Spectral analysis plays an invaluable role in the production of roasted nuts, nut butters, and a host of other food products that let the delicious taste and high nutritional value of nuts shine through. By continuously monitoring the appearance of processed nuts, in-line spectrophotometers allow manufacturers to adhere to grading guidelines, evaluate process variables, and immediately identify unwanted color variations that compromise product taste and quality. But evaluation of processed nuts is only the final step in ensuring quality in nut products; recent applications of spectrophotometric technology in the analysis of raw nuts are demonstrating the immense potential of spectrally-based optical sorting systems to enhance the safety and quality of nuts, whatever their intended use.

The Limits of Visual Assessment in Nut Sorting

Regardless of the form a nut ultimately takes, the quality of the final product depends on selecting the best raw ingredients. By sorting raw nuts according to desirable characteristics and removing inferior or contaminated product, you can ensure that only those nuts deemed appropriate for consumption are selected for further processing to both preserve safety and avoid the expense of processing unsuitable product. Traditionally, sorting has been done manually via visual assessment, a laborious process that is vulnerable to human error. Non-destructive visual assessment of shelled nuts is particularly difficult, as you are limited to evaluating the exterior of the shell, leaving the nut itself unexamined. Because nuts are vulnerable to range of defects that may not be apparent from visual inspection of the shell, their very nature presents a major barrier to quality control, as potential damage often remains hidden to the human eye.

Nut Classification Using Spectral Analysis

To overcome the challenges of visual assessment, researchers have begun using spectrophotometry to identify wavelength bands associated with defective and contaminated nut products and create optical sorting systems based on spectral data. Spectrophotometers allow for the identification and quantification of spectral qualities of the shell undetectable to the human eye, which can provide critical information regarding interior conditions to reveal a more complete picture of palatability and safety without disturbing the surface of the nut. In 2009, researchers examined the potential of using transmittance NIR spectrophotometry to sort in-shell Brazil nuts according to specific wavelengths found to correspond with "various levels of quality and potential for aflatoxin contamination."[1] Specifically, nuts with wavelengths between 2200 and 2500 nm were identified as presenting a high risk of aflatoxin contamination and were quarantined. Not only was the sorting method successful in identifying desirable aesthetic characteristics, but it was also able to "detect nuts with inner nut deterioration, an undesirable defect that the current Brazilian manual sorting system cannot detect without destroying or de-shelling the nuts."

Similarly, NIR spectrophotometry has been found capable of detecting common nut defects caused by insect damage, germination, and mold growth in other types of shelled and de-shelled nuts. After visual assessment of these quality parameters was determined to be insufficient, a group of Brazilian researchers sought to investigate the feasibility of spectrophotometric analysis in identifying compromised in-shell macadamia nuts. They discovered that spectral data provided an extraordinarily accurate basis for intact macadamia nut sorting and noted that "this technique can be used as a non-destructive method and could be a valid and simple tool to reduce the quality control costs of monitoring macadamia nuts' quality."[2] Spectral analysis is also considered a reliable method of identifying damaged pistachio hulls associated with contaminants such as insect pupae, fungal decay, and navel orange worm with 96.3% accuracy, facilitating segregation of defective product. As the functional and economic benefits of optical sorting systems using spectral analysis become more apparent, nut product manufacturers are increasingly integrating spectrophotometric instrumentation for raw nut evaluation and classification purposes, allowing for greater quality control throughout the production chain.

Full article with photos available here:

https://www.hunterlab.com/blog/color-food-industry/utilizing-spectral-analysis-for-determining-optical-sorting-systems-raw-nuts/