

## A METHOD OF AUTHENTICATING EDIBLE BIRD'S NEST

### Field of the Invention

5 This invention relates to a method of authenticating edible bird's nest. More particularly, this invention relates to a method of authenticating edible bird's nest using hyperspectral imaging.

### Background

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The quality of edible bird's nest samples is important for ensuring safety and efficacy for consumption. High nutritional and medicinal values as well as high price of EBN have led to rampant adulteration of the edible bird's nest by the addition of various cheaper substances to these products. For example, edible bird's nest is usually  
15 adulterated with one or more of the substances including, Tremella fungus, karaya gum, red seaweed, pigskin, egg white, gelatin, soybean, rice, milk, starch and agar.

The current authentication method used in the industry is by physical inspection of the edible bird's nest based on its appearance (e.g. colour, shape and texture). Such  
20 method is often subjective and hardly reliable as it relies on the buyer's experience and tacit knowledge on edible bird's nest. Other methods used in the industry involved lab-based chemical analysis of edible bird's nest. These methods are not ideal when considering that trading of expensive edible bird's nest cannot go hand-in-hand with on-site scientific authentication of what is being sold. There is currently no rapid  
25 "golden standard" method for authentication and characterization of genuine edible bird's nest products.

It is therefore desirable to provide a method for authenticating edible bird's nest that seeks to address at least one of the problems described hereinabove, or at least to  
30 provide an alternative.

### Summary of Invention

In accordance with one aspect of this invention, a method of authenticating edible bird's nest is provided. The method comprises obtaining from a hyperspectral imaging spectrometer a reflectance spectrum of an edible bird's nest sample; performing an image recognition analysis of the reflectance spectrum measured at wavelengths  
5 between 470 nm and 870 nm; determining whether the reflectance spectrum of the edible bird's nest sample is one of the reflectance spectrum selected from the group consisting of a 3-phase gradient transition, a no-phase transition and a non-definitive 3-phase gradient transition of the reflectance spectrum; and identifying based on the determined reflectance spectrum, whether the edible bird's nest sample is real, fake or  
10 adulterated.

In accordance with one embodiment of this invention, the reflectance spectrum shows a 3-phase gradient transition between said wavelengths, indicating that the edible bird's nest sample is real.

15 In accordance with one embodiment of this invention, the reflectance spectrum shows a no-phase transition between said wavelengths, indicating that the edible bird's nest sample is fake.

20 In accordance with one embodiment of this invention, the reflectance spectrum shows a non-definitive 3-phase gradient transition between said wavelengths, indicating that the edible bird's nest is adulterated.

In accordance with one embodiment of this invention, the step of obtaining the  
25 reflectance spectrum of the edible bird's nest sample from the hyperspectral imaging spectrometer comprises placing the edible bird's nest sample under the hyperspectral imaging spectrometer; illuminating the sample uniformly using a fiber coupled light source to obtain a first reading; replacing the edible bird's nest sample with a calibrated labsphere broadband reflectance surface of about 80% reflectivity and  
30 measuring the reflected spectrum to obtain a second reading; dividing the first reading by the second reading to obtain a third reading; and multiplying the third reading by 80% to obtain the reflectance spectrum of the edible bird's nest sample.

### Brief Description of the Drawings

The above advantages and features of a method and apparatus in accordance with this invention are described in the following detailed description and are shown in the  
5 drawings:

Figure 1 shows the experimental setup used to obtain the results of Example 1.

Figure 2 shows the spectral reflectance of the 13 samples of Example 1.

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Figure 3 shows the spectral profiles of a real, fake and adulterated edible bird's nest measured at wavelengths between 470 nm and 870 nm.

### Detailed Description

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This invention relates to a method of authenticating edible bird's nest. More particularly, this invention relates to a method of authenticating edible bird's nest using hyperspectral imaging.

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The method comprises obtaining from a hyperspectral imaging spectrometer a reflectance spectrum of an edible bird's nest sample, performing an image recognition analysis of the reflectance spectrum measured at wavelengths between 470 nm and 870 nm; determining whether the reflectance spectrum of the edible bird's nest sample is one of the reflectance spectrum selected from the group consisting of a 3-phase  
25 gradient transition, a no-phase transition and a non-definitive 3-phase gradient transition of reflectance spectrum; and identifying based on the determined reflectance spectrum, whether the edible bird's nest sample is real, fake or adulterated.

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Edible bird's nest as used herein refers to any types and any grades of edible bird's nest. Edible bird's nest can be grouped into different types and categories based on certain criteria such as where the edible bird's nests are harvested and the species of the swiftlets that build the nest. For example, edible bird's nest can be classified by the habitat of swiftlets, the species of swiftlets or by the colour of the edible bird's nest. In terms of classification by the habitat of swiftlets, there are two main categories,  
35 namely cave bird's nest and house bird's nest. Cave bird's nest refers to the nests built

by swiftlets in natural stone walls or limestone caves. House bird's nests are bird's nests built in swift houses and used by swifts for nesting. In terms of classification by the colour of the edible bird's nest, there are three main categories such as red bird's nest, white bird's nest and yellow bird's nest. The method of the present invention is  
5 suitable for use in authenticating edible bird's nests of different categories and grades.

As used herein, the term "3-phase gradient transition" refers to a change in the gradient of the reflectance spectrum over 3 different phases in the spectral between 470 nm and 870 nm. An exemplary embodiment of a 3-phase gradient transition of a  
10 reflectance spectrum is shown in Figure 3.

In one embodiment, the first phase occurs in the spectral between 470 nm and 570 nm. The second phase occurs in the spectral between 570 and 820 nm. The third phase occurs in the spectral between 820 nm and 870 nm.

15 As used herein, the term "no-phase transition" refers to a spectrum that shows no change in the gradient of the reflectance spectrum taken in the spectral between 470 nm and 870 nm. An exemplary embodiment of a no-phase transition of a reflectance spectrum is shown in Figure 3.

20 As used herein, the term "non-definitive 3-phase gradient transition" refers to a spectrum that shows a non-definite or non-defined change in the gradient of the reflectance spectrum over 3 different phrases in the spectral between 470 nm and 870 nm. In other words, there is no distinctive gradient transition in the spectrum over the  
25 3 different phases between the said wavelengths. An exemplary embodiment of a non-definitive 3-phase gradient transition of a reflectance spectrum is shown in Figure 3.

In the present invention, a reflectance spectrum showing a 3-phase gradient transition  
30 in the wavelengths between 470 nm and 870 nm indicates that the edible bird's nest sample is real. A no-phase transition in the reflectance spectrum in the said wavelengths indicates that the edible bird's nest sample is fake. A non-definitive 3-phase gradient transition in the reflectance spectrum in the said wavelengths indicates that the edible bird's nest is adulterated.

Any suitable type of hyperspectral imaging spectrometer may be used in accordance with the method of the present invention without departing from the scope of the invention.

5 In one embodiment, the reflectance spectrum of the edible bird's nest is obtained from the hyperspectral imaging spectrometer by placing the edible bird's nest sample under the hyperspectral imaging spectrometer and illuminating the sample uniformly using a fiber coupled light source to obtain a first reading. The edible bird's nest sample is then replaced with a calibrated Labsphere broadband reflectance surface of about 80%  
10 reflectivity and the reflected spectrum is measured by the same spectrometer in the exact setup to obtain a second reading. This is followed by dividing the first reading (the edible bird's nest spectral measurement) by the second reading (the Labsphere's calibrated surface's measurement) to obtain a third reading. The third reading is then multiplied by 80% to obtain the reflectance spectrum of the edible bird's nest sample.

15 Hyperspectral imaging spectrometer looks at objects using a vast portion of the electromagnetic spectrum. Certain objects leave unique "fingerprints" across the electromagnetic spectrum. These 'fingerprints' are known as spectral signatures, and they enable identification of the materials that make up a scanned object.  
20 Hyperspectral imaging used in the method of the present invention is able to distinguish between a real, fake and adulterated edible bird's nest based on their unique signatures.

In another embodiment, the method of the present invention is applied for use in  
25 combination with a portable spectrometer that allows reflectance spectrum of an edible bird's nest sample to be obtained on-site. This allows authentication to be carried relatively quickly on-site as compared to conventional methods known in the art which require lab-based chemical analysis of the sample. Lab-based analysis of edible bird's nest often involves breaking part of a sample from the edible bird's nest for chemical  
30 analysis. Such method is invasive, destructive and costly as edible bird's nest is relatively expensive. The present invention offers a non-lab based, fast and accurate method that leverages on the physical chemistry principles of the edible bird's nest to distinguish between a real, fake and adulterated edible bird's nest. The signature profiles of the edible bird's nest can be validated relatively quickly and accurately to  
35 predict whether the edible bird's nest sample is real, fake or adulterated. The method

is non-destructive, reliable and allows rapid authentication of edible bird's nest sample on-site or off-site. The method of the present invention also allows authentication to be carried out without the need to further process the edible bird's nest physically or chemically before authentication. This further enhances the speed of authentication since no additional steps and efforts are required to further process the edible bird's nest for authentication.

To facilitate a better understanding of the present invention, the following examples of specific embodiments are given. In no way should the following examples be read to limit or define the entire scope of the invention. One skilled in the art will recognize that the examples set out below are not an exhaustive list of the embodiments of this invention.

## EXAMPLES

### Example 1

A total of 13 edible bird's nest (EBN) samples were analyzed using PolarSnap hyperspectral imaging.

In this example, PolarSnap technology was used to obtain scanless hyperspectral imaging on edible bird's nest samples. PolarSnap captures 3-D spatial-spectral information in just a single frame. It has the capability to generate spectroscopic information from every pixel of the image within a single snapshot. The technical specifications of the PolarSnap spectral imager used in this example are shown in Table 1.

Table 1

| Specification           | PolarSnap CL                                 | PolarSnap GE  |
|-------------------------|----------------------------------------------|---------------|
| Operating wavelength    | 470 to 870 nm                                | 470 to 870 nm |
| 3D hypercube resolution | 140 x 140 x 40 bands                         |               |
| Mode of operation       | Snapshot capture / continuous live streaming |               |
| Lens                    | Fixed mounted, non-interchangeable           |               |
| Nominal Field-of-View   | 7°                                           |               |

|                               |                  |                  |
|-------------------------------|------------------|------------------|
| Aspect Ratio                  | 1:1 (square)     |                  |
| Weight                        | < 500g           |                  |
| Dimensions (including lenses) | 52 x 52 x 120 mm | 52 x 52 x 140 mm |
| Input voltage                 | 10 to 30 VDC     | 20 to 30 VDC     |
| Power consumption             | Approx. 5.5 w    | Approx. 8.4 w    |
| Interface                     | Camera Link      | Dual GigE        |

Figure 1 shows the experimental setup that was used to measure the spectral reflectance of the edible bird's nest samples. The light source used is a halogen light bulb coupled through an optical fiber to the edible bird's nest samples.

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The experiment was carried out by first placing an EBD sample a few centimetres below a spectral sensor (11) and illuminating the sample uniformly using the fiber coupled halogen light source (12). The measured Lambertian diffuse light from the EBN sample was captured by the spectral sensor (11). The EBN sample was then replaced by a calibrated Labsphere broadband reflectance surface of approximately 80% reflectivity and the reflected spectrum was measured by the same spectral sensor (11) in the exact same setup. The EBN spectral measurement obtained was then divided by the Labsphere's calibrated surface's measurement. The result obtained was then multiplied by 80% to obtain the spectral reflectance of the EBD samples.

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Figure 2 shows the spectral reflectance of the 13 samples which were measured. The samples were classified into three categories as real, fake and adulterated EBN based on their distinct spectral trend or signature. For fake EBN, the spectral reflectance increases monotonically with a uniform gradient. At 870 nm, it starts to decrease. On the other hand, for real EBN, the spectral reflectance increases with wavelength, starting with a steeper gradient. At 570 nm, this increase becomes gentler, and then until about 820 nm, it becomes steeper again, all the way to about 870 nm. After that, it starts to decrease. For adulterated EBN, the variations in gradient seem less prominent but it does exist, to a lesser extent, as shown in Figure 3.

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This example demonstrates that a reflectance spectrum with a 3-phase gradient transition in the spectral between 470 nm and 870 nm indicates that the edible bird's nest sample is real. A no-phase transition in the reflectance spectrum in the same spectral indicates that the edible bird's nest sample is fake. A non-definitive 3-phase

gradient transition in the reflectance spectrum in the same spectral indicates that the edible bird's nest is adulterated. This imaging technique provides a feasible way to determine the authenticity of an EBN sample relatively quickly.

- 5 The above is a description of the subject matter the inventors regard as the invention and is believed that those skilled in the art can and will design alternative embodiments that include of this invention as set forth in the following claims.

**CLAIMS**

1. A method of authenticating edible bird's nest, the method comprising:  
obtaining from a hyperspectral imaging spectrometer a reflectance spectrum of  
5 an edible bird's nest sample;  
performing an image recognition analysis of the reflectance spectrum  
measured at wavelengths between 470 nm and 870 nm;  
determining whether the reflectance spectrum of the edible bird's nest sample  
is one of the reflectance spectrum selected from the group consisting of a 3-phase  
10 gradient transition, a no-phase transition and a non-definitive 3-phase gradient  
transition of reflectance spectrum; and  
identifying based on the determined reflectance spectrum, whether the edible  
bird's nest sample is real, fake or adulterated.
- 15 2. The method according to claim 1, wherein the reflectance spectrum shows a 3-  
phase gradient transition between said wavelengths, indicating that the edible bird's  
nest sample is real.
3. The method according to claim 1, wherein the reflectance spectrum shows a  
20 no-phase transition between said wavelengths, indicating that the edible bird's nest  
sample is fake.
4. The method according to claim 1, wherein the reflectance spectrum shows a  
non-definitive 3-phase gradient transition between said wavelengths, indicating that  
25 the edible bird's nest is adulterated.
5. The method according to claims 1-2 and 4, wherein the 3-phase gradient  
transition includes a first phase, a second phase and a third phase, wherein the first  
phase occurs in the spectral between 470 nm and 570 nm, the second phase occurs in  
30 the spectral between 570 and 820 nm and the third phase occurs in the spectral  
between 820 nm and 870 nm.
6. The method according to claim 1, wherein the step of obtaining the reflectance  
spectrum of the edible bird's nest sample from the hyperspectral imaging spectrometer  
35 comprises:

placing the edible bird's nest sample under the hyperspectral imaging spectrometer;

illuminating the sample uniformly using a fiber coupled light source to obtain a first reading;

5        replacing the edible bird's nest sample with a calibrated labsphere broadband reflectance surface of about 80% reflectivity and measuring the reflected spectrum to obtain a second reading;

dividing the first reading by the second reading to obtain a third reading; and

10        multiplying the third reading by 80% to obtain the reflectance spectrum of the edible bird's nest sample.