Abstract

Nowadays, herbal products of the Royal Project Foundation employ herbal extracts and essential oils as major ingredients. Consequently, applying nanotechnology to these products would enhance the product's efficacy and stability, which would lead to the quality enhancement and add more value to the products of the Royal Project Foundation. Therefore, the present research aimed to develop the suitable nanotechnology process for plant extracts and essential oils using in herbal products of The Royal Project Foundation.

The present study reviewed the literature of 8 highland plants, including horsetail (*Equisetum debile*), Assam tea (*Camellia sinensis*), Indian ivy-rue (*Zanthoxylum limonella*), litsea (*Litsea cubeba*), mamikil (*Harrisonia perforate*), thyme (*Thymus vulgaris*), chamomile (*Chamaemelum nobile*), and lavender (*Lavandula angustifolia*). Additionally, 9 herbal extracts and essential oils were extracted, including horsetail extract, Assam tea extract, chamomile extract, thyme extract, lavender extract, mamikil extract, Indian ivy-rue essential oil, litsea essential oil, and lavender essential oil. Additionally, the solubility of the extracts and essential oils in various solvents were investigated. The biological activities related to the cosmetic applications on skin, hair, and oral, all extracts and essential oils were investigated for their antioxidant, skin whitening, anti-wrinkle, anti-acne, anti-oral pathogen, and hair-loss reducing activity, were also determined. Furthermore, the microemulsions containing the extracts and essential oils were developed and investigated for their biological activities.

In the solubility test, the best solvent be able to dissolve all extracts and essential oils was dimethyl sulfoxide, followed by methanol and ethanol. In contrast, DI water could not dissolve any extracts nor essential oils. In the aspect of their biological activities, the most appropriate extracts and essential oils for topical use were Assam tea extract which possessed the best whitening effect, chamomile extract which possessed the most potent inhibition against collagenase and elastase, lavender essential oil which possessed the most potent hyaluronidase inhibition, and litsea essential oil which possessed the most potent anti-acne activity. Additionally, the most appropriate extract for hair care was mamikil extract since it possessed a potent antioxidant activity and the most potent inhibition against 5-alpha reductase. Moreover, horsetail extract Assam tae extract, and litsea essential oil were suggested for using in oral care products since they possessed the most potent anti-microbial activity.

In the development of microemulsion, various factors affecting microemulsion, including oil types, surfactant types, co-surfactant type, and the surfactant to co-surfactant ratio were investigated. The results remarked that all factors affected the microemulsion formation. The microemulsion base from almond oils A3 which composed of 30% Almond oil, 48% Tween 85, 12% butylene glycol, and 10% DI water (size = 178.8±2.4 nm, PDI = 0.285±0.053), were selected for the incorporation of highland herbal extracts at the concentration of 10%. The microemulsion containing lavender, thyme, Assam tea, chamomile, horsetail, and mamikil had a small internal droplet size of 233.8±0.3, 244.6±0.4, 302.7±0.4, 332.8±0.5, 380.7±0.7, and 400.1±0.5 nm, respectively. The PDI of these microemulsion were 0.33-0.65. All microemulsions containing the extracts was very stable. On the other hand, the essential oil from Indian ivy-rue, litsea, and lavender were used as the oil phase in the microemulsion development. The best microemulsion of Indian ivy-rue essential oil was formulation M4, which composed of 10% Indian ivy-rue essential oil, 40% Tween 20, 10% butylene glycol, and 40% DI water. The best microemulsion of litsea essential oil was formulation T4, which composed of 10% litsea essential oil, 40% Tween 20, 10% butylene glycol, and 40% DI water. The best microemulsion of lavender essential oil was formulation L2, which composed of 10% lavender essential oil, 28% Tween 20, 7% butylene glycol, and 55% DI water. The microemulsion containing essential oil from Indian ivy-rue, litsea, and lavender had small internal droplet size of 157.7±6.1, 311.4±67.7, and 323.3±22.0 nm, respectively, as well as, narrow PDI of 0.383±0.046, 0.226±0.108, and 0.478±0.031, respectively. All microemulsion formulations were very stable. Microemulsions could enhance the biological activities of local highland plant extract. Anti-hyaluronidase and antioxidant activity of all plant extracts had been enhanced after incorporation into microemulsions. On the other hand, the whitening effect, anti-collagenase, and 5-alpha reductase inhibition could be enhanced by microemulsion in only some extracts. However, microemulsions did not enhance the anti-elastase and antimicrobial activities of any extracts.

Therefore, 5 different nano cosmetic products from highland plant extracts were developed, including (1) nano anti-wrinkle and whitening facial cream from microemulsion containing chamomile extract, (2) nano anti-wrinkle and whitening facial serum from microemulsion containing lavender essential oil, (3) whitening and conditioning lotion from microemulsion containing Assam tea extract and microemulsion containing mamikil extract, (4) anti-acne gel from microemulsion containing litsea essential oil, and (5) anti-hair loss tonic from microemulsion containing mamikil extract. Microemulsion containing chamomile extract cost the highest (4,291.68 baht), followed by microemulsion containing thyme extract (2,241.68 baht), lavender extract (2,141.68 baht), horsetail (2,141.68 baht), Assam tea extract (2,041.68 baht), mamikil extract (1,891.68 baht), lavender oil (920.90 baht), Indian ivy-rue oil (804.00 baht), and litsea oil (504.00 baht).