NEW TRENDS IN COSMETICS: THE POTENTIAL USE OF
RED PITAYA AND ITS BY-PRODUCTS AS COSMETIC
ACTIVE INGREDIENTS

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Abstract

Over the past few decades, massive quantities of solid wastes are being
produced from the red pitaya fruits by the food and beverage industries and their
disposal leads to severe environmental issues. Despite being waste materials, the red
pitaya’s by-products such as peels, seeds, and pulps are rich in beneficial active
ingredients with diverse functionalities. Besides, the sophisticated technological
advancements available today contribute greatly to the development of a variety of
processes to convert these waste materials into high-value bio-products of excellent
qualities. This review will be focusing on the potentialities and the current use of
extracts and chemical constituents of the red pitaya and its by-products in the
cosmetic field as antioxidants, natural coloring, moisturizing, anti-aging, and anti-
inflammatory agents. These types of plant-derived actives are efficacious, economical
and bio-sustainable, and therefore are theoretically suitable to substitute artificial
and synthetic active ingredients, more customarily incorporated in cosmetic
formulations.

Keywords: Red pitaya, By-product, Skin care, Cosmetic, Natural

I. Introduction

Fruits and vegetables are undeniably a quintessential source of nutrition
without which our diet routine will be incomplete and this has been an intensively
studied topic over the years. Apart from primary metabolites such as lipids, amino acids and saccharides, plants also synthesize a wide variety of secondary metabolites that are of paramount significance in shielding them against abiotic and biotic stresses [II]. Having great reputations as source of cosmeceuticals, preservatives, pharmaceuticals, flavors, fragrances and dyes, secondary metabolites are also capable of mediating numerous vital interactions with the external environment and also with organisms occupying the identical ecological habitat [XX]. Moreover, a large number of existing epidemiological studies in the broader literature have claimed that consuming fruits and vegetables have improved human health significantly including curing different categories of cancers and minimizing the risk for stroke and coronary heart disease [XXX]. The solid waste produced by industries that process agricultural products ranges about 10% to 60% and in some instances, raw materials originating from the wastes or plant by-products possessed much greater beneficial chemical properties analogous to their edible counterparts [XVII].

Practically unexplored approximately two decades ago, pitaya has currently become an inseparable part from the growing niche in the exotic fruit market as well as in the domestic markets of producer countries, such as Vietnam, Malaysia, Colombia, Mexico, Costa Rica and Nicaragua. Pitaya or also known as dragon fruit (Hylocereus spp) is a climbing vine cactus species which has successfully acquired international attention, both as an ornamental plant and as an economical fruit crop. Its fruit is regarded as the most beautiful in the Cactaceae family, with a bright red skin studded with green scales and white or red flesh with well dispersed small black seeds. There are three varieties of pitaya; namely and red flesh pitaya with red peel (Hylocereus polyrhizus), white flesh pitaya with yellow peel (Selenicereus megalanthus) and white flesh pitaya with red peel (Hylocereus undatus) as shown in Figure 1 [IV], [XXXVI]. The scope of this review is to highlight among the most pivotal applications of the red pitaya’s by-products that possess large potentialities as effective and natural cosmetic ingredients for various skin concerns.

Fig. 1: Three commonly found classes of pitaya (Hylocereus polyrhizus, Selenicereus megalanthus and Hylocereus undatus).

II. Antioxidants

Antioxidants are the star ingredient in various beauty products marketed today, be it a luxury cosmetic brand or an ordinary drugstore skincare item. The production of reactive oxygen species (ROS) such as superoxide anion, hydrogen peroxide and hydroxyl radicals via oxidation initiates chain reactions that cause severe impairment to the skin cells and destructs the crucial molecules in the body, resulting in tissue injuries and cell death [XXVII]. The elevation of these detrimental free radicals beyond the limit that can be handled by body’s pre-existing antioxidants...
increases the likelihood of wrinkle formation, hyperpigmentation, excessive skin dryness, elastosis and photo-aging of the skin. That being the case, external application of antioxidant rich formulations may greatly supplement the body’s own supply of antioxidants to curb the generation and proliferation of ROS to safeguard the skin from environmental stress triggered by free radicals [XVIII]. Polyphenols, flavonoids and tocopherols are among the most coveted antioxidants whose contributions to inhibit and regulate the oxidation of cellular constituents are immense and according to previous literatures, polyphenols are the major compounds elucidated from *Hylocereus* species [XXVII], [XIII].

Prior research suggests that when extracted with 70% ethanol, the flesh and peels of red pitaya exhibited 2, 2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity of 27.45±5.03% and 83.48±1.02% at the concentration of 1.0 mg/mL respectively. The total phenolic content (TPC) is highly correlated to the DPPH radical scavenging ability of the plant extracts. Accordingly, the TPC value obtained from the peels was 28.16 mg of of gallic acid equivalents (GAE) /100g which is much higher than its flesh (19.72 mg of GAE/100g). Both peels and flesh contain polyphenolic compounds but a major portion of flavonoids were found in its peels [X]. Method employed to extract these constituents also impacts the yield of polyphenolic content from the red pitaya peels and thus sub-fractionation was utilized to narrow down the number of phytochemical classes in a single fraction as it lessens the probability of interferences during experimental procedures [XXVII]. The fractionated peels extract displayed greater DPPH radical scavenging activity of 805.1±1.2 μmol trolox equivalents (TE)/100 g fresh weight in contrast to the non-fractionated sample that showed only 95.2±1.2 μmol TE/100g fresh weight. In addition, betacyanin rich fractions showed greater DPPH radical scavenging activity while approximately 10 times higher TPC was detected in the peels (645.6 mg±1.0/100 g fresh weight) than the flesh (78.1 mg±1.4/100 g fresh weight). Consequently, the peels fraction also showed excellent reducing capacity when its extract was subjected to ferric reducing antioxidant power (FRAP) assay [XXVII].

Vitamin C is a well-established antioxidant that is found abundantly in the human skin. It plays a prominent role in the formation of complex classes of enzymatic and non-enzymatic antioxidants which collaborate with each other to shield the skin from deleterious effects of ROS as in protecting against UV-induced immunosuppression. Inclusion of vitamin C in the formulation of various pharmaceutical and cosmeceutical products with therapeutic and prophylactic properties are highly desirable as it excels as an anti-aging agent, DE pigmenting agent, replenisher of vitamin E, and photo-carcinogenesis protector [XII]. The vitamin C content analysis carried out by Choo and Yong [XXXVII] revealed that the pulp is richer in ascorbic acid (32.65 ± 1.59) than the whole fruit comprising of the pulp and peel (18.94 ± 2.51). However, the results obtained were are not in agreement with the experimental data as reported previously [XXXVII] since the ascorbic acid content of pulp was much lower at only 13.0 ± 1.5 mg/100g puree. Sample preparation techniques along with experimental methods to evaluate vitamin C content could have contributed to these dissimilarities, owing to the fact that the authors carried out the extraction using 100% methanol solution followed by
concentrating it at 40°C via partial vacuum. Environmental growth factors, soil type, climatic changes and variation in maturation stage also fairly influence the vitamin C content in fruits [XXI].

III. Natural Coloring Agent

Reliance in the therapeutic power of color might be ancient but it should be noted that color in the earlier times was not a philosophical concept as it was frequently associated to its origin in nature. Following the increasing awareness on the feasible or authenticated detrimental effects imposed by artificial colorants used in cosmetic producing industries, the exploitation of natural products to substitute the current synthetic colorants are becoming a pragmatic approach even though it is less economical. To meet the consumer’s demand for ecological products, industrialist and cosmetic scientists are striving to come up with revolutionary natural colorants that can provide multiple usefulness such as UV protection, anti-aging effects, moisturizing properties and other relatable performances in the development of foundations, lipcare, hair coloring and color cosmetic products. At present, among the leading commercial sources of natural colorants is red beetroot, enriched with color pigment known as betacyanin. Yet, the presence of geosmin and pyrazines in the red beetroot are both accountable for the undesirable pettiness of this crop together with the high concentrations of nitrate compounds that are linked with the production of carcinogenic nitrosamines [XXIV]. On contrary to red beetroot, this unpleasant sensorial impact is absent in the red pitaya fruit which makes it an exemplary candidate to substitute red beetroot as a potential source of natural pigments. The coloring application of the red pitaya comes from betalain, betacyanins and betaxanthins compounds [XV], [XXXIII]. The peels and pulp of red pitaya contain nearly equivalent amounts of betalains [XVII]. Some authors have driven the further development of the *Hylocereus* genus and discovered that betaxanthin are completely devoid in red pitaya whereas seven betacyanin compounds including isobetanin, isophyllocactin, betanidinbetaninphyllocactin, isobetanidin and bougainvillein-R-1 were elucidated using reverse phase HPLC [XXV]. Other than this, anthocyanin pigments which may appear red, blue or purple, are also abundant in red pitaya which further enhances its prospective as a natural dye [XXXIX]. Therefore, these findings justifies the employment of red pitaya peel in the color preparation for cosmetics.

Lip butter is an excellent remedy to heal cracked and dry lips and prior studies demonstrated the suitability of red dragon fruit to be incorporated in the lip moisturizer formulation. Not only red pitaya will serve as natural dye to enhance the aesthetic appeal, it also improves the skin imperfections by acting as antioxidant, antimicrobial agent, immune system booster and vitamin E, vitamin C and vitamin B3 provider. Sandriani and her colleagues formulated a lip butter with red pitaya extract as its natural dye using different types of oil phases [XXXIX]. The end product exhibited a good texture with pleasant aroma while its pH also correlated with the physiological pH of the lips when measured at the right melting point. Another study by Phebe et al. [IX] also suggested the potential of red pitaya to be used as natural colorant in beauty and health products. The research was conducted to investigate the color, total betacyanins content, and separation of betacyanins in the
peels and flesh of red pitaya harvested at 25, 30 and 35 days after flower anthesis (DAA) and lastly the efficacy of tristimulus color evaluation as predictors of red pitaya pigment content. The results displayed alteration of color of the peels from green to red whereas the flesh changed from creamy white mixed red to red-violet as DAA proceeded from 25 to 35 DAA, with enormous modifications found in the fruit collected at 25 and 30 DAA. Furthermore, the elevation of protein level, categories of betacyanins being isolated and total betacyanin content revealed a good correlation with the color change expressed by the peels and flesh respectively. This study also highlighted the advantage of tristimulus measurements to determine betacyanins content of peels and flesh of red pitaya that can adequately replace the monotonous pigment extraction technique [IX].

IV. Moisturizing Agent

The oil produced by minute red pitaya seeds coated by mucilage is perceived as an excellent source of essential fatty acids. Any attempt that discourages the retrieval of these valuable seeds may nevertheless be superseded by its essential oil’s rich and beneficial constituents. In fact, the oil produced by these grainy seeds manifest remarkably high contents of linoleic and linolenic acids and their isomers. Linoleic acid makes up a substantial portion of the pitaya seed oil and its percentage is comparable to linoleic acids found in canola, grape seed, flaxseed and also sesame seed oil [I]. This distinguishable trait exhibited by the pitaya seed oil makes it to stand out as an eminent moisturizing agent. Its rich linoleic acid composition improves rough patchy and flaky skin while retaining the moisture level and smoothness of the skin. Not only that, this type of essential acids which cannot be synthesized by human body not only enhance skin health by healing eczema and psoriasis, but they also help to control excessive hair loss. When religiously applied to nails that are easily breakable, essential oils also improve the condition of the nails. The regulation of skin’s metabolism by balancing the flow of oils and nourishing collagen can be achieved competently with essential fatty acids [XXIX].

A large number of existing studies in the broader literature have examined the composition of fatty acids in red pitaya seeds. As reported by Arrifin et al. [I], about 50.8±0.53 % of pitaya seed oil comprised of polyunsaturated fatty acid (PUFA), whereby the biggest proportion was occupied by 49.6±0.33 % of linoleic acid while linolenic acid constitutes only 1.21±0.20 %. Apart from this, an appreciable amount of monounsaturated fatty acids (MUFA) of 25.6±0.88% was also identified in the seed oil whereby 21.6±0.53% was represented by oleic acid alongside 3.14±0.30 % of cisvaccenic acid and 0.91±0.05% of palmitoleic acid. Besides, the saturated fatty acids constitutes about 23.6±1.41% and it was governed by 17.9±0.53% of palmitic acid [I]. In a study conducted to compare the effects of hot and cold extraction conditions on the physiochemical characteristics of the red pitaya seed oil, the linoleic acid dominated its major fatty acid content whereby the cold method yielded 49 % followed by 48 % in the hot method [XXXI]. These findings are in accordance with the results illustrated by Ariffin et al. [I] and Lim et al. [XVI] respectively. Often accompanied by high molecular weight diesters and hydroxy esters, lanolin alcohols, lanolin acids and complex mixtures of esters, linoleic acid containing topical
preparation creates an inert layer on the skin via occlusion mechanism and penetrates across the damaged skin to restore the impaired barrier function. Consequently, the rate of transepidermal water loss is reduced considerably to promote skin hydration and this signifies linoleic acid as an ideal moisturizing agent [XXII].

IV. Anti-Aging Agent

Skin aging is presumably one of the inevitable dermatological concerns in the modern society as it affects one's confident level and self-esteem. From combating those unendurable free radicals to enhancing skin's natural collagen productivity, anti-aging products make some captivating promises. Elastin and collagen are both pivotal in boosting the skin’s structural support system. Chronic exposure to ultraviolet (UV) radiation produces ROS that accelerates the rate of collagen and elastin denaturation synthesized by elastase and matrix metalloproteinase enzymes in the dermis layer. In due course, this phenomenon induces physical modifications to the skin via complex metabolic pathways which are reflected by occurrence of wrinkles and photo-aging of the skin [III]. The red pitaya peels was subjected to anti-collagenase and anti-elastase assays to evaluate its anti-aging properties based on its efficacy to inhibit collagenase and elastase enzymes respectively as reported by Vijayakumar et al. [XXVIII]. The anti-elastase activity assay performed by taking ascorbic acid as a standard exhibited that red pitaya peels with the highest concentration of 1000 µg/ml possessed a high elastase inhibition percentage of 87.62±0.05%, whereas the standard solution of ascorbic acid showed 93.55±0.11%. The red pitaya peels extract showed moderately active elastase inhibition with IC50 of (29.83±0.21) µg/ml while ascorbic acid showed high activity against elastase with IC50 of (9.47±0.18) µg/ml. The collagenase inhibition percentage of the peel was 96.92±0.02%, whereas ascorbic acid showed inhibition of 97.97±0.18%. The red pitaya peels extract showed moderate collagenase inhibition with IC50 of (16.28±0.14) µg/ml while ascorbic acid was highly active against collagenase with IC50 of (7.67±0.11) µg/ml. The polyphenolic compounds in the red pitaya peels possess hydroxyl groups that might interact with the backbone as well as the side chain with different functional groups of collagenase and elastase enzymes. For instance, the hydrophobic interaction between the benzene ring of polyphenols and collagenase results in the conformational alterations causing malfunction of the enzymes involved [VI]. The capacity of the red pitaya peels to inhibit collagenase and elastase emphasized its prospective as a good source of natural anti-aging agent.

V. Anti-Inflammatory Agent

Not only teenagers, adults are also sometimes being distraught and victimized emotionally by dilemma called acne. Classified as a chronic inflammatory disorder of the pilosebaceous unit, acne should not be taken lightly and appropriate medical attention must be sought to prevent the outbreak from getting worse [XIV]. A number of authors have recognized the anti-inflammatory properties of red pitaya extract to function as a soothing ingredient in skincare products. The LC-MS/MS analysis carried out to investigate the presence of the potential anti-inflammatory chemical constituents in the red pitaya revealed that its ethanolic extract comprised of various flavonoids, polyphenols, and fatty acid esters. Among the metabolites that have been
identified to possess promising anti-inflammatory effects were luteolin, ellagic acid, and p-HPEA-AC [XXIII], [XI], [VII], [XXXVIII]. The anti-inflammatory activity of the ellagic acid is regulated based on the NF-kB transcriptional activation inhibition [XXXII]. Even though the question of the relevance of ellagic acid and glucoside binding to the mechanism of anti-inflammatory pathway has never been clearly addressed previously, it is crucial to note that several reports stated declination of anti-inflammatory activity was observed due to glucoside-luteolin binding [XXXII]. On top of that, precursors aiding in the synthesis of betalain compounds with good anti-inflammatory characteristics were also identified in the red pitaya’s methanolic extract [X]. In addition to betalains and other polyphenols, the abundance of vitamin C and linoleic acid in the red pitaya fruit and its by-products have also been exclusively focused in prior literatures. The efficiency of vitamin C to treat post-CO2 laser-induced erythema which is recognized as a clinical standard to evaluate dermal inflammation resulting from laser injury depicts its notable anti-inflammatory properties [XXV]. Besides, pretreatment with 10 % ascorbic acid decreased the severity of both histological sunburn cells and erythema triggered by UVB rays in pigs as evidently proved by Darr et al. [VIII] while linoleic acid is also shown to be an excellent anti-inflammatory agent [XIX], [XXVI].

VII. Conclusion

Beyond the shadow of a doubt, extracts loaded with numerous invaluable phyto-constituents derived from plant by-products are competent replacements for the synthetic ones being exploited in the cosmetic industrialization. In the light of this bibliographical study, some of the prominent functional cosmetic properties exhibited by various residual parts of red pitaya were represented. The literatures pertaining to righteous utilization of red pitaya by-products strongly suggests that the cosmetic industry are conclusively capable of furnishing a remunerable solution on recycling disposable wastes to develop “green” cosmetics that are inexpensive and eco-friendly. However, literatures reporting on other possible skin goodness of red pitaya by-products such as its depigmenting and photo-protective potency as well as intricate investigations on its mechanism of actions are still scarce. In conclusion, scrutinization in the pursuit of extended education on plant residues will eventually distinguish efficacious ingredients from fallacious claims.

References

I. A. A. Ariffin, J. Bakar, C. P. Tan, R. Abdul Rahman R, “Essential fatty acids of pitaya (dragon fruit) seed oil”, Food chemistry, Volume: 114, Issue: 2, Pages: 561-564, 2009

II. A. Barbulova, F. Apone, G. Colucci, “Plant cell cultures as source of cosmetic active ingredients”, Cosmetics, Vol: 1, Issue: 2, Pages: 94–104, 2014
III. A. C. Laga, G. F. Murphy, “The translational basis of human cutaneous photoaging: On models, methods, and meaning”, American Journal of Pathology, Volume: 174, Issue: 2, Pages: 357-360, 2009

IV. A. Nerd, Y. Sitrit, R. A. Kaushik, Y. Mizrahi, “High summer temperatures inhibit flowering in vine pitaya crops (Hylocereusspp)”, ScientiaHorticulturae, Volume: 96, Issue: 1-4, Pages: 343 – 350, 2002

V. A. Wojdylo, J. Osmianski, R. Czemerys, “Antioxidant activity and phenolic compounds in 32 selected herbs”, Food Chemistry, Volume: 105, Issue: 3, Pages: 940-949, 2007

VI. B. Madhan, G. Krishnamoorthy, J. R. Rao, B. U. Nair, “Role of green tea polyphenols in the inhibition of collagenolytic activity by collagenase”, International Journal of Biological Macromolecules, Volume: 41, Issue: , Pages: 16-22, 2007

VII. C. M. Park, Y. S. Song, “Luteolin and luteolin-7-O-glucoside inhibit lipopolysaccharide-induced inflammatory responses through modulation of NF-kB/AP-1/P13K-Akt signaling cascade in raw 264.7 cells”, Nutrition Research and Practice Journal, Volume: 7, Issue: 6, Pages: 423-429, 2013

VIII. D. Darr, S. Combs, S. Dunston, “Topical vitamin C protects porcine skin from ultraviolet radiation-induced damage”, British Journal of Dermatology, Volume: 127, Issue: 3, Pages: 247–253, 1992

IX. D. Phebe, M. K. Chew, A. A. Suraini, O. M. Lai, O. A. Janna O.A, “Red-fleshed pitaya (Hylocereuspolyrhizus) fruit colour and betacyanin content depend on maturity”, International Food Research Journal, Volume: 16, Issue: 2, Pages: 233-242, 2009

X. D. Tan, Y. Wang, B. Bai, X. Yang, J. Han, “Betanin attenuates oxidative stress and inflammatory reaction in kidney of paraquat-treated rat”, Food and Chemical Toxicology, Volume: 78, Pages: 141-146, 2015

XI. E. Zhou, Y. Fu, Z. Wei, Z. Yang, “Inhibition of allergic airway inflammation through the blockage of NF-kB activation by ellagic acid in an ovalbumin-induced mouse asthma model”, Food Functions, Volume: 5, Issue: 9, Pages: 2106-2112, 2014

XII. F. Al-Niaimi F, N. Y. Z. Chiang N.Y.Z, “Topical vitamin C and the skin: Mechanisms of action and clinical applications”, The Journal of Clinical and Aesthetic Dermatology, Volume: 10: Issue: 7, Pages: 14-17, 2017

XIII. G. C. Tenore, E. Novellino, A. Basile A, “Nutraceutical potential and antioxidant benefits of red pitaya (Hylocereuspolyrhizus) extracts”, Journal of Functional Foods, Volume: 4, Issue: 1, Pages: 129-136, 2012

XIV. H. C. Williams, R. P. Dellavalle, S. Garner, “Acne vulgaris”, Lancet, Volume: 379, Issue: 9813, Pages: 361–379, 2012
XV. H. J. Kim, H. K. Choi, J. Y. Moon, Y. S. Kim, A. Mosaddik, S. K. Cho, “Comparative antioxidant and antiproliferative activities of red and white pitayas and their correlation with flavonoid and polyphenol content”, Journal of Food Science, Volume: 76, Issue: 1, Pages: C38-44, 2011

XVI. H. K. Lim, C. P. Tan, J. Bakar, S. P. Ng, “Effects of different wall materials on the physicochemical properties and oxidative stability of spray-dried microencapsulated red-fleshed pitaya (Hylocereuspolyrhizus) seed oil”, Food Bioprocess Technology, Volume: 5, Issue: 4, Pages: 1220-1227, 2012

XVII. I. Goñi, D. Hervert-Hernández, “By-Products from plant foods are sources of dietary fibre and antioxidants, phytochemicals - bioactivities and impact on health”, Prof. IrajRasooli (Ed.), ISBN: 978-953- 307-424-5, InTech, 2011

XVIII. I. Kusumawati, G. Indrayanto, “Natural Antioxidants in Cosmetics”, Studies in Natural Products Chemistry, 40, Pages: 485-505, 2013

XIX. K. L. Liu, M. A. Belury, “Conjugated linoleic acid reduces arachidonic acid content and PGE2 synthesis in murine keratinocytes”, Cancer Letters, Volume: 127, Issue: 1-2, Pages: 15–22, 1998

XX. K. M. Oksman-Caldentey, D. Inze D, “Plant cell factories in the post-genomic era: New ways to produce designer secondary metabolites”, Trends in Plant Science, Vol: 9, Issue: 9, Pages: 433–440, 2004

XXI. K. Mahattanatawee, J. A. Manthey, G. Luzio, S. T. Talcott, K. Goodner, E. A. Baldwin, “Total antioxidant activity and fiber content of select Floridagrown tropical fruits”, Journal of Agricultural and Food Chemistry, Volume: 54, Issue: 19, 7355–7363, 2006

XXII. K. R. Feingold, B. E. Brown, S. R. Lear, A. H. Moser, P. M. Elias, “Effect of essential fatty acid deficiency on cutaneous sterol synthesis”, Journal of Investigative Dermatology, Volume: 87, Issue: 5, Pages: 588–591, 1986

XXIII. M. A. Rosillo, M. Sanchez-Hidalgo, A. Cardeno, C. Alarcon de la Lastra C, “Protective effect of ellagic acid, a natural polyphenolic compound, in a murine model of crohn's disease”, Biochemical Pharmacology, Volume: 82, Issue: 7, Pages: 737-745, 2011

XXIV. M. R. Moßhammer, F. C. Stintzing, R. Carle, “Colour studies on fruit juice blends from Opuntia and Hylocereus cacti and betalain-containing model solution derived therefrom”, Food Research International, Volume: 38, Issue: 8-9, Pages: 975-981, 2005

XXV. P. S. R. Ow, A. N. Boyce, C. Somasundram C, “Pigment identification and antioxidant properties of red dragon fruit (Hylocereuspolyrhizus)”, African Journal of Biotechnology, Volume: 9, Issue: 10, Pages: 1450-1454, 2010

XXVI. P. W. Wertz, “Biochemistry of human stratum corneum lipids”, In: Elias PM, Feingold KR, editors. Skin Barrier. New York: Taylor & Francis: 10, 2006
XXVII. R. Nurliyana, I. Syed Zahir, K. Mustapha Suleiman, M. R. Aisyah, K. Kamarul Rahim, “Antioxidant study of pulps and peels of dragon fruits: a comparative study”, International Food Research Journal, Volume: 17, Issue: 2, Pages: 367-375, 2010

XXVIII. R. Vijayakumar, S. S. AbdGani, N. F. MohdMokhtar, “Anti-elastase, anti-collagenase and antimicrobial activities of the underutilized red pitaya peel: An in vitro study for anti-aging applications, Asian Journal of Pharmaceutical and Clinical Research, Volume: 10, Issue: 8, Pages: 251-255, 2017

XXIX. S. Cunnane, M. Anderson, “Pure linoleate deficiency in the rat: influence on growth, accumulation of n-6polyunsaturates, and [1-14C] linoleate oxidation”, Journal of Lipid Research, Volume: 38, Issue: 4, Pages: 805 – 812, 1997

XXX. S. Djilas, J. Canadanovic-Brunet, G. Cetkovic G, “By-products of fruits processing as a source of phytochemicals”, Chemical Industry and Chemical Engineering Quarterly, Vol: 15, Issue: 4, Pages: 191–202, 2009

XXXI. S. Murugesu, A. A. Ariffin, T. C. Ping, B. H. Chern, “Physicochemical properties of oil extracted from the hot and cold extracted red pitaya (Hylocereuspolyrhizus) seeds”, Journal of Food Chemistry and Nutrition, Volume: 1, Issue: 2, Pages: 78-83, 2013

XXXII. S. Umesalma, G. Sudhandiran G, “Differential inhibitory effects of the polyphenol ellagic acid on inflammatory mediators NF-kappaB, iNOS, COX-2, TNF-alpha, and IL-6 in 1,2-dimethylhydrazine-induced rat colon carcinogenesis”, Basic & Clinical Pharmacology & Toxicology, Volume: 107, Issue: 2, 650-655, 2010

XXXIII. S. Wybraniec, B. Nowak-Wydra, K. Mitka, P. Kowalski, Y. Mizrahi, “Minor betalains in fruits of Hylocereus species”, Phytochemistry, Volume: 68, Issue: 2, Pages: 251–259, 2007

XXXIV. S. Wybraniec, I. Platzner, S. Geresh, H. E. Gottlieb, M. Haimberg, M. Mogilnitzki, Y. Mizrahi, “Betacyanins from vine cactus Hylocereuspolyrhizus”, Phytochem, Volume: 58, Issue: 8 , Pages: 1209-1212, 2001.

XXXV. T. S. Alster, T. B. West, “Effect of topical vitamin C on postoperative carbon dioxide laser resurfacing erythema”, Dermatologic Surgery, Volume: 24, Issue: 3, Pages: 331–334, 1998

XXXVI. T. T. Hoa, C. J. Clark, B. C. Waddell, A. B. Woolf, “Postharvest quality of dragon fruit (Hylocereusundatus) following disinfesting hot air treatments”, Postharvest Biology and Technology, Volume: 41, Issue: 1, Pages: 62 – 69, 2006

XXXVII. W. S. Choo, W. K. Yong, “Antioxidant properties of two species of Hylocereus fruits”, Advances in Applied Science Research, Volume: 2, Issue: 3, Pages: 418-425, 2011
XXXVIII. Y. Mizushina, Y. Ogawa, T. Onodera, I. Kuriyama, Y. Sakamoto, S. Nishikori S, “Inhibition of mammalian DNA polymerases and the suppression of inflammatory and allergic responses by tyrosol from used activated charcoal waste generated during sake production”, Journal of Agricultural and Food Chemistry, Volume: 62, Issue: 31, Pages: 7779-7786, 2014

XXXIX. Y. Sandriani, B. H. Nugroho, S. F. I. Tsani, Y. Syukri, “Formulation of lipbutter using red dragon fruit's extract (HylocereusCostaricensis) as natural dyes with various oil phase concentration”, International Journal of Research in Science, Volume: 3, Issue: 3, Pages: 6-8, 2017