

A Literature Review on Indigowoad Root Hydrogel Development for Skincare

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Indigowoad Root is traditional Chinese medicine. It belongs to the “cool blood herb” category which has been used for anti-inflammatory and anti-infections situations regarding the Yin-Yang theory. Hydrogel is one of the biomaterials for drug delivery that provided a large surface area and permeability, enhanced the characteristics of solubility and absorption of traditional Chinese medicine, for example, curcumin. Based on the pieces of evidence, these might have some possible methods for the synthesis of Indigowoad Root hydrogel on skincare in the future (Figure 1).

Keywords: Indigowoad Root; Traditional Chinese medicine; Hydrogel; Skincare.

Indigowoad Root belongs to the “*Brassicaceae*” family and is derived from the roots of *Isatisindigotica Fort.* This is a flowering plant and produced in the various provinces of Henan, Hebei, Anhui, Jiangsu, and northeastern China. Woad Root is classified as a “cool blood herb” category in traditional Chinese medicine. In the theory of *Yin-Yang*, the nature of Woad Root is “cool” (*Yin*). Its function to eliminate too much “Internal heat” inside the body for people (remove excess of *Yang*). This has strong antibacterial and antiviral properties to clear inflammatory and infectious conditions. According to the traditional Chinese theory, Woad Root regulates the

movements of “*Qi*” and body fluids also restores the internal energy via the stomach and liver meridians to balance the body performances.¹

Hydrogel is one of the biomaterials for drug delivery that has a 3D dimensional cross-linked network polymer capable of absorbing and retaining a large number of water contents because of the presence in hydrophilic groups such as -NH₂, -COOH, -OH, -CONH₂, -CONH-, and -SO₃H.² It is synthesized from natural or synthetic polymers, protein polymers such as collagen, elastin, and polysaccharide polymers like glycosaminoglycans or alginate through chemical or physical methods.³ Hydrogels have several advantages consist

of biocompatibility potential, hydrophilicity, controlled drug release, smart drug delivery, and lower toxicity.⁴ In the present article, we would like to propose the development of Indigowoad Root hydrogel on skincare and discuss its possibility according to previous human clinical studies from literature reviews.

Pharmaceutical properties of Indigowoad Root

Indigowoad Root has antibacterial and antiviral properties contributing to the function of anti-inflammatory and anti-infectious. It should better be applied to the hydrogel delivery system to further provide a large surface area and permeability, enhance the characteristics of solubility and absorption between the hydrogel and Indigowoad Root itself. Up to the present, there is only a little literature published relating to the Indigowoad Root hydrogel. That is only focusing on the Indigowoad Root antibacterial or antiviral and anti-inflammatory properties including:

Huang CY *et al.* reported the Indigowoad Root was high in phenolic compound contents possessed antimicrobial activity against *Staphylococcus aureus* and *Pseudomonas aeruginosa* in the infected epithelial tissue. These antimicrobial activity tests were determined by Minimal Inhibitory Concentration (MIC) and the disk diffusion methods. MIC was the lowest concentration of an antimicrobial agent that inhibited the visible growth of the microorganism. However, the disk diffusion method was a measurement of the ring diameter that formed around a colony after treatment. The size of the ring indicated the degree of antimicrobial activity. *Staphylococcus aureus* and *Pseudomonas aeruginosa* were obtained from the Bioresource Collection and Research Center (BCRC) of the Food Industry Research and Development Institute (FIRDI), Hsinchu, Taiwan. The procedures for culturing the nutrient agar plates were incubated at 37°C for 16-24h. The inoculum for each strain was adjusted by using the 0.5 McFarland standard for visual comparison obtaining a suspension density equivalent to around 1.5×10^8 CFU mL⁻¹ then measured using a UV spectrophotometer at 600 nm wavelength. The disk diffusion method for the zone inhibition of an Indigowoad Root in *Staphylococcus aureus* and *Pseudomonas aeruginosa* were 25 mm and 9 mm, and the MIC of *Staphylococcus aureus* and *Pseudomonas*

aeruginosa were 2.5 mg mL⁻¹ and 10 mg mL⁻¹ respectively.⁵

Clinical study of Indigowoad Root on the skin

In 2009, Wu *et al.* identified Indigowoad Root as a medicament for treating verruca plana with the usage of *Sangusorbae Radix*, *Caulis Cucumidis sativiv*, *Angelicae Dahuricae Radix*, *Flos Carthami*, *Glycyrrhizae Radix*, *Arnebiae (Lithospermi) Radix*, *Portulacae Herba*, *Cortex Phellodendri*, *Houttuyniae Herba*, *Sophorae Flavescentis Radix*, *Cortex Dictamni*, *Folium Artemisia Argyi*, *Molluginis Pentaphyllae Herba*, *Fructus Kochiae* and *Schizonepetae Herba*. Indigowoad Root function was to clear and remove heat from the blood for preventing swollen skin ulcers. This medication was carried in the 80 patients' human clinical trials including 42 males and 38 women. Patients were being taken one course of treatment when the symptoms alleviate appear. Symptoms would be disappeared such as reduce redness and spots after 3 courses of treatment taken, then become fully recovered. The effective rate ranged from 85.96% to 96.52%.⁶

Patent of Indigowoad Root

Psoriasis is an inflammatory skin disorder that causes skin cells to multiply up to 10 times faster than normal and makes the skin build up into bumpy red patches covered with white scales. Sun W *et al.* discovered that Indigowoad Root was used to treat psoriasis disease in a Chinese herbal medicine (CHM) formulation. This formulation comprised of *Smilacis glabrae rhizoma*, *Folium isatidis*, *Angelica sinensis*, *Hedyotis diffusa*, Sichuan lovage rhizome, Plantain herb, *Fructus kochiae*, Chinese lobelia, *Nidus vespae*, *Rhizoma alismatis*, *Cortex dictamni* and *Glycyrrhizae radix* which provided by The First Affiliated Hospital of Guangzhou University in China.⁷

The Chinese herbal medicine (CHM) formulation inhibited the Vitamin D receptor (VDR) mediated nuclear NF-κB and STAT signaling pathways by decreased the concentrations of TNF-α, IFN-γ, IL-22, IL-17C, IL-1β, IL-4, and increased the concentration of 25-hydroxyvitamin D3 (25HVD3) to suppress the TNF-α inflammatory response against the skin. These experiments were studied in the HaCaT cells model from low to high dosage of Chinese herbal medicine (CHM) formulation. Its Chinese herbal medicine (CHM) formulation had been proved as non-toxic and

non-stimulated which was used over a long time in China and around 2% of patients received similar therapy in the USA.⁸

Possible methods for the synthesis of Indigowoad Root hydrogel

Indigowoad Root is possible to synthesize the hydrogel on skincare. The synthetic method is similar to a common traditional Chinese medicine, "Curcumin hydrogel". There are several published papers for evidence such as:

Kamel NA *et al.* reported the hydrogel system obtained from curcumin-loaded polyvinyl alcohol (PVA), chitosan (Cs), and PVA/Cs blend (50:50). There was no toxic effect on the wound dressing and it had an excellent antimicrobial activity when the concentration of curcumin increased from PVA/cur nanocomposite.⁹

Shefa AA *et al.* discovered a hydrogel system that incorporated curcumin and gelled with polyvinyl alcohol (PVA) attached to the TEMPO-oxidized cellulose nanofiber (TOCN). It was effective for the wound healing processed because of 1,929 fibroblast cells internalized with curcumin from the TOCN-PVA-Cur hydrogel within 4 h incubation.¹⁰

Dai X *et al.* indicated curcumin/gelatin-blended nanofibrous mats (NMs) increased the

bioavailability of the hydrophobic curcumin for wound repair. Curcumin was simultaneously released from the hydrogel system that suppressed the inflammatory response through decreased expression of monocyte chemoattractant protein-1 in fibroblasts.¹¹

Vigato AA *et al.* identified curcumin with the lipid-ploxamer-based organo-gels for skin delivery. The hydrogel system developed between hydrophilic and lipophilic. Curcumin was attached to the micelle-micelle interface which presented at a low toxicity effect and the 50% inhibitory concentration (IC₅₀) of organo-gel was less than 4.83 µgcm⁻² for the curcumin topical administration in the skin delivery system.¹²

Sharma M *et al.* proved an efficient way for the curcumin conjugated to hyaluronic acid (HA) in wound healing. The Cur-HA hydrogen system exhibited bactericidal activity and inhibited cell proliferation, decreased oxidative damage induced by H₂O₂ in wound healing.¹³

The above authors illustrated the significance of hydrogel usage in curcumin which increased the solubility, bioavailability, inflammatory response, and antimicrobial activity, because of hydrogel's distinct properties such as high water content, controllable swelling behavior, ease of handling, and biocompatibility.

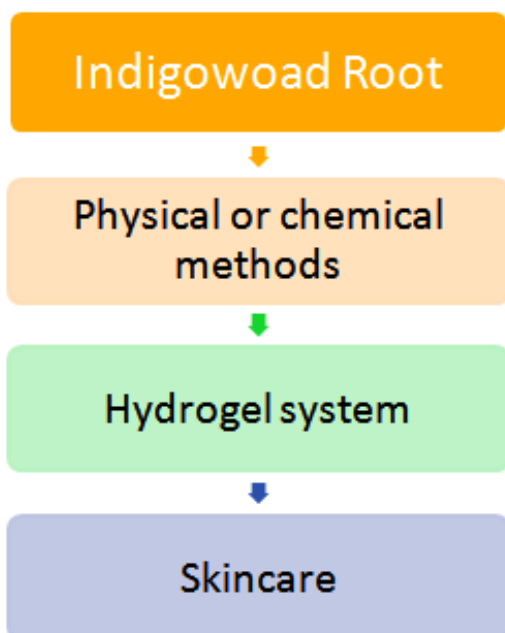


Fig. 1. A flow chart for Indigowoad Root to hydrogel system on skincare

DISCUSSION

Hydrogel has several advantages for drug delivery applications include the possibility of sustained release, proper mechanical strength, and porous structure to achieve a large surface area for drug absorption. Its biocompatibility and tunable biodegradability make the hydrogel system without toxic effects on humans.

Indigowoad Root possesses a wide range of pharmacology activities such as antibacterial, antiviral, and anti-inflammatory properties. However, this is slightly soluble in water which influences biological actions in the human body.

Growing evidence has shown that incorporation with hydrogel improves Indigowoad Root bioavailability which increases its solubility as the hydrogel system is a three-dimensional structural network contain high water content. It helps to encapsulate the Indigowoad Root by its physical (porous structure) and chemical

(synthesize with polymer) methods. This hydrogel system supports holding and release the Indigowoad Root in a controlled manner.

In the future, Indigowoad Root should better be applied to the hydrogel delivery system because it would use a minimum concentration to achieve the target on skincare. Compared to the current and published works of literature, some safety assessments on the Indigowoad Root hydrogel system must be done in the cell to animal models, and human clinical trials.

CONCLUSION

All of the information demonstrates that Indigowoad Root is a possible candidate to develop cosmetic cream and it would be synthesized hydrogel by the natural or synthetic polymers to enhance its antibacterial and antiviral properties applied to skincare based on the above strategies. However, much more work needs to be done such as cytotoxicity, animal models, clinical trials as well as safety assessments on the human skin.

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Conflicts of interest

The authors declare that have no conflicts of interest.

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