tedious and time-consuming. In addition, they respond irreversibly to either oxidation (by free radicals) or reduction (with antioxidants), and hence are unable to detect processes with opposite redox chemistries occurring. Their specificity also limits detection to a particular subset of free radicals/ antioxidants which are well-studied and understood, leaving no room for presently unknown systems. Most of the existing assays are designed based on the principle of "fluorescence turn on/off" in the presence of target analytes, which is difficult to observe visually, unless a very obvious fluorescence enhancement/ quenching results.

Therefore, there is a need for easy-to-use assay systems for such detection, especially those for measurement in one-pot.

Another problem with present assays for the detection of redox properties is that they cannot be easily observed as they require complex measurements.

There is a need to detect free radicals and antioxidants in a simple way without using complex methods.

There is a further need to detect the free radicals and antioxidants in a simple way by mixing a sample with a reagent and observing the resulting physical change in the same pot.

Summary

According to the disclosure, there is provided a method for detecting oxidants and reductants wherein the method comprises the reaction of a sample with a substrate and observing a fluorescence color change.

According to a first aspect, there is provided a method for detecting oxidants and reductants wherein the method comprises the reaction of a sample with a metal nanocluster and observing a fluorescence color change, wherein the metal nanocluster is a mixture of metal nanoclusters templated with two different DNA sequences.

Advantageously, the method may be useful for two-way simultaneous detection of free radicals and antioxidants of a sample by a simple reversible color change

guaranteeing a comprehensive survey of the overall effects from all known and unknown free radicals and antioxidants present.

The unambiguous fluorescence color change can enhance the reliability and feasibility of visual-detection without any instrumentation.

The substrate of the method is a metal nanocluster ("mNC" or "metal NC"). The substrate serves as a surface on which other materials may be templated to. The metal nanocluster is templated with a DNA sequence.

Advantageously, this method allows for the detection of both free radicals and antioxidants simultaneously. Two opposite redox processes can be observed for their overall effect in one assay using this method.

Advantageously, this method allows the observation for a wide range of free radicals and antioxidants.

Advantageously, according to this method no toxic reagents are used and the method can be carried out in aqueous medium at room temperature. Accordingly this non-toxic method may have in-vitro and in-vivo applications.

Advantageously, this method allows for real-time monitoring of reduction and oxidation, because the color change is reversible.

Preferably, in the disclosed method the metal nanocluster may be templated with a 2 mer to 20 mer of the DNA sequence or templated with a homocytosine single-stranded DNA sequence.

Advantageously, the short DNA sequences disclosed to be usable in the method are obtainable at low cost and customizable and do not need to be harvested from any living organism, rendering the disclosed method highly versatile, cost-effective, sensitive, safe and reliable

for their application across a wide variety of both in-vivo and in-vitro sensing platforms.

The method makes use of mixtures of metal nanoclusters templated with two different DNA sequences.

Advantageously, the disclosed method allows for adapting the detection method to the specific purpose, e.g. to achieved a high sensitivity.

In another embodiment the metal of the metal nanocluster may be selected from the group consisting of silver, gold, copper, palladium, ruthenium, rhodium, osmium, iridium, platinum, mercury, rhenium, and alloys thereof, with silver being specifically mentioned.

Advantageously, these nanoclusters based substrates, especially the silver nanocluster substrates, are less susceptible to photo bleaching and oxidative quenching and are therefore stable for storage at room temperature for months.

In another embodiment of the method the color change is recorded as Emission Color Ratio (CR).

Advantageously, this method enhances the sensitivity compared to the pure visual detection by measuring quantitative CR values.

Preferably the particle size of the nanoclusters is below 2 nm. Advantageously, these small size nanoclusters show a desirable utility in the disclosed method.

According to a second aspect, there is provided an assay for detecting oxidants and reductants comprising at least one step wherein the inventive method is used.

Advantageously, the assay allows for the detection of both free radicals and antioxidants by observing a color change.

In one embodiment of the assay, the assay comprises the following two steps:

a) mixing a metal nanocluster with a sample in a medium

b) observing the fluorescence color change of the mixture.

This assay can be modified according to another embodiment of the disclosed assay to allow for the real-time observation of the mixture.

Advantageously, the assay can then be run as a simple one-pot mix-and-test format for real time observation.

According to the present disclosure, there is provided the use of the assays for detecting free radicals or antioxidants potentially relating to aging processes or diseases.

According to a third aspect, there is provided the use of the assays for detecting free radicals or antioxidants relating to aging processes or diseases.

Advantageously, the use of the assay allows for a simple way to analyze the redox properties of samples in biomedical research.

According to a fourth aspect, there is provided the use of the assays for evaluating the shelf-life of a food, beverage, health care, personal care or sports product.

Advantageously, the use of the assay allows for a simple way to analyze the redox properties such products with a use in health care, personal care, sports or the food and beverage industries.

According to the present disclosure, a corresponding assay kit for detecting oxidants and reductants in a redox system of a sample comprising at least one metal nanocluster is provided.

According to a fifth aspect, there is provided an assay kit for detecting oxidants and reductants in a redox

system of a sample according to the assays as defined above comprising a mixture of metal nanoclusters templated with two different DNA sequences.

According to the present disclosure, the use of metal nanoclusters for detecting oxidants and reductants by fluorescence color change analysis is disclosed.

Claims

1. A method for detecting oxidants and reductants wherein the method comprises the reaction of a sample with a metal nanocluster and observing a fluorescence color change, wherein the metal nanocluster is a mixture of metal nanoclusters templated with two different DNA sequences.

2. The method according to claim 1, wherein the DNA sequences are a 2 to 20 mer.

3. The method according to claims 1 or 2, wherein the DNA sequences are selected from the group consisting of homocytosine single-stranded DNA sequence, homoadenine single-stranded DNA sequence, homothymine single-stranded DNA sequence and homoguanine single-stranded DNA sequence or mixtures thereof.

4. The method according to claim 1, wherein the metal of the metal nanocluster is selected from the group consisting of silver, gold, copper, palladium,

ruthenium, rhodium, osmium, iridium, platinum, mercury, rhenium, and alloys thereof.

5. The method according to claim 4, wherein the metal of the metal nanocluster is silver.

6. The method according to any of claims 1 to 5 wherein the color change is recorded as Emission Color Ratio.

7. The method according to any of claims 1 to 6 wherein the oxidant is a free radical and the reductant is an antioxidant.

8. The method according to any of claims 1 to 5 wherein the nanocluster has a particle size of 0.01 nm to 10 nm, 0.01 nm to 8 nm, 0.01 nm to 6 nm, 0.01 nm to 4 nm, 0.01 nm to 2 nm, 0.1 nm to 10 nm, 1 nm to 10 nm, 0.1 nm to 8 nm, 0.1 nm to 6 nm, 0.1 nm to 4 nm and 0.1 nm to 2 nm.

9. An assay comprising at least one step wherein a method according to any of claim 1 to 8 is used.

10. An assay according to claim 9 comprising the following two steps

a) mixing a metal nanocluster with a sample in a medium

b) observing the fluorescence color change of the mixture.

11. The assay according to claim 10 wherein the observation of the mixture is performed in real-time.

12. Use of an assay according to any of claims 9 to 11 for detecting free radicals or antioxidants relating to aging processes or diseases.

13. Use of an assay according to any of claims 9 to 11 for evaluating the shelf-life of a food, beverage, health care, personal care or sports product.

14. An assay kit for detecting oxidants and reductants in a redox system of a sample according to the assays of any claims 9 to 11 comprising a mixture of metal nanoclusters templated with two different DNA sequences.