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(54) Title: A METHOD FOR TESTING WHETHER OIL CAN PENETRATE INTO THE HAIR AND ITS PENETRABILITY

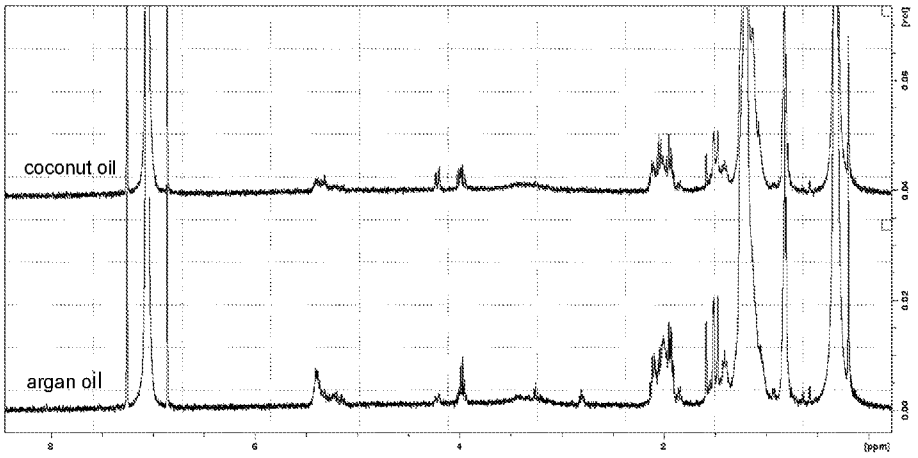

Fig.3

(57) Abstract: A test method, comprising steps of S1: treating blank hair tress 1 with oil a or oil b for no more than 10 minutes; S2: rubbing with surfactant solution, rinsing with water, then drying for further testing; S3: characterizing the organic solvent in which hair tress 1 to be tested has been soaked by ^{1}H NMR spectroscopy, observing whether the obtained ^{1}H NMR spectrum shows a peak at a position for comparison; S4: if no peak appears, proceeding to Step S5; if a peak appears, repeating Step S2 until the ^{1}H NMR spectrum measured in Step S3 shows no peak at the position for comparison; S5: treating blank hair tress 2 with oil a or oil b for at least 10 minutes, and repeating Step S2 and S3; if a peak related to hair tress 2 to be tested appears at the position for comparison, judging that oil a or b can penetrate into the hair; otherwise, the opposite is true. This method is easy, cheap and effective.

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A Method for Testing Whether Oil can Penetrate into the Hair and its Penetrability

Field of the Invention

The present disclosure relates to a test method, and in particular to a method for testing whether oil can penetrate into the hair and its penetrability.

Background of the Invention

Oils, especially vegetable oil, have been widely used in hair care products due to its mildness and unique efficacy. According to studies, vegetable oils can not only adhere to the hair surface, but also penetrate into the hair, lending it double-effect care. Although there have been no conclusive results about whether the penetrability of vegetable oils is a function of molecular weight and structure, those that are mainly composed of C8-C18 fatty acid triglycerides, such as coconut oil, have been theoretically or empirically proven to be able to penetrate into the hair.

However, there are still significant technical difficulties in characterizing whether they have penetrated into the hair, as vegetable oils present on the hair surface can cause significant interference in the analysis. The typical characterization method is time-of-flight secondary ion mass spectrometry ("TOF-SIMS" for short). The method makes use of the secondary ion mass spectra, which are obtained when the surface of the cross sections of hair fibers is bombarded with a positively charged gallium ion beam. By identifying characteristic peaks of a specific vegetable oil in the mass spectra, it can be determined whether or not the vegetable oil has penetrated into the hair. (*J. Cosmet.Sci 52, 169-184, 2001*)

Considering the high cost and cumbersome operation of TOF-SIMS, it is necessary to find a simple yet cost-effective method for testing whether vegetable oils can penetrate into the hair.

Summary of the Invention

In order to overcome the deficiencies of prior arts, the present disclosure provides a new method for testing whether oil can penetrate into the hair, which is cheaper and easier to apply than TOF-SIMS. Compared with other attempts by the inventor, for example, by measuring changes in the diameter of hair fibers through a microscope to

determine whether oil can penetrate into the hair, the new method produces more reliable and effective results. Further, the new method can also be used to show the ability of oil to penetrate into the hair to select oils with strong penetrability and high penetration rates.

As used herein, the term “blank hair tress” refers to a hair tress that is not treated with oils, especially vegetable oil, and can be any hair tress, as long as it is not treated with oil, for example, any hair tress from a male or female in any country or any region at any age. It may also be a healthy hair tress, or a hair tress that has been subject to, for example, mechanical, thermal, chemical and/or environmental damages, or an aged hair tress. The term “treat” include, but are not limited to, “coat” and “soak”. Hair tresses that have been treated with oil for a total of no more than 10 minutes, especially no more than 5 minutes, and then washed with a surfactant solution are also regarded as blank hair tresses in the present disclosure.

As used herein, the wording “capable of dissolving oil” means that the solubility of oil in a solvent at 20°C is greater than 1 g, preferably greater than 5 g, more preferably greater than 10 g. The term “solubility” refers to the maximum mass of a solute that can be dissolved in 100 grams of a solvent at a given temperature.

The present disclosure provides a test method comprising the following steps of

S1: treating blank hair tress 1 with oil a or oil b for no more than 10 min;

S2: rubbing the oil-treated hair tress with a surfactant solution, then rinsing with water, drying for further testing;

S3: characterizing the organic solvent in which hair tress 1 to be tested has been soaked by ^{1}H Nuclear Magnetic Resonance (^{1}H NMR) spectroscopy, observing whether the obtained ^{1}H NMR spectrum shows a peak at a position for comparison that is where the ^{1}H NMR spectrum of the test solvent in which blank hair tress 1 has been soaked shows no peak, but that of the oil a or oil b shows a peak, wherein the organic solvent for soaking hair tress 1 to be tested and the test solvent for ^{1}H NMR spectroscopy are capable of dissolving oil;

S4: if no peak related to hair tress 1 to be tested appears at the position for comparison in the spectrum, proceeding to Step S5; if a peak appears, repeating Step S2 until the ^{1}H NMR spectrum measured in Step S3 shows no peak at the position for comparison before proceeding to Step S5;

S5: treating blank hair tress 2 with oil a or oil b for at least 10 min, followed by the same rubbing and rinsing cycle as in Step S2 repeated the same times as in Step S4, and then characterizing hair tress 2 to be tested by ^{1}H NMR spectroscopy in the same manner as in Step S3; if a peak related to hair tress 2 to be tested appears at the position for comparison, judging that oil a or b can penetrate into the hair; otherwise, the opposite is true.

In the present disclosure, the oil includes natural oils and synthetic oils, and preference is given to natural oils. The natural oils include animal oils and vegetable oils, and preference is given to vegetable oils. The term “vegetable oil” herein refers to oils extracted from the roots, stems, leaves, flowers, fruits or seeds of plants, including but not limited to palm oil, palm kernel oil, coconut oil, olive oil, jojoba oil, argan oil, black cumin oil, bearberry oil, calophyllum oil, shea butter, almond oil, apricot oil, avocado oil, walnut oil, castor oil, corn oil, oat oil, cottonseed oil, rapeseed oil, linseed oil, grape seed oil, pomegranate seed oil, citrus seed oil, wheat germ oil, cashew nut oil, pine nut oil, macadamia oil, peanut oil, soybean oil, sesame oil, sunflower oil, safflower oil and tea tree oil.

In the present disclosure, oil a and oil b are different, wherein the letters a and b have no substantive meaning, and are used for convenience of reference only.

In the present disclosure, blank hair tresses 1 and 2 are of the same source, wherein the numbers 1 and 2 have no substantive meaning, but are used for convenience of reference only. In order to eliminate the impact of the weight of hair tresses on the test results, the weight of blank hair tresses 1 and 2 is supposed to be the same. Blank hair tresses 1 and 2 are preferably washed with a surfactant solution before use to get rid of the dirt from the hair surface, such as dust, dandruff, soot, oil, mineral oil, fatty acids, fatty alcohols. Suitable surfactants are described below.

In the present disclosure, hair tresses 1 and 2 to be tested are treated with oil for different periods of time, and both rubbed, rinsed and dried in exactly the same manner, wherein the numbers 1 and 2 have no substantive meaning, but are used for the convenience of reference only. The hair tresses to be tested obtained by being treated with different oils for the same period of time are all marked with the same reference number. For example, when they are marked as hair tress 1 to be tested, it should be understood that the hair tresses at this time are different depending on the type of oil

used, but they are treated for the same period of time, and rubbed, rinsed and dried in exactly the same manner.

In the present disclosure, the wording “penetrate into the hair” generally means that oil can penetrate into the area in the hair cuticle closing to the hair cortex, or into the hair cortex or medulla, especially into the hair cortex or medulla.

In the present disclosure, the method can be used to test whether oil can penetrate into the hair, and further determine its penetrability into the hair. Specifically, if oil a and b can both penetrate into the hair in Step S5, compare the signal intensity of the peak related to hair tress 2 to be tested treated with oil a with that of the peak related to hair tress 2 to be tested treated with oil b at the position for comparison; if the former is stronger than the latter, it is judged that the ability of oil a to penetrate into the hair is stronger than that of oil b; otherwise, the opposite is true.

In Step S1,blank hair tress 1 is treated for no more than 10 min, for example, no more than 9 min, 8 min, 7 min or 6 min, preferably no more than 5 min, or even no more than 3 min or 1 min.

In Step S2, the surfactant can be those conventionally used in daily chemicals, including anionic, nonionic, amphoteric and cationic surfactants. The surfactant preferably has a HLB value of equal to or greater than 9, such as 9-13, 14-18, 19-25, and 26-40.

Non-limiting examples of suitable surfactants include fatty alcohol sulfates such as sodium lauryl sulfate and triethanolamine lauryl sulfate, fatty alcohol polyoxyethylene ether sulfates such as sodium laureth sulfate and triethanolamine polyoxyethylene fatty alcohol sulfate, sulfosuccinates such as disodium lauryl sulfosuccinate, disodium fatty alcohol polyoxyethylene ether sulfosuccinate and disodium cocoyl monoethanolamide sulfosuccinate, alkenyl sulfonates, N-acyl glutamates, alkyl phosphates, fatty alcohol polyoxyethylene ether phosphates, alkylolamides, fatty alcohol polyoxyethylene ethers, alkylphenol ethoxylates, ethylene oxide-sorbitan monolaurates, betaines such as lauryl dimethyl betaine, cocamidopropyl betaine, hydroiodide betaine, amine oxides such as C12-18 alkyl dimethyl amine oxide, lauramidopropylamine oxide, N-alkyl aminopropionate.

The surfactant solution generally refers to an aqueous solution of a surfactant, having a concentration that is not specifically defined.

In Step S2, in order to better get rid of the oil from the hair surface, it is preferred to wipe the surface of the hair tresses with oil-blotting paper before the hair tresses are rubbed together with the surfactant solution.

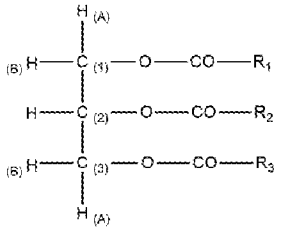
In Step S2, the rinsing water is not particularly specified, and may generally be tap water, deionized water, purified water, or distilled water. There are no special requirements for drying, and it can be air-dried.

In Step S3, the hair tresses to be tested are soaked in the organic solvent for preferably at least 10 min, such as at least 15 min, at least 30 min, at least 45 min, at least 1 h, at least 1.5 h, at least 2 h, at least 2.5 h, or at least 3 h, so that the oil inside the hair is dissolved as much as possible into the organic solvent.

Suitable organic solvents are those having a polar parameter of less than 6, including but not limited to acetone, methyl isobutyl ketone, pyridine, n-propanol, isopropanol, n-butanol, isobutanol, ethyl acetate, butyl acetate, dichloromethane, chloroform, carbon tetrachloride, benzene, toluene, n-pentane, isopentane, n-hexane, cyclohexane, n-heptane, isooctane, trimethylpentane, petroleum ether, ethyl ether, propyl ether and tetrahydrofuran.

The amount of the organic solvent is not particularly limited as long as the hair tresses to be tested can be completely soaked in it. Nevertheless, in order not to have a too low content of the oil dissolved into the organic solvent that results in a weak ^{1}H NMR spectroscopy signal of the subsequent test sample, it is preferable to immerse as many hair tresses to be tested in the organic solvent as possible.

In Step S3, the test solvent selected for ^{1}H NMR spectroscopy should satisfy the following conditions that: (1), it can dissolve the oil; (2), it does not react with the oil; (3), its resonance peak does not interfere with the signal of the oil. When the oil is a vegetable oil, the test solvent is preferably one that causes no peaks to appear at chemical shifts in the ^{1}H NMR spectrum of at least one of $H_{(A)}$ and $H_{(B)}$ bonded to $C_{(1)}$, H bonded to $C_{(2)}$, and $H_{(A)}$ and H_B bonded to $C_{(3)}$, and more preferably one that causes no peaks to appear at chemical shifts in the ^{1}H NMR spectrum of at least one of $H_{(B)}$ bonded to $C_{(1)}$, and $H_{(B)}$ bonded to $C_{(3)}$, as illustrated in the following structural formula (I):



(I)

wherein, the ^1H NMR spectra of $H_{(A)}$ bonded to $C_{(1)}$ and $H_{(A)}$ bonded to $C_{(1)}$ have the same chemical shifts in many cases, and the ^1H NMR spectra of $H_{(B)}$ bonded to $C_{(1)}$ and $H_{(B)}$ bonded to $C_{(3)}$ also have the same chemical shifts in many cases, while the ^1H NMR spectrum of H bonded to $C_{(2)}$ has a different chemical shift from those above.

In order to minimize the interference of hydrogen in the test solvent with the detection of hydrogen in the oil, the test solvent is preferably a deuterated organic solvent, suitably a deuterated organic solvent having a polarity parameter of less than 6, preferably deuterated benzene, deuterated toluene or deuterated chloroform.

In Step S3, the organic solvent used to soak the hair tresses to be tested can be the same as or different from the test solvent used for ^1H NMR spectroscopy. In one embodiment of the present disclosure, the organic solvent is the same as the test solvent, and the organic solvent sample that has been used to soak the hair tresses to be tested is not treated before ^1H NMR spectroscopy. In another embodiment of the present disclosure, the organic solvent is different from the test solvent, and the organic solvent sample that has been used to soak the hair tresses to be tested is first dried to remove the organic solvent, and then is dissolved in the test solvent for ^1H NMR spectroscopy.

In Step S3, the ^1H NMR spectroscopy test conditions for the test solvent that has been used to soak the blank hair tresses and the organic solvent that has been used to soak the hair tresses to be tested, such as magnetic field strength, number of scans, time of sample soaking in test solvent, type of the test solvent, and volume of the test sample, may be the same or different, preferably the same, so as to be free of interference of the blank hair tresses-related signals and other signals when determining whether the oil can penetrate into the hair, especially the hair cortex, and/or the hair medulla.

In Step S4, Step S2 is repeated until the ^1H NMR spectrum measured in Step S3 shows no peak at the position for comparison. In the process, Steps S2 and S3 may be

repeated as one unit until the ^{1}H NMR spectrum shows no peak at the position for comparison, or alternatively, Step S2 may be repeated as one unit for a few times, such as three times or more, and Step S3 is then performed until the ^{1}H NMR spectrum shows no peak at the position for comparison.

In Step S5, blank hair tress 2 is treated for at least 10 min, such as at least 20 min, at least 30 min, at least 1 h, or at least 2 h, preferably at least 3 h, such as at least 5 h, at least 8 h, or at least 12 h.

In Step S5, the wording "followed by the same rubbing and rinsing cycle as in Step S2 repeated for the same times as in Step S4" means: if Step S2 is not repeated in Step S4, hair tress 2 is rubbed and rinsed once according to Step S2; if Step S2 is repeated n times in Step S4, hair tress 2 is rubbed and rinsed n+1 times according to Step S2.

Description of drawings

Fig.1a is the ^{1}H NMR spectrum of a blank hair tress in deuterated benzene; Fig.1b is the ^{1}H NMR spectrum of coconut oil in deuterated benzene; Fig.1c is the ^{1}H NMR spectrum of hair tress 1 to be tested of Example 1 in deuterated benzene; Fig.1d is the ^{1}H NMR spectrum of hair tress 2 to be tested of Example 1 in deuterated benzene.

Fig.2a is the ^{1}H NMR spectrum of argan oil in deuterated benzene; Fig. 2b is the ^{1}H NMR spectrum of hair tress 1 to be tested of Example 2 in deuterated benzene; Fig. 2c is the ^{1}H NMR spectrum of hair tress 2 to be tested of Example 2 in deuterated benzene.

Fig. 3 is the ^{1}H NMR spectra of the hair tresses to be tested that are first treated with coconut oil (top) and argan oil (bottom) in the same manner, and then soaked in deuterated benzene for 3 hours under the same conditions before testing under the same conditions.

Fig. 4a is the ^{1}H NMR spectrum of hair tress 1 to be tested of Comparative Example 1 in deuterated benzene, while Fig. 4b is the ^{1}H NMR spectrum of hair tress 2 to be tested of Comparative Example 1 in deuterated benzene.

Fig. 5 is a schematic diagram of the diameter of hair fibers tested with a microscope at the same position after being treated with coconut oil for 0 h (a), 1 h (b), 2 h (c), and 16 h (d).

Detailed Description of the Preferred Embodiments

The present invention is further illustrated by the following examples, but is not limited to the scope thereof. Any experimental methods with no conditions specified in the following examples are selected according to the conventional methods and conditions, or product specifications.

^{1}H NMR spectroscopy

It was performed using Bruker Ascend™ 400 NMR spectrometer and a BBO 400 MHz S1 5mm Probe with Z-gradient SP.

Microscopy

The test was conducted with Carl Zeiss Axio Scope A1 Polarizing microscope.

The ingredients used in the following Examples and Comparative Examples are all commercially available.

Blank hair tresses 1 and 2: they have not been treated with vegetable oil and are of the same source.

Example 1

A method for testing whether coconut oil can penetrate into the hair was performed by ^{1}H NMR spectroscopy as follows.

S1: 0.5 mL of coconut oil was applied evenly on 2 g of blank hair tress 1 and was left to stand for 1 min.

S2: the coconut oil on the surface of the hair tress was wiped away with oil-blotting paper, then 0.25 mL of an aqueous solution of sodium laureth sulfate (2-3 EO, HLB=30-40) having a concentration of 16 wt% was dropwise added onto the hair tress uniformly, and the hair tress was rubbed for 30s and then rinsed with water for 30 s; the above rubbing and rinsing process was repeated and then the hair tress was subject to air-drying.

S3: 90 mg of hair tress 1 which had been dried in Step S2, was weighed and put into a sample vial containing 3.6 mL of deuterated benzene for soaking for 1 min, 10 min, 1 h, or 3 h, respectively, before taking 0.6 mL of the sample from the vial for ^{1}H NMR spectroscopy, wherein the hair tress to be tested was always completely soaked in deuterated benzene;

90 mg of blank hair tress 1 was weighed and put into a sample vial containing 3.6

mL of deuterated benzene for soaking for 3 h, before taking 0.6 mL of the sample from the vial for ^{1}H NMR spectroscopy,where, the blank hair tress was always completely soaked in deuterated benzene; and

60 mg of coconut oil was weighed and added into a sample vial containing 3.6 mL of deuterated benzene, and after the coconut oil was completely dissolved, 0.6 mL of the sample was taken from the vial for ^{1}H NMR spectroscopy.

S4: the position near 4.2- 4.3 ppm was set as the position for comparison, as it was observed that the ^{1}H NMR spectrum of blank hair tress 1 (Fig. 1a) showed no peak around 4.2-4.3 ppm, while that of coconut oil (Fig. 1b) showed a peak around 4.2-4.3 ppm; and

Step S5 was taken as the next step, as it was observed that the ^{1}H NMR spectrum of hair tress 1 to be tested (Fig. 1c) showed no peak at the position for comparison.

S5: 0.5 mL of coconut oil was applied on 2 g of blank hair tress 2 and was left to stand for 12 h; the coconut oil on the surface of the hair tress was wiped away with oil-blotting paper, then the hair tress 2 was rubbed and rinsed twice in the same manner as in Step S2 followed by air-drying, and then hair tress 2 to be tested was characterized by^{1}H NMR spectroscopy in the same manner as in Step S3; and finally

it was determined that coconut oil can penetrate into the hair, as it was observed that the ^{1}H NMR spectrum of hair tress 2 to be tested (Fig. 1d) showed a peak at the position for comparison.

In this example, hair tresses 1 and 2 to be tested were all treated with coconut oil. However, no signals of coconut oil was detected for hair tress 1 to be tested, while the opposite is true for hair tress 2 to be tested. Due to the short period of time of treating hair tress 1 to be tested with coconut oil, the coconut oil only adhered to the hair surface, without penetrating into the hair, and was then cleaned away by the sodium laureth sulfate in Step S2, so no signals of coconut oil was detected. However, the duration of treating hair tress 2 to be tested with coconut oil was long enough for the oil to not only adhere to the hair surface, but also penetrate into the hair. Although the sodium laureth sulfate in Step S5 cleaned the coconut oil from the hair surface, but failed to get rid of what had penetrated into the hair. The coconut oil inside the hair was then dissolved into the deuterated benzene, so the signal of coconut oil was detected.

Example 2

A method for testing whether argon oil can penetrate into the hair by ^{1}H NMR spectroscopy.

The method of this Example had the same steps as that in Example 1, except that coconut oil was replaced with argan oil.

It was observed that the ^{1}H NMR spectrum of argan oil (Fig 2a) showed a peak around 4.2-4.3 ppm, while that of blank hair tress 1 (Fig.1a) showed no peak around 4.2-4.3 ppm, so the position near 4.2-4.3 ppm was set as the position for comparison; and the ^{1}H NMR spectrum of hair tress 1 to be tested (Fig. 2b) showed no peak at the position for comparison, while that of hair tress 2 to be tested (Fig. 2c) showed a peak at the position for comparison, so it was determined that argan oil can penetrate into the hair.

Example 3

A method for testing the penetrability of coconut oil and argan oil by ^{1}H NMR spectroscopy.

The coconut oil of Example 1 and the argan oil of Example 2 were both determined to be able to penetrate into the hair, wherein hair tress 2 to be tested was treated with coconut oil or argan oil in the same manner and tested using ^{1}H NMR spectroscopy under the same conditions. Comparing the signal intensity of the peak related to hair tress 2 to be tested of Example 1 with that of the peak related to hair tresses 2 to be tested of Example 2, after being soaked in deuterated benzene (Fig. 3) for 3 hours, it is concluded that the ability of the coconut oil to penetrate into the hair is greater than that of argan oil.

Comparative Example 1

It was the same as Example 1, except that the following operations in Steps S2 and S5 were different. After the coconut oil on the surface of hair tresses 1 and 2 was wiped away with oil-blotting paper, hair tresses 1 and 2 were immersed respectively in 10 mL of toluene for 1 min, the toluene on the hair surface was blotted with oil-blotting paper, and then the hair tresses were put respectively into 10 mL of toluene to wash for 30 s before transferring them to a fume hood for air-drying.

It was observed that both the ^{1}H NMR spectrum of hair tress 1 to be tested (Fig. 4a) and hair tress 2 to be tested (Fig. 4b) in Step S3 showed a peak at the position for comparison. The reason was that in Step S2 toluene failed to clean the coconut oil from the hair surface so that the coconut oil on the surface of hair tresses 1 and 2 to be tested and the coconut oil inside hair tress 2 were all dissolved into the deuterated benzene leading to detected signals of coconut oil.

Comparative Example 2

A method for testing whether coconut oil can penetrate into the hair was performed with a microscope as follows.

S1: three blank hair fibers of the same source were respectively fixed on microscope slides and their initial diameter were measured with a microscope in transmission mode.

S2: the three blank hair fibers were soaked in coconut oil for 1 h, 2 h and 16 h, respectively, and then were observed in the same mode to get their diameter at the same position as measured in Step S1.

S3: the hair diameter measured in Step S2 was compared with the initial diameter measured in Step S1; if it is observed that the diameter of the hair fibers after treatment with coconut oil for different periods of time is greater than the initial diameter, it is determined that the coconut oil can penetrate into the hair; otherwise, the opposite is true.

The specific test results were shown in Fig. 5, from which it is not observed that the diameter of the hair fibers after treatment with coconut oil for different periods of time was significantly larger than the initial diameter. In theory, coconut oil can not only adhere to the hair surface, but also penetrate into the hair. After being treated with coconut oil for different periods of time, the diameter of hair will become larger due to swelling. However, in practice, it is not feasible to judge whether coconut oil can penetrate into the hair by measuring the hair diameter with a microscope.

Claims

1. A test method comprising the following steps of

S1: treating blank hair tress 1 with oil a or oil b for no more than 10 min;

S2: rubbing the oil-treated hair tress with a surfactant solution, then rinsing with water, drying for further testing;

S3: characterizing the organic solvent in which hair tress 1 to be tested has been soaked by ^{1}H NMR spectroscopy, observing whether the obtained ^{1}H NMR spectrum shows a peak at a position for comparison that is where the ^{1}H NMR spectrum of the test solvent in which blank hair tress 1 has been soaked shows no peak, but that of the oil a or oil b shows a peak, wherein the organic solvent for soaking hair tress 1 to be tested and the test solvent for ^{1}H NMR spectroscopy are capable of dissolving oil;

S4: if no peak related to hair tress 1 to be tested appears at the position for comparison in the spectrum, proceeding to Step S5; if a peak appears, repeating Step S2 until the ^{1}H NMR spectrum measured in Step S3 shows no peak at the position for comparison before proceeding to Step S5;

S5: treating blank hair tress 2 with oil a or oil b for at least 10 min, followed by the same rubbing and rinsing cycle as in Step S2 repeated the same times as in Step S4, and then characterizing hair tress 2 to be tested by ^{1}H NMR spectroscopy in the same manner as in Step S3; if a peak related to hair tress 2 to be tested appears at the position for comparison, judging that oil a or b can penetrate into the hair; otherwise, the opposite is true.

2. The method of Claim 1, characterized in that in Step S5 if oil a and b can both penetrate into the hair, compare the signal intensity of the peak related to hair tress 2 to be tested treated with oil a with that of the peak related to hair tress 2 to be tested treated with oil b at the position for comparison; if the former is stronger than the latter, it is judged that the ability of oil a to penetrate into the hair is stronger than that of oil b; otherwise, the opposite is true.

3. The method of Claim 1 or 2, characterized in that said penetrating into the hair is penetrating into the hair cortex and/or medulla.

4. The method of any one of Claims 1 to 3, characterized in that said oil is natural oil.

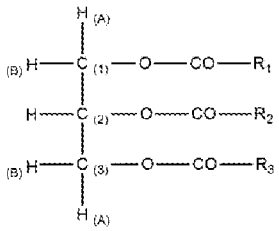
5. The method of any one of Claims 1 to 4, characterized in that in Step S1 blank

hair tress 1 is treated for no more than 5 min.

6. The method of any one of Claims 1 to 5, characterized in that in Step S3 the hair tresses to be tested are soaked in the organic solvent for at least 10 min.

7. The method of any one of Claims 1 to 6, characterized in that in Step S5 blank hair tress 2 is treated for at least 3 h.

8. The method of any one of Claims 4 to 7, characterized in that said test solvent is one that causes no peaks to appear at chemical shifts in the ^{1}H NMR spectrum of at least one of $H_{(A)}$ and $H_{(B)}$ bonded to $C_{(1)}$, H bonded to $C_{(2)}$, and $H_{(A)}$ and H_B bonded to $C_{(3)}$, as illustrated in the following structural formula (I):



(I).

9. The method of Claim 8, characterized in that said test solvent is one that causes no peaks to appear at chemical shifts in the ^{1}H NMR spectrum of $H_{(B)}$ bonded to $C_{(1)}$ or $H_{(B)}$ bonded to $C_{(3)}$, as illustrated in the structural formula (I).

10. The method of any one of Claims 1 to 9, characterized in that said organic solvent is the same as said test solvent, and the organic solvent sample that has been used to soak the hair tresses to be tested is not treated before ^{1}H NMR spectroscopy.

11. The method of any one of Claims 1 to 9, characterized in that said organic solvent is different from said test solvent, and the organic solvent sample that has been used to soak the hair tresses to be tested is first dried to remove the organic solvent, and then is dissolved in the test solvent for ^{1}H NMR spectroscopy.

12. The method of any one of Claims 1 to 11, characterized in that said test solvent is a deuterated organic solvent having a polarity parameter of less than 6.

13. The method of any one of Claims 1 to 12, characterized in that said deuterated organic solvent is selected from deuterated benzene, deuterated toluene and deuterated chloroform.

14. The method of any one of Claims 1 to 13, characterized in that said surfactant has a HLB value of equal to or greater than 9.

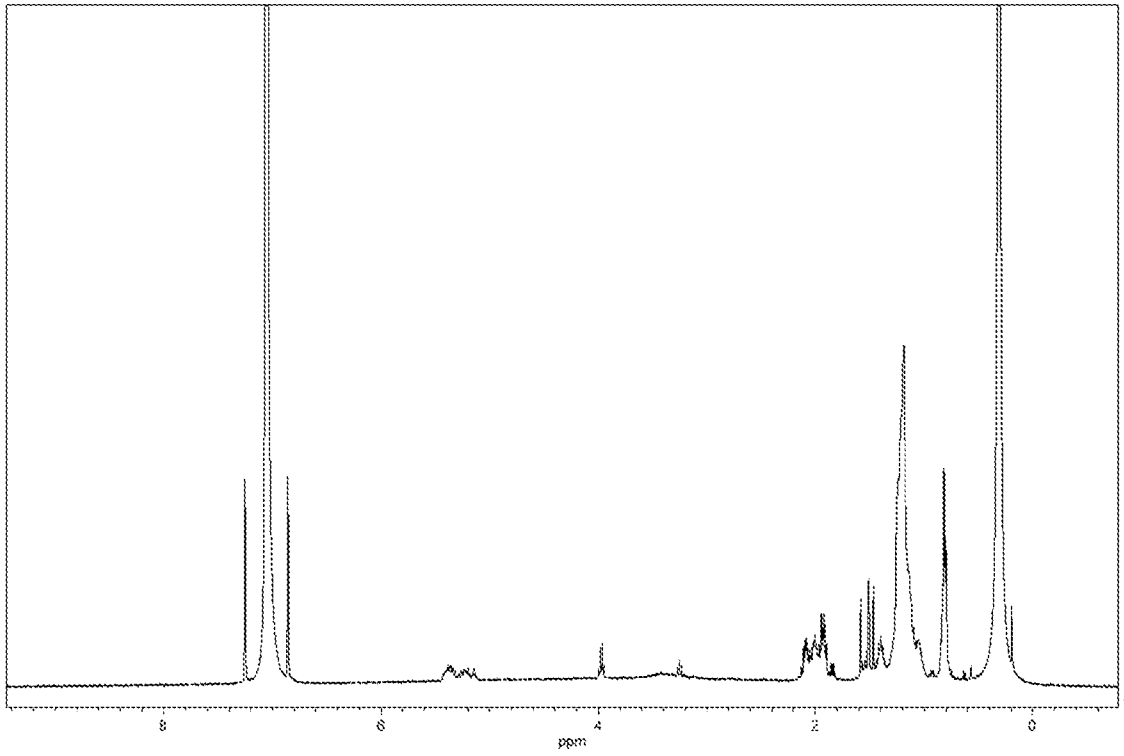


Fig.1a

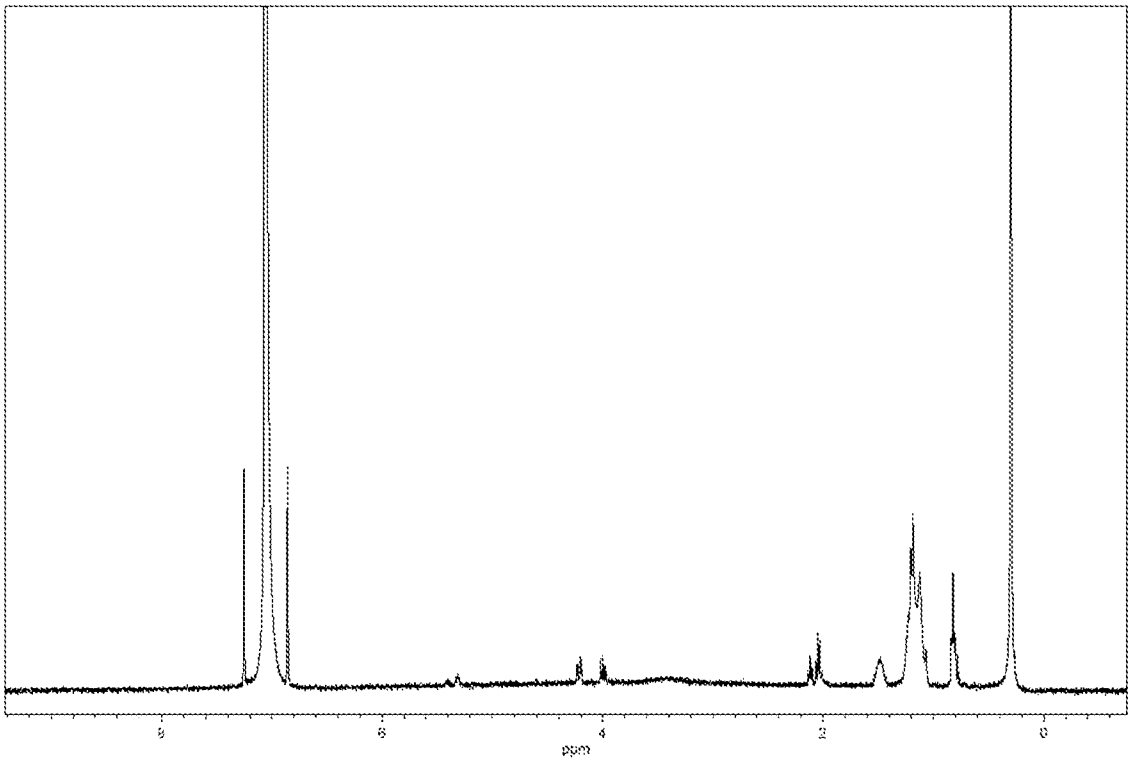


Fig.1b

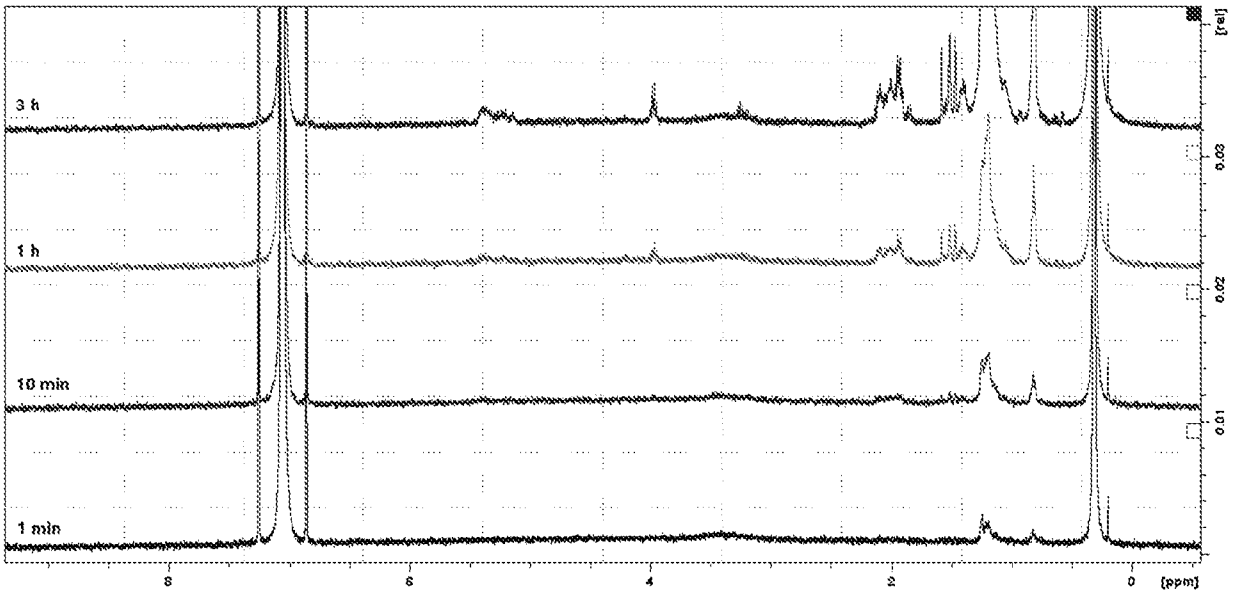


Fig.1c

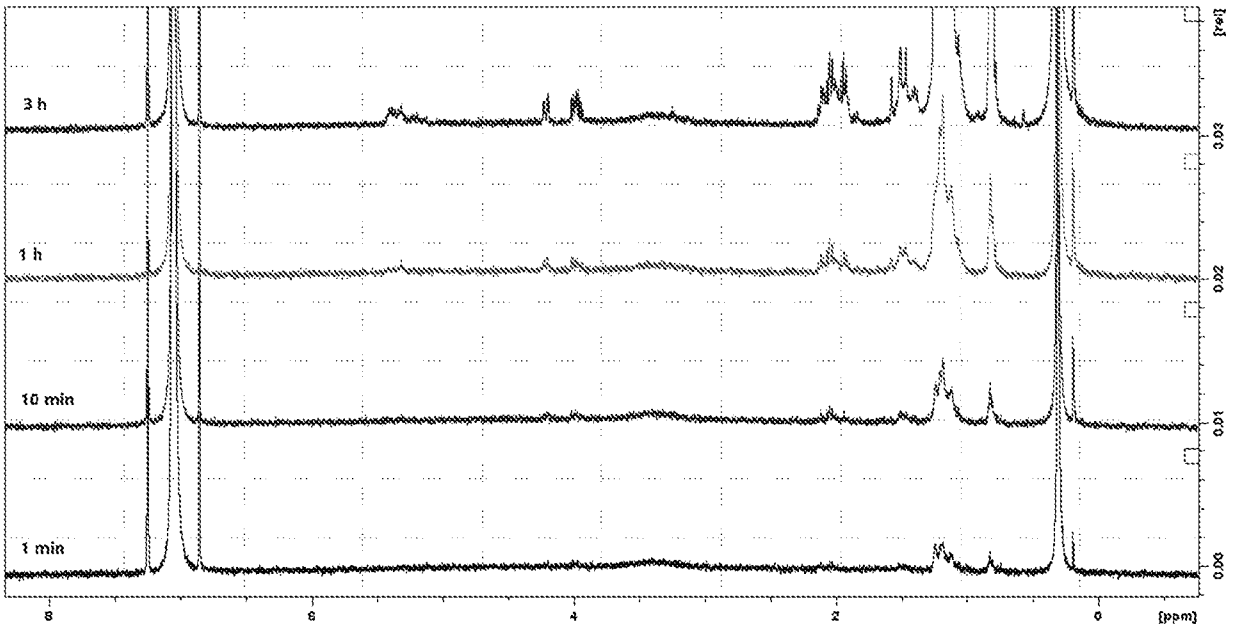


Fig.1d

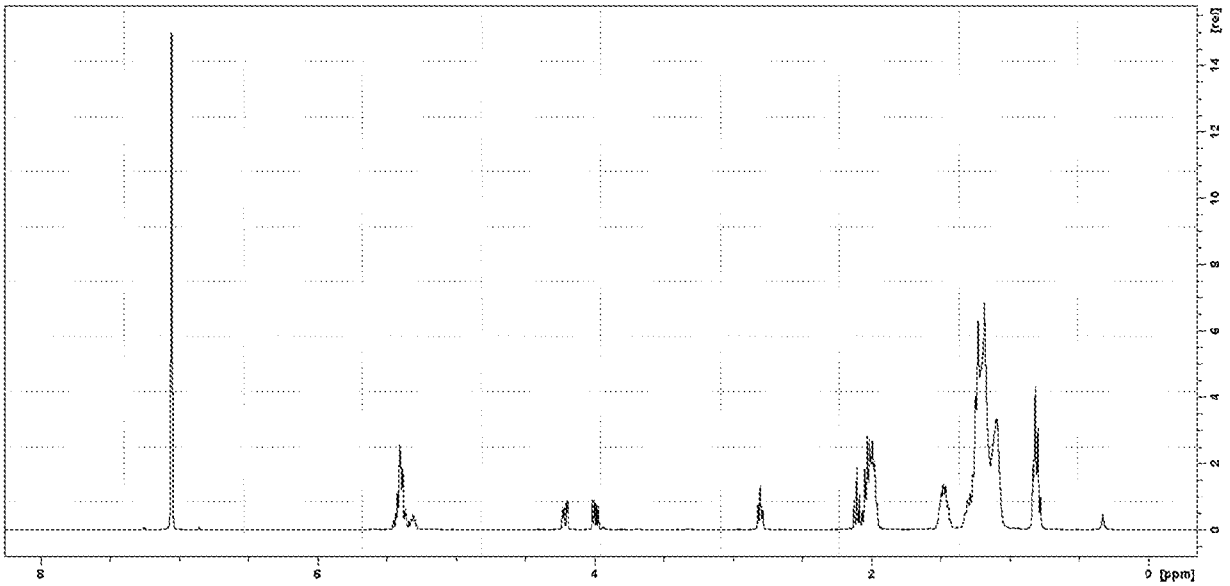


Fig.2a

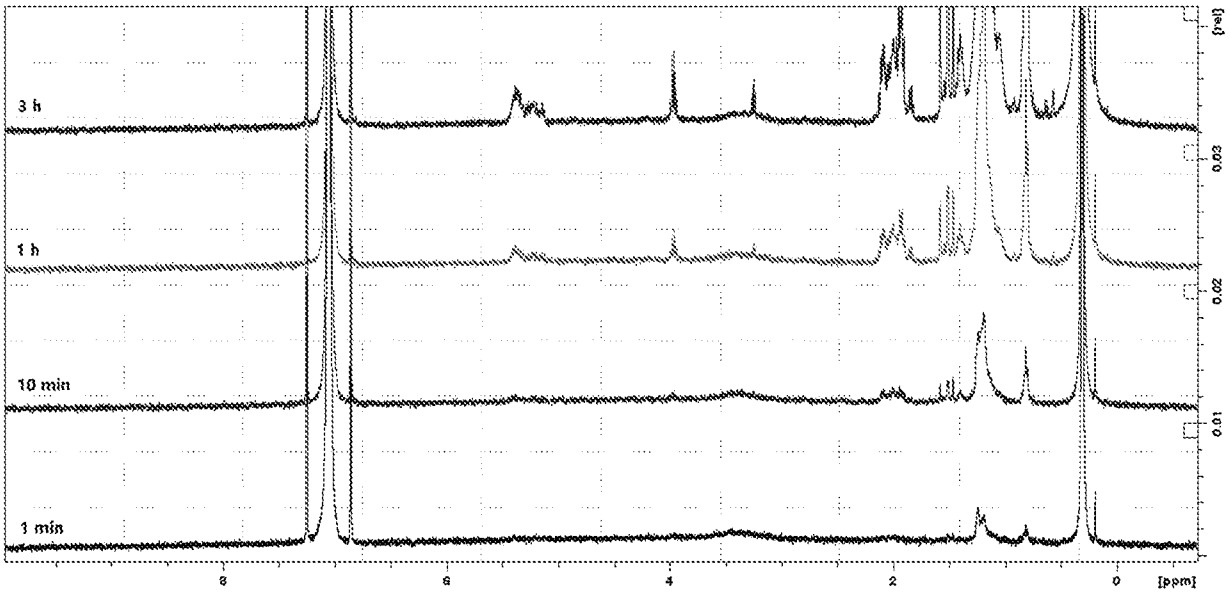


Fig.2b

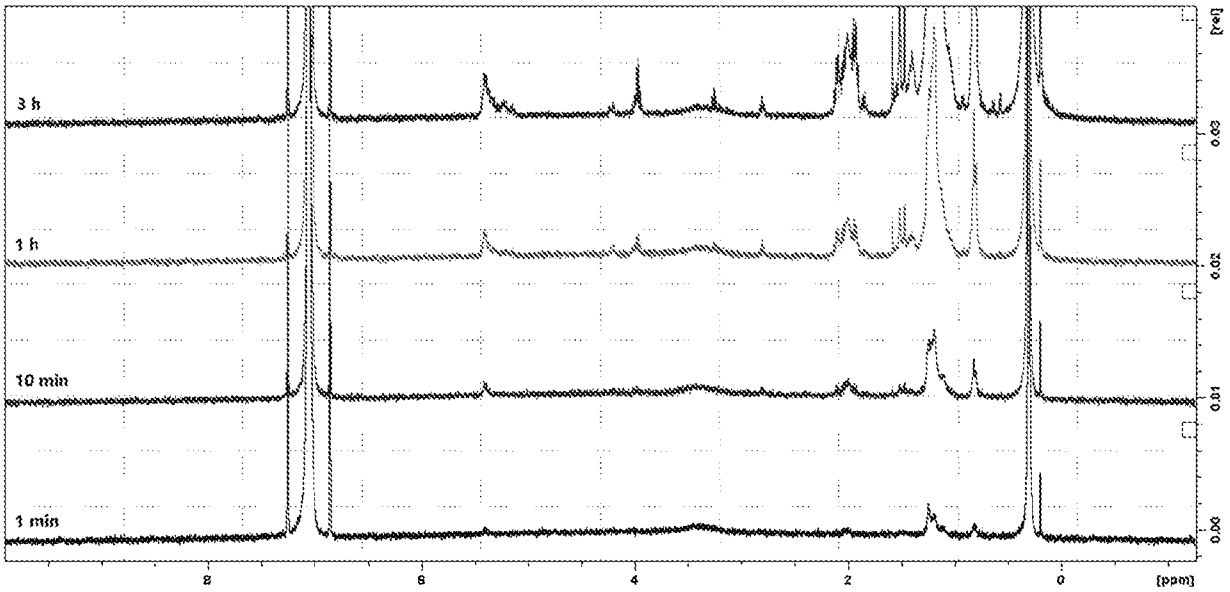

3 h
1 h
10 min
1 min
8
6
4
2
0
[ppm]
[rel]

Fig.2c

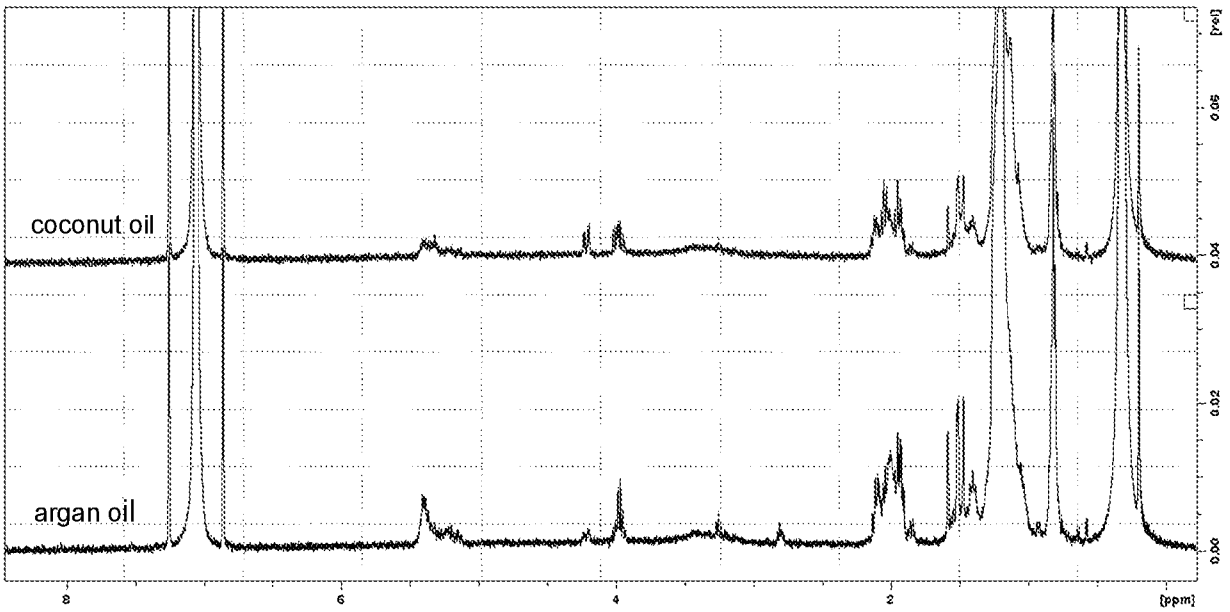
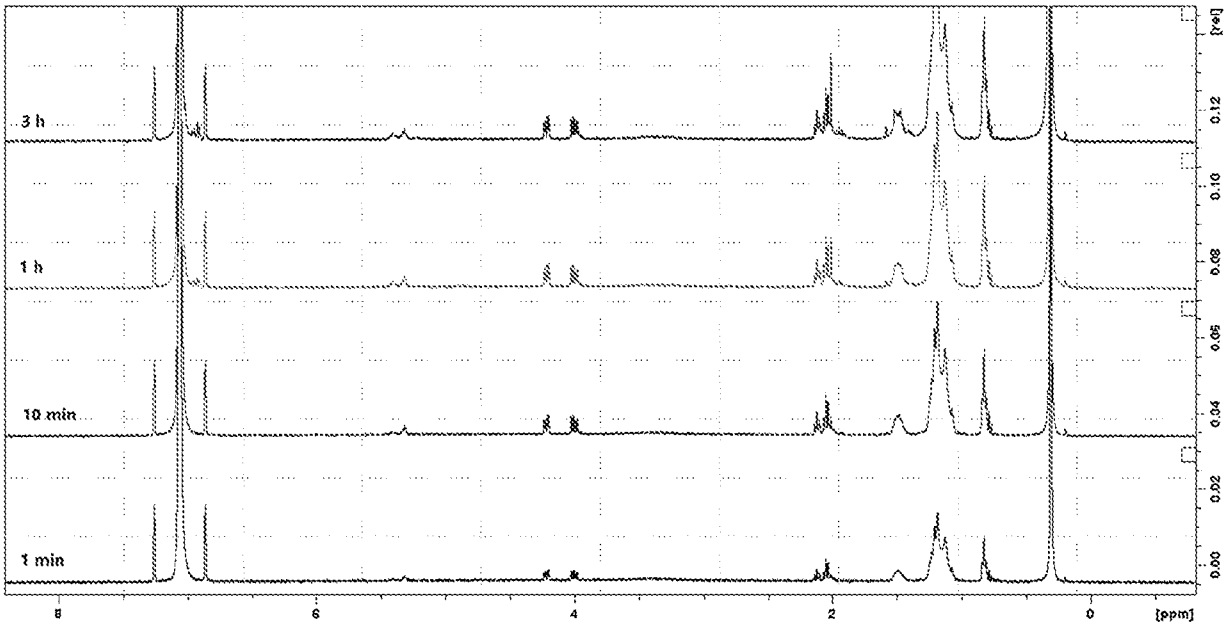

coconut oil
argan oil
8
6
4
2
[ppm]
[rel]

Fig.3


3 h
1 h
10 min
1 min
8
6
4
2
0
[ppm]
[rel]
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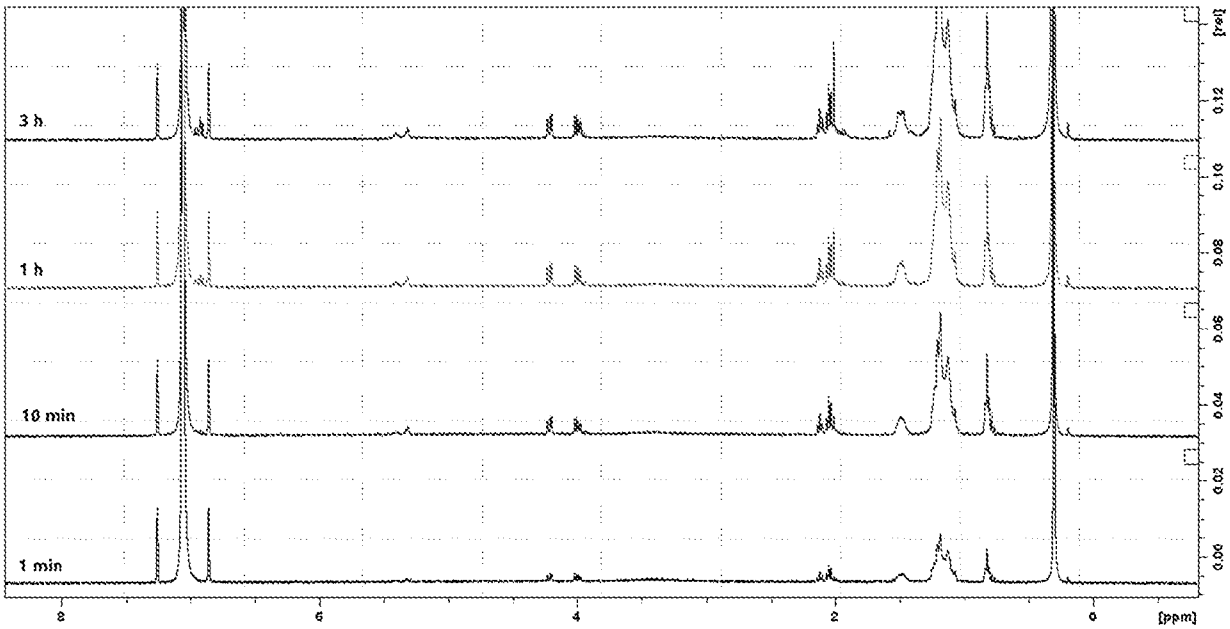
0.10
0.08
0.06
0.04
0.02
0.00

Fig.4a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1 h
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1 min
8
6
4
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[rel]
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0.04
0.02
0.00

Fig.4b

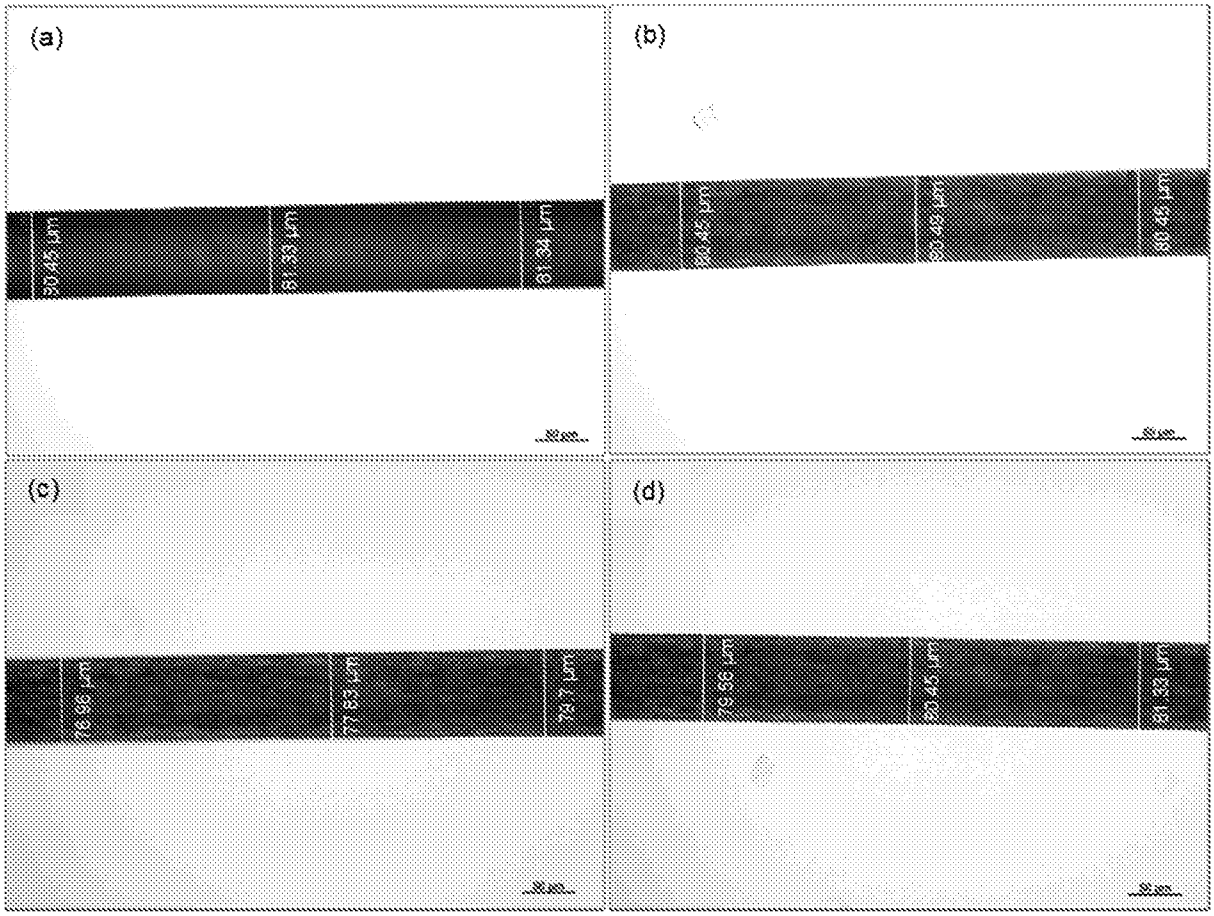

Fig.5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/079040

A. CLASSIFICATION OF SUBJECT MATTER

G01N 24/08(2006.01)i; A61Q 5/12(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01N24/-,A61Q5/-

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT,CNKI,WPI,EPODOC: hair, oil, solution, solvent, water, H NMR, spectr+, peak, penetrate, absorb, soak, magnet+, resonance, nuclear, organic, test, measure

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 102901745 A (UNIV. XIAMEN) 30 January 2013 (2013-01-30) description, paragraphs [0040]-[0052] and figures 1-5	1-14
A	CN 108760791 A (UNIV. NANCHANG) 06 November 2018 (2018-11-06) the whole document	1-14
A	CN 103487455 A (UNIV. SHANGHAI) 01 January 2014 (2014-01-01) the whole document	1-14
A	US 2015315454 A1 (RACIONAL ENERGY AND ENVIRONMENT COMPANY) 05 November 2015 (2015-11-05) the whole document	1-14
A	US 4866983 A (SHELL OIL COMPANY) 19 September 1989 (1989-09-19) the whole document	1-14
A	US 6436715 B1 (DEGUSSA HULS AG.) 20 August 2002 (2002-08-20) the whole document	1-14
A	CN 104757938 A (CHANGCHUN OPTICS FINE MECH.) 08 July 2015 (2015-07-08) the whole document	1-14

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 December 2019	**19 December 2019**
Name and mailing address of the ISA/CN **National Intellectual Property Administration, PRC** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing** **100088** **China**	Authorized officer **HU,Jinyun**
Facsimile No. **(86-10)62019451**	Telephone No. **86-(10)-53962452**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2019/079040

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	CN 101516322 A (PROCTER & GAMBLE) 26 August 2009 (2009-08-26) the whole document	1-14

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2019/079040

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CN 108760791 A	06 November 2018	None	
CN 103487455 A	01 January 2014	CN 103487455 B	27 April 2016
US 2015315454 A1	05 November 2015	US 9334436 B2	10 May 2016
US 4866983 A	19 September 1989	None	
US 6436715 B1	20 August 2002	EP 1065514 A2	03 January 2001
		JP 2001056366 A	27 February 2001
		KR 20010015114 A	26 February 2001
		DE 19930141 A1	18 January 2001
		EP 1065514 B1	21 November 2001
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		US 2008256724 A1	23 October 2008
		US 7591861 B2	22 September 2009
		WO 2008033390 A2	20 March 2008
		JP 2010502721 A	28 January 2010
		EP 1902703 A2	26 March 2008
		EP 2092932 A2	26 August 2009