Portable device for controlling an alcoholic beverage through a container, a system and a method associated thereto

The present invention relates to the field of the authentication of a content such as a beverage, in particular an alcoholic beverage. More specifically, the invention concerns a device and a method allowing to authenticate a beverage through the walls of a container, more particularly when this container is a bottle.

The production and marketing costs of the high-end alcoholic beverages, such as vintage wines and spirits, lead to high selling prices. These high prices generate, as often for the luxury products, fraud as well as acts of counterfeiting. Thus, there is regularly observed the appearance on the market of counterfeit bottles, that is to say having the external appearance of a genuine bottle, but filled with a beverage of much lower quality than the quality of the original product. This phenomenon of counterfeiting is particularly significant for high-end wines and spirits, such as cognac.

For economic, safety and brand image reasons, the concerned producers are vigorously fighting against these acts of fraud and counterfeiting. This struggle is reflected in particular in the manufacture of bottles including increasingly advanced anti-counterfeiting devices, aiming at preventing the exact reproduction of a bottle and/or its reuse.

However, counterfeiters also make constant efforts and are able to reproduce genuine bottles with such faithfulness that it becomes very difficult to distinguish a counterfeit bottle from a genuine bottle. In other cases, counterfeiters recover used genuine bottles, which are then filled with a non-genuine product.

Therefore, there is a need to remove any doubts about the authenticity of a bottle, by directly authenticating the content itself. Of course, since it is not possible to open each bottle whose authenticity would be doubtful, such authentication should be possible to make through the walls of the bottle.

In addition, this question of authentication arises in various places related to different actors in the distribution chain (resellers, distributors, etc.). The diversity of these actors and their potential remoteness from the places of production mean that there is a need for an authentication device to be portable, easy to use and inexpensive, as well as for an authentication method to be reliable and efficient, in particular in terms of timeliness.

The present invention aims to meet these needs.

An aspect of the invention provides a portable device for controlling an alcoholic beverage in an at least partially transparent container, including:

- a single light source emitting a monochromatic excitation light beam having a wavelength comprised between 350 and 650 nanometers;

- a beam splitter oriented at 45° with respect to the direction of emission of the light source to reflect the excitation light beam;

- a focus and collection lens;

- a positioning device allowing to orient the light beam coming from the light source along a direction substantially normal to the outer surface of the container, the positioning device also allowing to position the outer surface of the container at a predetermined distance from the focus lens, the predetermined distance between the focus lens and the container is chosen so that the light beam is focused inside the container, at a distance from the wall of the container less than 1 millimeter and preferably less than 500 micrometers, the positioning device including a through opening for the passage of the light beam coming from the light source;

- a filtering device for filtering the fluorescence radiation captured by the focus lens and transmitted by the beam splitter, so as to eliminate the wavelengths which are shorter than or equal to the wavelength of the light beam emitted by the light source;

- a spectrometer module for producing a signal corresponding to the measured spectrum of the fluorescence radiation of the beverage;

- an analysis module for comparing the measured spectrum with a reference spectrum.

By using the fluorescence phenomenon, the device in accordance with embodiments of the invention may allow reducing the power of the excitation light source with respect to known devices, particularly those using the Raman effect (the intensity of the light emitted in the fluorescence process is indeed about a million times more intense than the Raman scattering). The device in accordance with the invention includes a single light source, which may contribute to the simplicity and portability of the system. In addition, by being limited to wavelengths greater than 350 nanometers, the influence of water and ethanol molecules (very much predominating in concentration in an alcoholic beverage such as a wine or a spirit) may be limited. Indeed, water and ethanol molecules do not absorb the light radiation for wavelengths which are greater than 200 nanometers. Furthermore, by providing an assembly called "reflection" assembly, the attenuation of the fluorescence radiation is limited. Moreover, the 180° angle of incidence between the emitted ray and the reflected fluorescence ray may allow minimizing the undesirable effects due to the wall of the container, since the traversed thickness will be minimal. Finally, by providing a positioning device, it may be ensured that the focus of the emitted beam will be at the desired location, without any

adjustment being necessary. The repeatability and reproducibility of the measurements may thus be optimized.

In one embodiment, the beam splitter is a dichroic filter, in particular a high-pass dichroic filter (relative to the wavelengths).

In one embodiment, the filtering device includes a Notch-type band-stop filter and/or a high-pass filter (relative to the wavelengths).

In one embodiment, the spectrometer module is linked to the filtering device via an optical fiber.

In one embodiment, the positioning device includes a contact surface configured to be complementary to the outer surface of the container.

In one embodiment, the device includes a display device allowing in particular to display the result of the comparison between the measured spectrum and the reference spectrum.

In one embodiment, the device includes a casing which is secured to the positioning device.

In one embodiment, the casing includes all the components of the device.

In one embodiment, the positioning device is connected to the casing by means of a flexible connection, the focus lens being integrated to the positioning device, the flexible connection including an optical fiber for transmitting the light beams passing through the focus lens.

In one embodiment, the analysis module and the display device are included in an appended portable device, such as a tablet computer or a mobile phone.

In one embodiment, the device includes connection means to a remote database.

The invention also concerns a system for controlling an alcoholic beverage, the system including a device as defined above and a database stored in a remote server of the device.

In one embodiment, the database includes one or more reference spectrum/spectra that can be downloaded by the device.

Another aspect of the invention further provide a method for controlling an alcoholic beverage through an at least partially transparent container, the method including the steps of:

- acquiring a fluorescence spectrum of the beverage through the wall of the container;
- normalizing the profile of the spectrum measured with respect to the maximum intensity of the reference spectrum;
- calculating a resemblance factor between the measured spectrum and the reference spectrum;

- determining, according to the obtained value of the resemblance factor, whether the beverage is genuine.

The control method in accordance with embodiments of the invention has many advantages. Thanks to the step of normalizing the measured spectrum, for example with respect to the maximum intensity of the reference spectrum, the dispersions due to the temperature of the controlled content and to the variations in the characteristics of the container (in particular the dimensional characteristics) may be avoided. This normalization step may also allow collecting, with a low-power excitation source, a signal of sufficient quality to be correctly analyzed. In addition, the step of comparing the measured spectrum with the reference spectrum, which involves the calculation of a resemblance factor, may require very limited calculation capacity, which capacity is now available on a "smartphone" type mobile phone.

In one embodiment, the fluorescence spectrum is acquired by using a source emitting a monochromatic beam of a wavelength comprised between 350 and 650 nanometers.

In one embodiment, the resemblance factor is calculated over a predetermined wavelength range, for example a wavelength range comprised between 550 and 650 nanometers.

In one embodiment, the resemblance factor is calculated by the method called least squares method or by an algorithm of the Hausdorff algorithm type.

In one embodiment, the beverage is determined to be non-genuine if the resemblance factor is greater than 20.

In one embodiment, the reference spectrum is obtained from the measurement of the fluorescence spectrum measured on a sample of a plurality of genuine bottles.

In one embodiment, the method includes a step of downloading the reference spectrum from a remote database.

In one embodiment, the method is implemented using a device or a system as defined above.

The invention will be better understood upon reading the description below, made with reference to the appended drawings, among which:

- Figures 1 and 2 show a device in accordance with the invention in use, respectively from a side and a top view;
- Figure 3 shows the device of Figure 1, from a front view;
- Figure 4a is a block diagram of a device in accordance with the invention;
- Figure 4b is a detail of Figure. 4a;
- Figure 5 shows a variant of the device of Figure 4a;

Claims

1. A portable device for controlling an alcoholic beverage in an at least partially transparent container, including

- a single light source emitting a monochromatic excitation light beam having a wavelength comprised between 350 and 650 nanometers;
- a beam splitter oriented at 45° with respect to the direction of emission of the light source to reflect the excitation light beam;
- a focus and collection lens;
- a positioning device allowing to orient the light beam coming from the light source along a direction substantially normal to the outer surface of the container, the positioning device also allowing to position the outer surface of the container at a predetermined distance from the focus lens, the predetermined distance between the focus lens and the container being chosen so that the light beam is focused within the container, at a distance from the wall of the container less than 1 millimeter and preferably less than 500 micrometers, the positioning device including a through opening for the passage of the light beam coming from the light source;
- a filtering device for filtering the fluorescence radiation captured by the focus lens and transmitted by the beam splitter, so as to eliminate the wavelengths which are shorter than or equal to the wavelength of the light beam emitted by the light source;
- a spectrometer module for producing a signal corresponding to the measured spectrum of the fluorescence radiation of the beverage;
- an analysis module for comparing the measured spectrum with a reference spectrum.

2. The device according to claim 1, wherein the beam splitter is a dichroic filter, in particular a high-pass dichroic filter.

3. The device according to claim 1 or 2, wherein the filtering device includes a Notch-type band-stop filter and/or a high-pass filter.

4. The device according to any of the preceding claims, wherein the spectrometer module is linked to the filtering device via an optical fiber.

5. The device according to any of the preceding claims, wherein the positioning device includes a contact surface configured to be complementary to the outer surface of the container.

6. The device according to any of the preceding claims, wherein the device comprises a display device, allowing in particular to display the result of the comparison between the measured spectrum and the reference spectrum.

7. The device according to any of the preceding claims, wherein the device comprises a casing which is secured to the positioning device.

8. The device according to the preceding claim, wherein the casing includes all the components of the device.

9. The device according to claim 7, wherein the positioning device is connected to the casing via a flexible connection, the focus lens being integrated to the positioning device, the flexible connection including an optical fiber for transmitting the light beams passing through the focus lens.

10. The device according to any of claims 6 to 9, wherein the analysis module and the display device are included in an appended portable device, such as a tablet computer or mobile phone.

11. The device according to any of the preceding claims, wherein the device comprises connection means to a remote database.

12. A system for controlling an alcoholic beverage, wherein the system comprises a device according to claim 11 and a database stored in a remote server of the device.

13. The system according to claim 12, wherein the database includes one or more reference spectra that can be downloaded by the device.

14. A method for controlling an alcoholic beverage through an at least partially transparent container, the method including the steps of:

- acquiring a fluorescence spectrum of the beverage through the wall of the container;

- normalizing the profile of the measured spectrum with respect to the maximum intensity of a reference spectrum;

- calculating a resemblance factor between the measured spectrum and the reference spectrum;

- determining, according to the obtained value of the resemblance factor whether the beverage is genuine.

15. The method according to the preceding claim, wherein the fluorescence spectrum is acquired by using a source emitting a monochromatic beam of a wavelength comprised between 350 and 650 nanometers.

16. The method according to claim 14 or 15, wherein the resemblance factor is calculated over a predetermined wavelength range, for example a wavelength range comprised between 550 and 650 nanometers.

17. The method according to any of claims 14 to 16, wherein the resemblance factor is calculated by the method called least squares method or by an algorithm of the Hausdorff algorithm type.

18. The method according to the preceding claim, wherein the beverage is determined as non-genuine if the resemblance factor is greater than 20.

19. The method according to any of claims 14 to 18, wherein the reference spectrum is obtained from the measurement of the fluorescence spectrum measured on a sample of a plurality of genuine bottles.

20. The method according to any of claims 14 to 19, including a step of downloading the reference spectrum from a remote database.

21. The method according to any of claims 14 to 20, wherein the method is implemented using a device in accordance with any of claims 1 to 11 and/or a system in accordance with any of claims 12 and 13.