes. Quality control for these type of ingredients (and even for the final powdered products) is a challenge for most manufacturers as there are not specific methods that can provide reliable results. Adulterations and food safety failures are difficult to detect in this kind of products.

Approximately 2 billion people (26.7% of the world population) derive their livelihoods from agriculture, giving rise to a large network of small and medium-sized companies associated with the food industry. They are the input to a global food industry with no globally agreed measurement of quality agreements.

80% of the world´s food is produced by small hold farmers and SMEs who will use #SaaS to comply and compete

Therefore, there is a real need to implement a methodology to perform quality control in a more reliable, faster and easier way, that can be conducted by any minimally trained technician, avoiding human error and providing reliable levels of identification and minimizing risks, while, at the same time, increasing a company's food-safety standards and establishing a precise and fully replicable quality-control process.

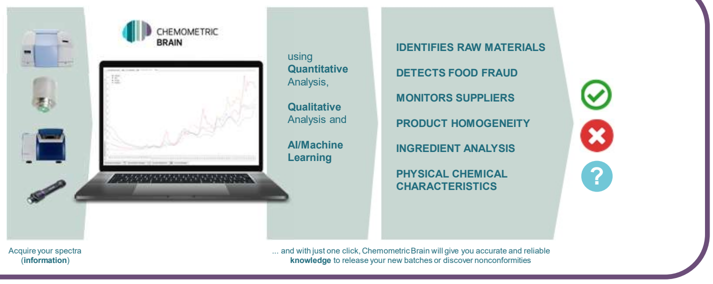
Chemometric Brain is presented as a powerful tool capable of solving some of the current critical points in the food industry:

- Ensure the qualification of the ingredients
- Validate the homogeneity of the blended product
- Control every single batch of ingredient and finished product
- Facilitate a quick technological analysis for validation or rejection
- Reduce human errors in analytics
- Centralize approvals from any production site
- Unify a globally replicable food quality system

2. How does Chemometric Brain work?

Large database of NIR spectra + mathematical algorithms = Improved food safety

Based on a well-known but underutilized technology (NIRS), we have developed a breakthrough in **digitized Quality Control** by using different techniques like qualitative and quantitative NIR measurements and **Machine Learning** to confirm consistency of product quality, the composition and origin of ingredients and instant identification of any adulteration or error in production.


CHEMOMETRIC BRAIN
using
Quantitative
Analysis,
Qualitative
Analysis and
AI/Machine
Learning
IDENTIFIES RAW MATERIALS
DETECTS FOOD FRAUD
MONITORS SUPPLIERS
PRODUCT HOMOGENEITY
INGREDIENT ANALYSIS
PHYSICAL CHEMICAL CHARACTERISTICS
Acquire your spectra (information)
... and with just one click, Chemometric Brain will give you accurate and reliable knowledge to release your new batches or discover nonconformities

3. Examples of Chemometric Brain deployment in the food industry

Adulteration of a milk protein concentrate with sweet whey powder

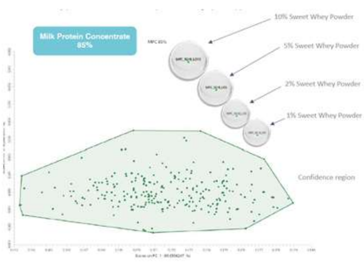


Figure 1

Food adulteration can have serious effects on health and safety. The detection of food fraud in production processes, whether intentional or accidental, can lead to large economic losses as well as a bad business reputation.

Using Chemometric Brain in the production chain is possible to detect food fraud: 4 samples from a validated batch were altered with 1%, 2%, 5% and 10% of sweet whey protein. The protein analysis did not show differences in their protein content with respect to other validated batches of MPC 85%. However, the adulterated samples could be clearly identified when using our model for MPC 85% developed by Chemometric Brain.

The "fingerprints" of the new batches were analyzed and compared with those previously validated through a Principal Component Analysis (PCA). As shown in Figure 1, the altered MPC 85% samples (light green) were different from the ones in the model as they were outside the confidence area (dark green).

Detection of changes on the raw material received (mislabelling)

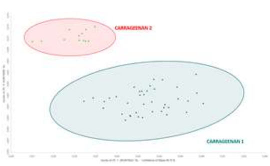


Figure 2

Through the use of Chemometric Brain SaaS is possible to assess the compliance or not compliance of new manufactured batches. In this particular case, new batches of an additive blend based on carrageenan and gum were identified as not compliant since they showed non-conformities with respect to the previous batches received.

Figure 2 shows the results of projecting the new batches of the stabilizer received (carrageenan 2, red circle) onto a model including only batches produced with carrageenan 1 (green circle) as a blinder. As you can see in the image, the use of Chemometric Brain allowed to identify that the new shipment of this product contained batches manufactured with a new formulation.

Chemometric Brain analysis noticed that new received batches showed differences with respect to the rest of the batches considered as conforming and these differences were attributed to the use of a new carrageenan in the blend received from their supplier.

Detection of errors in the manufacturing process

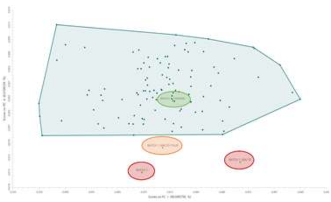


Figure 3

During the production of an energy drink, a routine quality analysis of the manufactured batches using NIR and Chemometric Brain and one of them was identified as non-compliant. After investigating what could have happened, one or more ingredients of the formula may have not been added to the product since as a deficit in the final weight of the batch was detected.

Three new samples were taken and the components that might be missing were added, respectively: taurine, maltodextrin and taurine + maltodextrin. Once the samples were prepared, they were measured by using a NIR spectrometer and their spectra were projected onto the qualitative model specific for that product. The Chemometric Brain analysis indicated that the missing ingredient was taurine, since when adding this ingredient to the blend, its NIR fingerprint was similar to those of the batches already included in the model. On the other hand, samples to which maltodextrin or a combination of maltodextrin and taurine was added were still not correct.

After that, the corresponding amount of was added to the whole batch and a NIR measurement was taken again. At that time, the batch was identified by the software as valid, thus demonstrating the software's ability to detect the problem in the manufacturing process and identify the missing ingredient. This way, Chemometric Brain enabled the customer to avoid the complete discarding of the manufactured batch or the possible economic losses and claims for releasing an incorrect one.

Quick Quality Control Response: Rapid Conformity Test (sample accepted or rejected)

Next example illustrates how using the sample validation tool of Chemometric Brain software is possible to perform a rapid and easy test that allow to categorize the batches of the products under assessment with a "green tick (✓; as conforming) or a "red cross (✗; as non-conforming) depending on the results obtained after projection of the batches onto a model built with "good" samples. Figure 4 shows that the projection of two new batches "Batch 1" and "Batch 2" onto the target product model reveals that both appear inside of the confidence area defined by the model.

Additionally, Chemometric Brain also displays a table summarizing the results after projection action. As it can be observed Table 1, you can easily identify in a visual way if the batches under study can pass or not the quality control test. In this specific case, our software indicates with the following symbol (✓) that both batches appear as conforming. By this way is possible to check at the same time that the product has not any problem of adulteration and is similar to the "good" batches of the model.

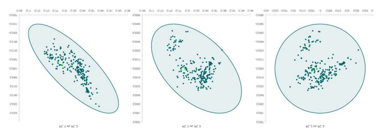


Figure 4

Nº.	Spectrum Id.	Global Validation	Class Validation Classification	Risk Level	Correlation Threshold	Correlation Coefficient	Q Residual Model Limit	Q Residual Value	PC 1 vs. PC 2	PC 1 vs. PC 3	PC 2 vs. PC 3
1	BATCH 1	✓	CLASS 1	LOW RISK	0,9872369065177633	0,9981351489513033	0,00003115267435156252	0,00001253443532117818	✓	✓	✓
2	BATCH 2	✓	CLASS 1	LOW RISK	0,987[illegible]	[illegible]	[illegible]00031115267435156252	0,00001051003554592016	✓	✓	✓

Table 1

Ingredient analysis

	Colour	Ingredient Category	Proportion(%)	Presence	Regression	Success(%)
1		GENU PECTIN LM-106-AS-YA	15.55	✓	0.143843	100.0
2		WPC 60	11.68	✓	0.108074	100.0
3		SWEET WHEY POWDER	62.95	✓	0.582331	100.0
4		MONO- AND DIGLYCERIDES OF FATTY ACIDS	9.81	✓	0.090764	100.0

Table 2

Chemometric Brain includes the Ingredient Analysis section in which, thanks to the Artificial Intelligence technology used, it is possible to determine the ingredient composition of a product and the proportion of those ingredients in the blend. The system performs a learning process by analyzing the thousands of data available in the database about ingredients, their percentage in different products and their response to NIR radiation. After this process, the software is able to make a prediction of the composition of any spectrum.

Once the data training has been carried out and after loading the spectrum to be predicted, the algorithm execution is performed and the software offers not only the components of the blend, but also their proportion (Table 2). This methodology has also been successfully applied in the identification of microcomponents and the determination of the proportion of each one of them in the blend.

4. Conclusions

- ✓ Chemometric Brain as a digitized Quality Control tool based on NIR technology and Machine Learning techniques.
- ✓ Our software offers a powerful, accessible and easy-to-use tool for the quality control of companies in the food industry, whether they are SMEs or large entreprises.
- ✓ Chemometric Brain is able to solve most of the routine problems found in the food industry: detection of food fraud, detection of changes on the raw material received (mislabelling), detection of errors in manufacturing processes, rapid conformity test (sample accepted or rejected) and ingredient analysis of a product blend.

For further information, visit our website https://www.chemometricbrain.io or contact us by email: info@chemometricbrain.io