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Identification of Rhinoceros Horn and its Substitutes

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Abstract. In order to provide technical support to the quality check departments, this paper researches on the identification of the rhinoceros horn and its substitutes. The rhinoceros horn and its substitutes have been respectively studied by means of appearance and characteristic analysis and infrared spectral analysis. The results show: due to their similar appearances and characteristics, it is difficult to distinguish the rhinoceros horn and its substitutes. The rhinoceros horn has two absorption peaks of P-H stretching vibration of sphingolipid at 2350cm^{-1}, while other horns only have one or no absorption peak in this region. What's more, compared with other horns, it has weak absorption peaks of C=O stretching vibration of hexosamine at 1733 cm^{-1}, and absorption peaks of S-O stretching vibration of taurine at 881 cm^{-1}. However, other horns have none of these absorption peaks.

Introduction

Currently, the testing of the quality of the rhinoceros horn products is rather difficult. Most of the existing methods, such as thin layer chromatography [1], atomic absorption spectrometry [2], HPLC [3], UV spectrometry [4], mass spectrometry [5], are all detrimental to the rhinoceros horn products, which need to pulverize the sample into powder, then make them into solution to composition testing. This paper uses the method of the infrared spectroscopy to identify the rhinoceros horn and its substitutes, which provides a new testing method for the non-destructive test and identification of the rhinoceros horn and its substitutes and this method can be widely applied in such fields as the public security, customs and quality inspection institutions, and so on.

Experimental Procedures

Specimens of the rhinoceros horns were provided by the private collectors, and the other horns, such as cattle horns, yak horn, goat horn and sheep horn, were all provided by slaughterhouse.

The observation of the appearance and characteristic of the samples was completed with GI-MVL Gem Microscope and the infrared spectral picture was taken with TENSOR 27 FTIR spectrometer through reflection method. The experimental parameters are as follows: Resolving power 0.5 cm^{-1}; Sample Scan Time 16 Scans; Background Scan Time 16 Scans; Measurement Range 4000 cm^{-1} ~ 400 cm^{-1}. Furthermore, the infrared spectra obtained were transformed by the K-K transformation.

Results and Discussions

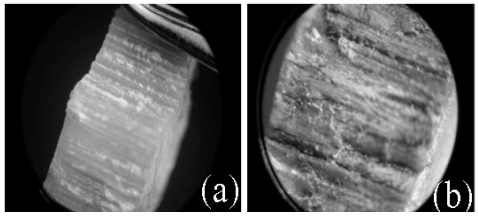

Fig. 1 Photographs of (a) rhinoceros horn and (b) the surface of rhinoceros horn

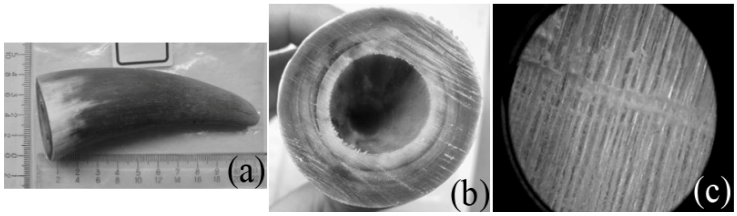

Fig. 2 Photographs of (a) cattle horn; (b) cattle horn's bottom section; and (c) cattle horn.

Appearance and characteristic analysis. The appearance and characteristic of the rhinoceros horn are shown in Fig.1 (a, b). The results indicate that the color of rhinoceros horn products is brown, while the rhinoceros horn is yellow and its powder is gray-white. The surface of the rhinoceros horn has hair-pattern structure [6], and the inclined section is rough, with some bumps. And there is melanin depositing in the surface. In addition, the light transmittance is good, and the smell is micro-fishy [7].

The color of cattle horns is various, mostly is yellow tone. Fig.2 (a, b, c) shows the appearance and characteristic of cattle horn. The results show that the cattle horn is in cone-shaped and a little bending, without the hole in the tip. And there is ring-shaped structure in the cross or inclined section. Magnified 40 times, the appearance of the longitudinal section is beam-like structure. Besides, with hard texture, the light transmittance of the cattle horn is bad, and the smell is slightly fishy.

Fig.3 (a, b, c) shows the appearance and characteristic of yak horn. The results show that the color of yak horn is dark gray, and it is smooth and delicate texture, with a bamboo-like shape [8]. There is not only horizontal circle but also longitudinal texture in the surface. The surface appearance is beam-like structure, which is magnified. And there is ring-shaped structure in cross section.

The appearance and characteristic of the goat horn are shown in Fig.4 (a, b, c). The results show that the color of goat horn is dark gray or gray, and the color of the power is white or gray. With a elongated conical shape and no hole in the tip, the goat horn is a little flat in its side and slightly twisted. And there are ring-shaped protuberance in the bottom section that is near the skin. The surface appearance is loose beam-like structure. What's more, with crisp texture, it is lighttight. And its smell is slightly fishy.

The appearance and characteristic of the sheep horn are shown in Fig.5 (a, b, c). The results show that the color is yellowish white. And it is spiral bending, with a triangular conical shape. There are several orbicular edges with different space. The surface appearance is short beam-like structure. In

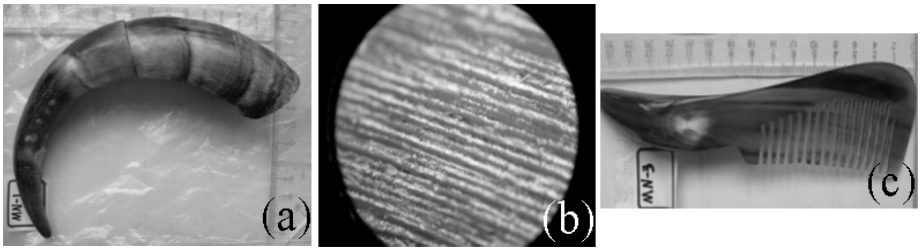

Fig.3 Photographs of (a) yak horn; (b) yak horn and (c) yak horn comb.

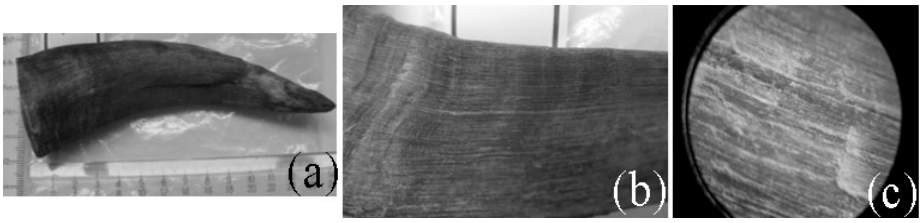

Fig.4 Photographs of (a) goat horn; (b) goat horn's ansa; (c) goat horn

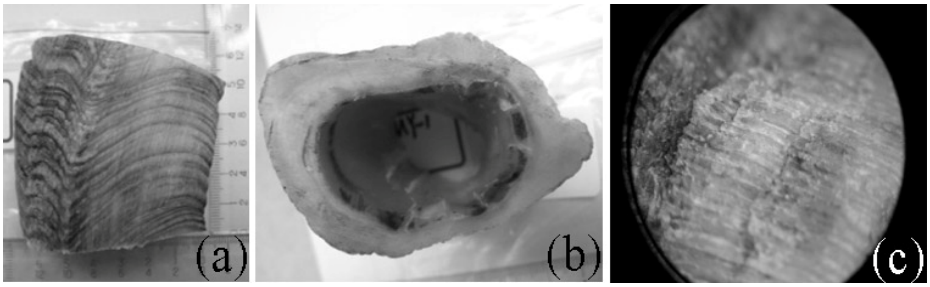

Fig.5 Photographs of (a) sheep horn's orbicular edge; (b) sheep horn's cross section; and (c) sheep horn magnified 40 times.

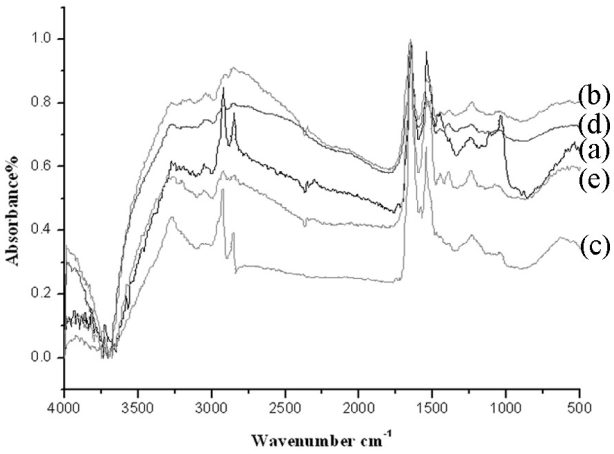

Fig.6 FTIR spectra of (a) rhinoceros horn; (b) cattle horn; (c) yak horn; (d) goat horn;(e) sheep horn.

addition, it has hard texture, and its smell is fishy.

Infrared spectra analysis. The chemical components of rhinoceros horn are made up of amino acids [9], cholesterol, taurine, hexosamine [10], phospholipid [11] and so on.

Amino acid: 1650 cm^{-1} belongs to C=O stretching vibration; 3050 cm^{-1} belongs to N-H stretching vibration.

Cholesterol: 3270 cm^{-1} belongs to O-H stretching vibration; 1540 cm^{-1} belongs to C=C stretching vibration.

Taurine: 1116 cm^{-1} belongs to S=O asymmetric stretching vibration; 1040 cm^{-1} belongs to S=O symmetric stretching vibration; 881 cm^{-1} belongs to S-O stretching vibration. Hexosamine: 1733 cm^{-1} belongs to C=O stretching vibration.

Phospholipids: 2355, 2300 cm^{-1} belongs to P-H stretching vibration; 1240 cm^{-1} double peaks belong to P=O stretching vibration.

Other saturated hydrocarbons: 2920 cm^{-1} belongs to C-H asymmetric stretching vibration; 2850 cm^{-1} belongs to C-H symmetric stretching vibration; 1450 cm^{-1} belongs to C-H bending vibration.

Fig.6(b) and Fig.6(a) respectively show the infrared spectra of cattle horn and rhinoceros horn. The results show that the absorption peaks of the cattle horn's infrared spectrum at 2907 cm^{-1}, 2850 cm^{-1}, 1446 cm^{-1} are obviously weaker than those of the rhinoceros horn, which are respectively C-H asymmetric stretching, C-H symmetric stretching vibration, C-H bending vibration. And the weaker absorption peak intensity means the content of saturation hydrocarbon is lower. The cattle horn's infrared spectrum has only one absorption peak at 2350 cm^{-1}, yet the rhinoceros horn's infrared spectrum has two absorption peaks, which is P-H stretching vibration region of phospholipid; And the absorption peak intensity at1076 $cm^{-1}$of cattle horn is weaker obviously than that of rhinoceros horn, which is the S=O stretching vibration. Furthermore, there is no C=O stretching vibration absorption peaks of hexosamine at 1733 $cm^{-1}$and no S-O stretching vibration peak of taurine at 881 cm^{-1} in the cattle horn's infrared spectrum.

Fig.6(c) shows the infrared spectra of yak horn. The results are as follows: In the yak horn's infrared spectrum, compared to that of rhinoceros horn, there are out-of-plane bending N-H vibration at 634 cm^{-1} of amino acid and NC=O symmetric stretching vibration at 1583 cm^{-1} of amino acids, and there is no P-H stretching vibration absorption peaks of phospholipids at 2350 cm^{-1} and no S-O stretching vibration absorption peaks of taurine at 881 cm^{-1}.

Fig.6(d) shows the infrared spectra of goat horn. The results show that the absorption peaks of the goat horn's infrared spectrum at 2920 cm^{-1}, 2850 cm^{-1}, 2450 cm^{-1} are obviously weaker than those of the rhinoceros horn, which are respectively C-H asymmetric stretching, C-H symmetric stretching vibration, C-H bending vibration. This explains the saturated hydrocarbon content of the goat horn is less. Compared to the rhinoceros horn's infrared spectrum, there is no P-H stretching vibration absorption peaks of phospholipids at 2350 cm^{-1}, no C=O stretching vibration absorption peaks of hexosamine at 1733 cm^{-1} and no S-O stretching vibration absorption peaks of taurine at 881 cm^{-1} in the goat horn's infrared spectrum.

Fig.6(e) shows the infrared spectra of sheep horn. The results show that sheep horn's O-H stretching vibration absorption peaks at 3295 cm^{-1}, 3259 cm^{-1},3206 cm^{-1}, 3060 cm^{-1} are much more than those of rhinoceros horn, meaning sheep horn's cholesterol content is high. Compared Fig.6(a) and Fig.6(b), the sheep horn's infrared spectrum has only one absorption peak at 2352 cm^{-1}, yet the rhinoceros horn's infrared spectrum has two absorption peaks, which is P-H stretching vibration region of phospholipid. What's more, there is no C=O stretching vibration absorption peaks of

hexosamine at 1733 cm^{-1} and no S-O stretching vibration absorption peaks of taurine at 881 cm^{-1} in the sheep horn's infrared spectrum.

Conclusions

The color of rhinoceros horn is very similar to that of its substitutes, such as cattle horn, goat horn and sheep horn, whose color belongs to brownish yellow hue. But the color of yak horn is more special, it is dark grey.

The most significant difference in appearance between rhinoceros horn or its products and its substitutes is the hair-pattern structure, which can be observed carefully with naked eye or through microscope. And only cattle horns and yak horns, including their products, have ring-shaped structure in their cross section. Besides, the textures of the two cavels are entirely different, due to the fact that goat horn has crisp texture while the sheep horn has hard texture.

The infrared spectra of rhinoceros horn is significantly different from that of other horns, which can be used to identify the rhinoceros horn and its substitutes. Three significant differences are as follows: Firstly, the rhinoceros horn has two absorption peaks of P-H stretching vibration of sphingolipid at 2350cm^{-1}, while other horns only have one or no absorption peak in this region. Secondly, compared to other horns, only the rhinoceros horn has absorption peaks of C=O stretching vibration of hexosamine at 1733 cm^{-1}. Thirdly, only the rhinoceros horn has absorption peaks of S-O stretching vibration of taurine at 881 cm^{-1}.

The infrared spectra of yak horn is most closely similar to that of rhinoceros horn. But, compared with that of rhinoceros horn, there are out-of-plane bending N-H vibration at 634 cm^{-1} of amino acid and NC = O symmetric stretching vibration at 1583 cm^{-1} of amino acids, and there is no P-H stretching vibration absorption peaks of phospholipids at 2350 cm^{-1} and no S-O stretching vibration absorption peaks of taurine at 881 cm^{-1} in the yak horn's infrared spectrum.

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