Chapter 34

Garbage to Glamour: All Hail Red Pitaya By-Products for Innovative and Bio-Sustainable Age-Defying Beauty

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\textbf{ABSTRACT}

With the modernization of cosmetic industries in recent times, not only the health and safety features of the active substances incorporated in their skincare are being primary concerns to the consumers, but other details regarding their origin, ethical value, processing techniques, potency, and environmental footprint are also given great attention. Consequently, the popularity of plant-derived active ingredients with appropriately assessed bioactivities are experiencing a positive shift as dermatologists are adopting multiple strategies for the innovation of the plant active-based neoteric formulations. However, a major proportion of actives utilized in the preparation of cosmetic products especially the anti-aging skincare are being acquired from synthetic/animal sources which lead to multiple skin disorders and severe health complications. With the objective to derive a powerful, cost-effective, safe, and bio-sustainable anti-aging active ingredient from agricultural food waste, it is of utmost necessity to merge the food and cosmetic raw materials supply chains into a single supply chain serving both industries without subtracting to one another. Thus, for the first time, this research evaluates the potentialities of the red pitaya by-products, the peels and seeds to act as effective active ingredients in the topical anti-aging nano-formulation. The efficacy assessments revealed that nanoemulsion containing red pitaya peel extract and seed oil visibly reduced the appearance of wrinkles by -5.9\% while simultaneously improving the skin texture and energy to
stimulate rejuvenation of the aging skin upon 4 weeks of application. Furthermore, the skin moisture content increased substantially which indicates a good hydration provided by the formulation. This is a pre-eminent criterion for anti-aging formulations to act as an ultimate everyday all-rounder solution to counteract multiple skin concerns related to aging such as skin discolouration, decreased collagen production, wrinkle formation and inefficient protection against UV radiations since the natural hydration level of the skin deteriorates with age and dry skin will affect the product’s overall efficacy as the skin’s barrier function gets impaired.

**Key Words:** Red pitaya; Plant by-products; Anti-aging; Bio-sustainability; Green cosmetics

1. INTRODUCTION

Red pitaya or more commonly renowned as red dragon fruit, is one of nature’s most exotic plants, as it appears like a pink rosebud with peels that resembles an explosion of flame. This superfruit contains a surprising number of phytonutrients as it is loaded with antioxidants, vitamins, polyunsaturated fatty acids, and proteins (Kim et al., 2011). Based on a large body of existing modern pharmacological studies, different parts of pitaya comprising of its flesh, peels, and seeds exhibit various medicinal benefits including antioxidant, anti-cancer, anti-inflammatory, antidiabetic, and cardiovascular suppressing properties (Stintzing et al., 2002). Although the peels and seeds of red pitaya might contain valuable chemical compounds that are equal to if not better than its flesh, they are often regarded as waste materials and are being discarded which leads to serious environmental issues.

The fact that anti-aging in present scenario has become one of the most intriguing subjects to mankind is beyond the shadow of a doubt. It is anticipated that the global anti-aging market will undoubtedly experience exponential growth, owing to its ever-increasing demand. In fact, anti-aging products’ global market is anticipated to reach an estimated value of US$66.2 billion by 2023 with the compound annual growth rate (CAGR) of 5.7% from 2018 to 2023 (Anti-Aging Market Report, 2018). Skin aging is mainly manifested through the degeneration of extracellular matrix in both the epidermal and dermal layers as it leaves apparent alterations on the surface of skin and its physical properties are undesirably modified. While chronological aging is the reflection of passage of time, premature aging is induced by various environmental factors on skin which tend to produce visible signs of skin aging such as deep wrinkling, excessive dryness, dark/light pigmentation, sallowness, severe atrophy, telangiectases, premalignant lesions, laxity, and leathery appearance (Kim et al., 2004). This is when the utilization of skincare products to provide age-defying effects and slow down premature aging comes to play. Unfortunately, a major proportion of the skincare cosmetics targeting anti-aging effects available in the current market are formulated with synthetic active agents which have been largely associated with triggering various adverse
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reactions such as allergic contact dermatitis, irritant contact dermatitis, phototoxic, and photo-allergic reactions. Since the current alternatives to treat skin aging have become technologically more invasive; botanical extract-based anti-aging skincare products are becoming more relevant for their excellent efficiency and minimal or no risk of adverse effects on the skin (Kim et al., 2004). The motivation of this work is to promote the underutilized red pitaya peels as a natural cosmetic active ingredient which is of both theoretical and practical significance. Therefore, this study focused on evaluating the functional cosmetic properties of the underutilized red pitaya peels and seeds to function as an effective active ingredient in the formulation of a nanoemulsion based skin anti-aging cream. Besides, this endeavour will also encourage the commercialization of red pitaya by-products derived skincare in order to scale-up production to fulfil its unique and valuable cosmetological properties.

2. LITERATURE REVIEW

2.1 Pitaya Fruit

Pitaya or more commonly known as dragon fruit (Hylocereus spp) is a climbing vine cactus species which has successfully attained international recognition, both as an ornamental plant and as an economical fruit crop. There are three varieties of pitaya namely white flesh pitaya with yellow peel (Selencereus megalathus), white flesh pitaya with red peel (Hylocereus undatus) and red flesh pitaya with red peel (Hylocereus polyrhizus) (Hoa et al., 2006). Besides, it is also regarded as an excellent source of natural antioxidants and micronutrients (Lim et al., 2010). The red flesh variety is the most popular due to its high price at RM 8.00 (USD 2.00) per kg compared to the white-fleshed pitaya at RM 5.00 per kg (USD1.50). In spite of the fact that all three varieties of pitaya can be grown in Malaysia, the red flesh (H. polyrhizus) cultivars were found to have greater receptions from the farmers when compared to the white flesh type due to its high consumer predilections. Unfortunately, the tremendous increment in red pitaya processing also produces massive amounts of by-products especially the peels and seeds. In fact, according to the report by United Nations Food and Agriculture Organization (FAO), the waste materials originating from fruits and vegetables account for a whopping 60% when compared to other types of foods. Generally, the typical losses and wastes of pitaya are estimated to be in the range of 30-45% (Cheok et al., 2018). As for red pitaya, the peels comprise of approximately 22–44% while the composition of seeds being discarded is about 2–4% (Esquivel et al., 2007).

2.2 Cosmetics

Although there is a popular saying that goes, “beauty is in the eyes of the beholder”, yet money and also profitability are the major driving forces for any industry and the beauty industry which involves corporate cosmetic shareholders, cosmetic companies, and their paid entourage
of star skin care specialists, is definitely not an exception. Today, the cosmetic industry is witnessing a gigantic growth which is beyond from merely marketing lash-extending mascaras and hot pink lipsticks. Cosmetics are now being revolutionized to correct all sorts of skin imperfections rather than just concealing those imperfections to achieve a picture perfect and flawless skin. The intervention of cosmetics is closely associated with pharmaceutical research because as far as any healthcare products are concerned, the safety, efficacy, and compliance are the three crucial criterions that must be adhered. Therefore, the formulation must work to fulfil all three requirements. Plant-derived skincare comply with ethical standards and they reflect the idea of social responsibility, sustainability, and interdependence, which covers the preservation of the environment, community, good manufacturing practices, business management, and also the economy. In other words, all those respective brands that uphold the true natural cosmetic requirements are battling against animal cruelty, environmental assaults, and progressing towards green marketing (Aoun & Tournois, 2015).

2.3 Skin Aging

The most striking indicator of age is undeniably the human integument, which constitutes one-sixth of the total body weight. Being the largest, sophisticated and energetic organ of the human body, skin serves as the barrier, separating the internal environmental from the outside world (Klaassen et al., 1996). Aging is a complicated, multifactorial phenomenon in which both the intrinsic and extrinsic processes occur simultaneously, resulting in progressive depletion in configurational integrity and physiological performance of the skin that lead, inevitably, to death. The role of oxidative stress in the intrinsic, as well as the extrinsic process, of skin aging is extremely pre-eminent. There exist an ample body of research works emphasizing the effects of free radical that induces wrinkle formations via upregulation of metalloproteinases that destroy collagen. Besides, oxidative assault brought about by continuous UV irradiation bombards the skin with intense oxidizing effects that greatly harm the skin. As we reach 40 years mark, a gradual decrease in the quantity of hyaluronic acid in the dermis will be observed. This diminishment together with ineffective epidermal barrier function are the most probable reasons behind the loss of turgidity and skin hydration, which alters the skin elasticity. Not only the hydration level in the dermis layer gets lower, but the stratum corneum’s moisture content also becomes decreased since the lesser number of stratum corneum lipids minimize the water binding and retention capacity of the skin. Therefore, the formation of flaky, dry skin with fine lines is more noticeable in aged skin than younger skin (Howard et al., 2015).
3. METHODOLOGY

3.1 Materials
Red pitaya fruit was obtained locally from vicinity of Sepang (GPS location: 2.676151°, 101.759777°), Malaysia. Red pitaya peels and seeds were then manually separated from the red flesh in the lab. The peels and seeds were cleaned and washed under running tap water until all the flesh was removed. The peels and seeds were then dried, crushed into smaller particles in a mill and kept in a desiccator until further analysis.

3.2 Preparation of Red Pitaya Peel Extract (RPPE)
For the preparation of extract from red pitaya peels, 20 gm of powdered peels were added to 200 mL of 82% ethanol and refluxed for 103 min at 56 °C. The mixture produced was then filtered using Whatman No. 1 filter paper and the resulting supernatant was concentrated using a rotatory evaporator (EYELA, N-N series, Tokyo, Japan) at 40 °C. The RPPE was then kept in the dark under refrigerated condition until further analyses.

3.3 Supercritical Fluid Extraction (SFE) of Red Pitaya Seed Oil (RPSO)
SFE was carried out in a 60 mL extraction vessel using an SFE system (OV-SCF) supplied by Taiwan Supercritical Technology Co., Ltd. Briefly, 20 g of dried, ground red pitaya seeds were placed into the extraction vessel (4.5 cm internal diameter and 14.5 cm in height). CO2 was fed from a gas cylinder equipped with a cooler circulator to keep CO2 liquefied. The liquefied CO2 was pressurized under the needed pressure using an air-booster pump and fed the CO2 into the vessel. The precision of temperature and pressure of the extraction system were ±0.5°C and ±1 psi, respectively.

3.4 Preparation of Red Pitaya Nanoemulsion (RPN) With RPPE and RPSO
The RPN prepared following the method done by Gani et al. 2010 with several modifications. Oil and water phases were prepared separately. In general, o/w emulsions are produced by surfactants that are more soluble in water (hydrophilic) than in oil phase. RPPE and RPSO were used as oil phase and for the water (aqueous) phase, emulsifier, thickener and humectant were added into deionized water. Both oil and aqueous phases were heated separately to 70 °C until all the ingredients were dissolved and homogenized. The oil phase was added dropwise into the aqueous phase until completed and the mixture was further stirred till homogenous. The mixing was carried out by static mixing using IKA mixer (China) with stirring rate of 300 rpm. As the temperature of mixture reduced to 40 °C, the RPPE, RPSO, fragrance oil, and preservative were added. The mixture was further stirred until mixture cooled to room temperature and were put into sample bottles for further analysis.
3.5 Efficacy Evaluations

The acute moisturizing and anti-wrinkle properties of the RPN, their placebos and commercial products over 20 subjects were analyzed using the ANOVA (single factor) at 0, 30, 60, 90, 120 and 180 min and 4 weeks respectively. For the placebo, RPPE and RPSO were not added. The subjects were not allowed to undergo any beauty procedures, for instance, chemical peels, laser treatments, dermabrasion, and botulinum toxin injections performed by a physician or trained professional or even at home throughout the study period (Gani et al., 2010).

4. RESULTS AND DISCUSSION

4.1 Skin Moisturizing Effect

The mean skin hydration increased significantly from 54.3 corneometric unit (c.u) to 93.9 c.u after 180 min application of the RPN. Same goes to the commercial product and placebo applications where the skin hydration increased significantly from 51.9 c.u to 90.3 c.u and 51.9 c.u to 74.3 c.u, after 180 min application, respectively. The skin hydration increased by 72.93%, 73.99% and 43.16% after 180 min application of formulation, commercial product and placebo respectively. There is no significant different in skin hydration was recorded for the formulation when compared to the commercial product after 180 min application. On the other hand, the control showed no significant improvement in skin hydration. The application of RPN led to more increment in skin hydration compared to placebo due to the present of RPSO which act as humectant and occlusive agent. Humectants were reported to be able to attract water from dermis and environment into the stratum corneum while occlusive agents can form a layer on skin to prevent moisture loss (Gani et al., 2010). RPSO helps restoring the loss of natural skin lipid and absorbed into the intercellular space between the corneocytes in the stratum corneum to preserve skin hydration. The ability of these natural moisturizing factors and the RPSO to attract water explains the higher increment of skin hydration for nanoeulsion. Therefore, the RPSO used in this study was able to provide moisturizing effect by significantly increase the skin hydration, hence, it has potential to be used as a moisturizing agent in cosmeceutical formulation. Figure 1 illustrates the skin hydration versus time for all formulations.
4.2 Anti-Wrinkle Effect

Predominantly, wrinkling and loss of elasticity are the most obvious signs of aging that will be observed on the parts of the body such as the dorsal skin of the hands. The modification in the biomechanical characteristics and quantity of elastic fibers in the dermis layer gives rise to this phenomenon. After four weeks of application, the number of wrinkles (SEw) value dropped from the initial reading of 40.862 before the treatment commenced to 38.45 on the 4th week with a good reduction of -5.9% (Figure 2). Therefore, when applied consistently for a longer period of time, the RPN is believed to produce even better results to reverse signs of aging with the aid of powerful phytochemicals in RPPE such as polyphenols and vitamin C. In addition, the formation of wrinkles is closely associated with the depletion of collagen which has a direct relation to the skin moisture level and transepidermal water loss (TEWL) rate. The main reason for the collagen degradation is the high amount of epidermal water loss that causes the water retention potentials of the collagen to be greatly affected (Aburjai & Natsheh, 2003). On that account, the moisturizing properties of RPSO greatly supports the increased collagen production which in due course resulted in less visible wrinkles over time.
5. CONCLUSION AND RECOMMENDATION

Based on the findings of this research, the anti-aging efficacy assessments via anti-wrinkle and moisturizing assays clearly depicted that red pitaya peels and seeds based nano-formulation can effectively and safely reduce the clinical signs of aging with religious use. Besides, red pitaya by-products can be greatly utilized to replace the synthetic/animal derived agents to serve as a natural active ingredient. Therefore, in terms of practical implications, apart from their proven advantageous effects on human skin, plant residues are highly competent to emerge as trendsetters in the remunerative cosmetic field for their efficaciousness, bio-sustainability, as well as, cost-effectiveness and on the whole, red pitaya peels and seeds could potentially be one of such valuable ingredients. In addition, study to determine which genes and pathways exhibit the differential expression with age in multiple tissues, as well as, to get a detailed insight on how the genomic regulation of gene expression gets modified with age should be included in the future exploration of the red pitaya by-products. This is crucial since a substantial percentage of age-related alterations in the gene expressions tend to be tissue-specific with only a small number of genes sharing an age effect in the expression across tissues.

REFERENCES


