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Development of Multifunctional Upcycling Biochar for Removing Skin Foreign Substances and Delivering Active Ingredients

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Introduction

In the cosmetic industry, interest in eco-friendly scrub materials that can replace microplastics that cause environmental problems is increasing.

Charcoal used in cosmetics as a material that can replace microplastics in scrubs is a problem of environmental damage caused by logging and a problem of causing side effects on sensitive skin due to the dense and hard charcoal structure.

The word biochar can be defined as a compound word of biomass and charcoal, and is a carbonaceous material produced by the pyrolysis of biomass under anaerobic conditions. Biochar, a carbon material that can replace charcoal, has insufficient research on the application of cosmetic products and skin efficacy. We investigated to develop biochar as an upcycling material using technology that is not used in the cosmetic industry.

Materials and Methods

Biochar production

DK-1015(E) was used as the biochar manufacturing device, and nitrogen gas was injected into the chamber to make the internal environment of the manufacturing device anaerobic. The temperature increase for thermal decomposition was performed by a low-speed pyrolysis method, and carbonization was carried out at 800° C for 5 hours.

Specific surface area measurement

The surface area per unit weight of the sample was measured using 3flex, which is a specific surface area measuring device.

Oil absorption test

After mixing the biochar with linseed oil or artificial sebum little by little, ml/g was calculated until it became a paste.

Production of oil-containing biochar

After mixing biochar with oil, centrifugation and filtration were performed to obtain biochar on which oil was adsorbed.

Clinical evaluation

The effects of cleansing foam containing biochar for cleaning fine dust or makeup, improving skin moisture, and improving gloss were evaluated.

Results and Discussion

Characteristics of biochar

Biochar production increased the carbon content and specific surface area, and developed the microstructure of the surface(Figure 1A). The specific surface area increased to 398.8 m2/g for *Camellia japonica* seed shell biochar and 388.7 m2/g for *Torreya nucifera* seed shell biochar. Also, The results of XPS and XRD analysis indicate that the carbon binder of biochar increased(Figure 1B).

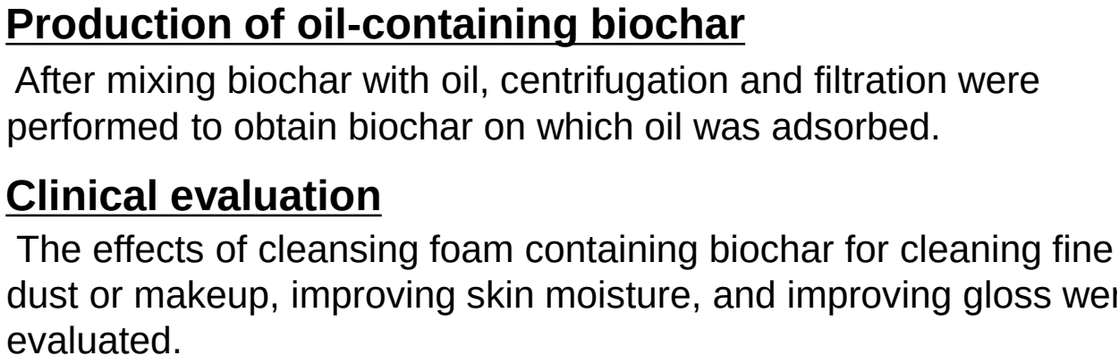


Figure 1. Characteristics of biochar.
(A) Elemental composition and specific surface area of biochar
(B) Carbon bond structure of biochar.

Results and Discussion

Oil absorption test

The increase in specific surface area and porous structure generated through pyrolysis and activation process increased oil absorption capacity and artificial sebum oil absorption capacity (Figure 2).

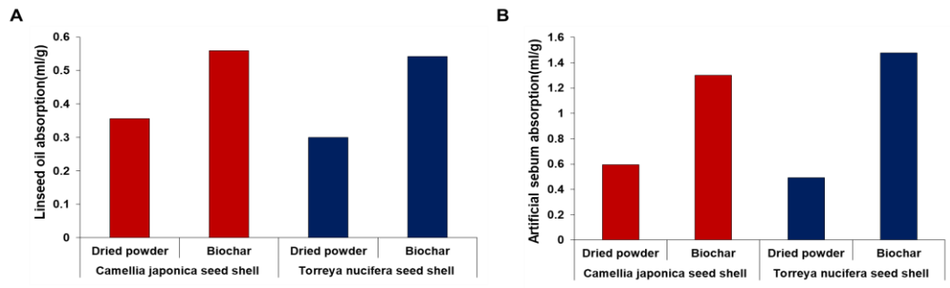


Figure 2. Oil absorption of biochar. (A) Linseed oil absorption (B) Artificial sebum oil absorption

Evaluation of cleaning effect

The excellent cleaning effect was shown through the porous structure of biochar(Figure 3).

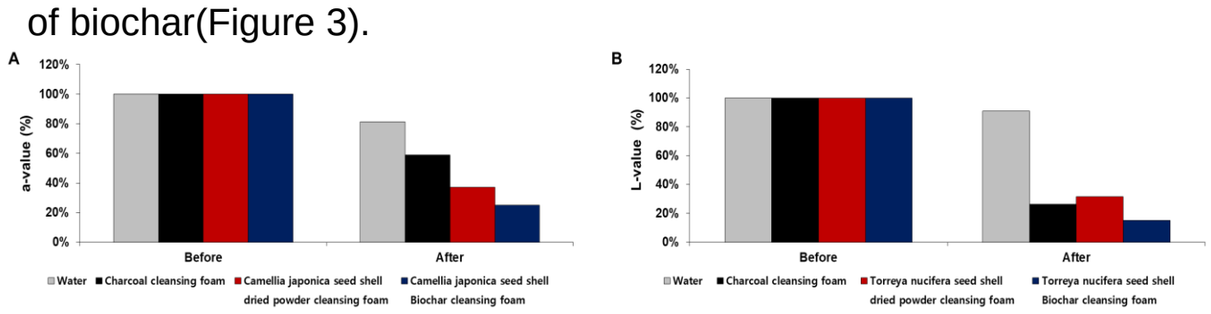
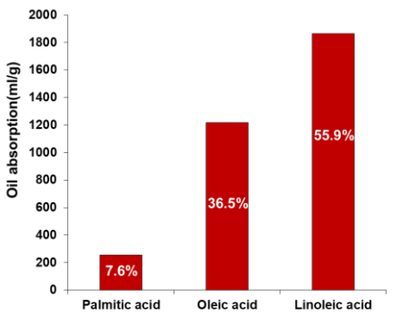


Figure 3. Evaluation of cleaning effect. (A) Makeup product cleaning evaluation (B) Carbon black cleaning evaluation.

Oil content of oil-containing biochar



As a result of adsorption of oil into *Torreya nucifera* seed shell biochar, palmic acid, oleic acid, and linoleic acid were contained in the biochar at 225mg/g, 1218mg/g, and 1865mg/g, respectively(Figure 4).

Figure 4. Oil content in biochar

Clinical evaluation of oil-containing biochar

Compared with biochar before adsorption, biochar containing *Camellia japonica* seed oil or *Torreya nucifera* seed oil increased skin moisture by 19.2% and 26.5%, respectively (Figure 5). Skin gloss was also increased by 52.5% and 104.7%, respectively (Figure 6).

These results indicate that the oil component contained in biochar has a positive effect on skin moisutrizing and glossiness.

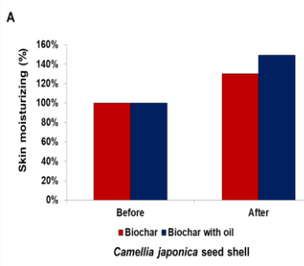


Figure 5. The skin moisturizing effect

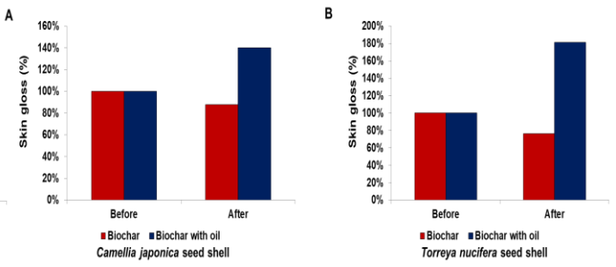


Figure 6. The skin gloss effect

Conclusions

The development of biochar as a cosmetic material is an upcycling technology, and it is a biotransfer technology that effectively removes foreign substances such as fine dust, sebum, and makeup, and delivers active ingredients to the skin to give moisture and gloss to healthy skin. These results indicate that it is an innovative technology and multifunctional cosmetic material that is rarely used in the cosmetic industry. Also, it is expected that the production of biochar using these by-products and residues will have a positive environmental, economic, and social impact.