DNA barcoding: A new tool for food traceability

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In a review published in Food Research International, researchers at University of Milan and University of Trieste analysed the findings from several studies to exploit the effectiveness of DNA barcoding as a tool for food traceability. The review also considered other applications such as quality control and detection of commercial fraud.

What is DNA barcoding?

DNA barcoding is a molecular based system, which allows scientists to identify particular species, by comparing short genetic markers in the specimen DNA with reference sequences. Its success depends on: i) the molecular variability between species and ii) the availability of high quality repositories of reference sequences (i.e. DNA sequences of known species). An example of the latter is the Barcode of Life Database (BOLD). This is coordinated by the International Barcode of Life Project and is a repository which supports the collection of reference sequences, with the aim of creating a reference library for all living species. It includes a species identification tool which returns a taxonomic assignment to the species level whenever possible. It is a useful resource for research and practical applications.

DNA barcoding of seafood, meat, edible plants, dairy products and processed foods

The authors of this review considered the applicability of DNA barcoding for the identification and traceability of seafood, meat, edible plants, dairy products and processed foods. They highlighted that DNA barcoding is particularly successful when applied to seafood because: i) in comparison to other animal sources (e.g. cattle, sheep, goat, horse) the number of species is higher, so the effectiveness of the technique is enhanced; ii) classical identification approaches are not useful in many cases (following industrial processing, morphological characteristics are often lost and classical identification processes are no longer effective) and iii) identification can often proceed beyond species level, allowing the identification of local varieties and hence the origin of the product. The technique has been used to identify commercial fraud, e.g. the illegal and dangerous substitution of the toxic puffer-fish mislabelled as monkfish. Despite its proven effectiveness, few studies on the application of DNA barcoding to certain categories of seafood (e.g. crabs and lobsters) have been conducted. Therefore, more extensive studies are required to confirm the potential use of this technique on all kinds of seafood, as a reliable traceability tool.

The applicability of DNA barcoding for the identification and traceability of mammalian (e.g. beef, pork, lamb, venison, horse) and avian (e.g. chicken, turkey) meat was also highlighted. However, the authors noted that there are several cases of species or breeds with the same DNA profile. In this case DNA barcoding would not be able to return a correct identification, thereby making it impossible to track some meat products. This phenomenon is common in livestock. An example is cattle where many breeds are derived from hybridisation events.

There are no technical limitations to the application of DNA barcoding to the traceability of plant raw materials. However, at cultivar level, the reduced genetic diversity often requires analysis of large portions of the genome. This has cost implications and is contrary to the basic DNA barcoding methodology, which requires the analysis of short and universal DNA regions only. Regarding dairy products, the authors pointed out that although no studies based on a strict DNA barcoding approach have been conducted, the use of molecular tools to characterise and trace dairy products is gaining large acceptance.

Regarding processed foods, DNA barcoding has been used to identify commercial tea, fruit species in yogurt, and fruit residues in juices, purees, chocolates, cookies etc. However, certain challenges were highlighted. During processing, the DNA structure of many ingredients (e.g. seeds, fruits, plants and animal parts) can be transformed as a result of physical (i.e. heating, boiling, UV radiation) or chemical (i.e. addition of food preservative, artificial sweeteners) treatments. For this reason, the application of DNA barcoding on transformed commodities can be ineffective.

Conclusion

The researchers concluded that DNA barcoding can be used as a universal tool for food traceability. It can be used in different contexts by different operators (e.g. by regulatory authorities, researchers). While some groups of organisms, such as fish, have a well-populated reference database, more work is required to provide high quality repositories of reference sequences for other groups of organisms.

For further information please see:

Galimberti, A., De Mattia, F., Losa, A., Bruni, I., Federici, S., Casiraghi, M., Martellos, S., Labra, M. (2013) DNA barcoding as a new tool for food traceability. Food Research International, 50, 55–63.