Antioxidant Potential and Cholesterol-Lowering Effects of Dragon Fruit Peel

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Abstract
Antioxidants are chemicals that may block or prevent the oxidation of readily oxidizable substrates, and their use is well recognized by the public. Antioxidant chemicals are present in different plant sections, including flowers, leaves, and fruit. One possible use for dragon fruit is as a natural antioxidant source. In addition to the flesh, the skin of the red dragon fruit (Hylocereus polyrhizus) may also be used. Vitamin C, vitamin E, vitamin A, alkaloids, terpenoids, flavonoids, thiamine, niacin, pyridoxine, cobalamin, phenolic compounds, carotene, and phytoalbumin are among the active substances found in the peel of red dragon fruit that have antioxidant properties. Cholesterol often serves to facilitate cellular formation in the human body. By inhibiting the activity of the enzyme HMG-CoA reductase and the cholesterol ester transfer protein (CETP), anthocyanins found in red dragon fruit's skin help lower cholesterol levels. Red dragon fruit thus lowers total cholesterol levels. The method used in this article is a literature review. The result is peel of red dragon fruit (Hylocereus polyrhizus) has significant promise as a source of natural antioxidants that combat oxidative stress and serve as a cholesterol-lowering agent.

Article History:

Keywords:
Antioxidants, Dragon fruit peel, Cholesterol

1. Introduction

Besides its unique taste and vibrant color, dragon fruit (Hylocereus spp.) has garnered significant attention for its remarkable health benefits. The skin of the dragon fruit is often discarded as garbage, despite the flesh being often consumed. Recent study indicates that dragon fruit peel is abundant in bioactive compounds, particularly antioxidants, which provide significant health advantages. Antioxidants are crucial in combating oxidative stress, which is associated with chronic diseases such as cancer, diabetes, and cardiovascular disorders.

Antioxidant is a substance or substance that can prevent or delay oxidized in substances that are easy to oxidized and that the general public has found to be very useful. The human body does not have a sufficient amount of antioksidan, so if a more radical paparan occurs, the body will need antioksidan that originates outside of the body. One plant that has the capacity to develop and serves as a natural antioxidant source is dragon fruit. Dragon fruit is becoming more and more popular, although it is usually mainly used for processing the fruit's flesh, while there are still plenty of uses for other plant parts, such as the fruit's skin.

The advantages of dragon fruit's skin make it an intriguing fruit. The peel of dragon fruit can be used to make natural food and beverage colors and in other food production and industrial processes. The skin of dragon fruit may be used as a key component in the cosmetics industry. The peel of dragon

fruit serves as a natural herbal treatment with potential pharmacological benefits due to its antioxidant properties. Setiawan et al. (2005), as cited in Niah & Helda (2016), show that dragon fruit skin has more antioxidant activity than the fruit's flesh, indicating that it may be a good source of natural antioxidants. Particularly to mitigate elevated blood glucose levels. The exogenous antioxidant capabilities of dragon fruit skin may limit oxidative damage in the body. Suryaningsing et al. (2021) assert that the skin of red dragon fruit has a greater concentration of antioxidants than its flesh. The phenol concentration in the skin is more than that in the flesh, measuring 28.16 mg/100 g compared to 19.72 mg/100 g in the flesh. Besides being rich in antioxidants, it also includes anthocyanins, which are plant color pigments.

Currently, several individuals remain unaware that dragon fruit skin has a higher concentration of antioxidants than the fruit itself. The elevated antioxidant content of dragon fruit may contribute to mitigating risk factors associated with coronary heart disease (CHD). Indriasari I. (2012) in the journal ED Sigarlaki and A Tjiptaningrum (2016) assert that red dragon fruit has greater antioxidant levels than white dragon fruit due to the presence of the red pigment anthocyanin. Anthocyanin is a polyphenolic molecule abundant in pigments, responsible for the red, purple, and blue hues seen in numerous fruits and vegetables. Anthocyanin is a flavonoid prevalent in dragon fruit. According to prior research published in the journal ED Sigarlaki by A. Tjiptaningrum (2016), anthocyanins provide several potential health advantages, including antioxidant, anti-inflammatory, antibacterial, and antiviral properties, as well as the ability to suppress platelet aggregation and lower the chance of cancer and heart disease. According to research by Haveni et al. (2019), cyanidin, one of the anthocyanin compounds found in the ethanol extract of super red dragon fruit skin, has strong antioxidant activity. With an IC50 value of 58.35 ppm, the DPPH method proved that the ethanol extract of super red dragon fruit skin had strong antioxidant activity. Because anthocyanins inhibit CETP, HDL cholesterol levels rise and LDL cholesterol levels fall. On the other hand, it could inhibit the HMG-CoA reductase enzyme, preserving normal liver and plasma cholesterol levels.

Eighty percent of cholesterol is produced from within the body (formed by the liver) and the remaining 20 percent from outside the body (food consumed). Cholesterol is a typical product of animal metabolism and its processed products such as egg yolks, meat, liver, brain, milk, cheese, butter, and others. Cholesterol that comes from food is rarely in the form of free cholesterol, usually in the form of cholesterol with fatty acids or often called cholesterol esters. Normally cholesterol functions to help and build cells in the human body (Achmad, 2011). Total cholesterol levels can be influenced by nutrient intake, namely from foods that are sources of fat (Budiatmaja) in the journal ED Sigarlaki, A Tjiptaningrum (2016). According to ED Sigarlaki, A Tjiptaningrum (2016) Consumption of dragon fruit that can be eaten directly in the form of fresh fruit can help lower cholesterol levels in the body.

2. Methods

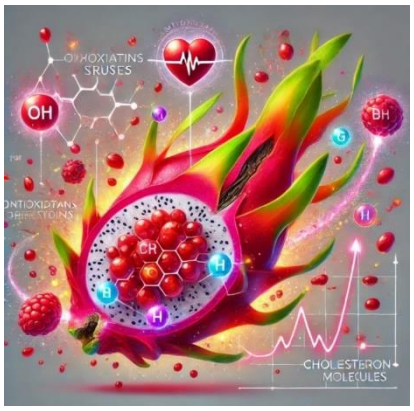
The research methodology employed in this article, "Antioxidant Potential and Cholesterol-Lowering Effects of Dragon Fruit Peel," is a literature review method. Relevant scientific articles about the antioxidant activity and cholesterol-lowering potential of dragon fruit peel (Hylocereus spp.) are reviewed and analyzed. The bioactive content of dragon fruit peel, its ability to lower cholesterol, and its antioxidant capacity are the three primary elements that this study assesses based on the references that have been gathered.

3. Results and Discussion

3.1 Antioxidant Potential of Red Dragon Fruit Peel

The red dragon fruit's skin possesses strong antioxidant qualities. According to studies using the DPPH approach, red dragon fruit skin ethanol extract efficiently reduces free radicals, exhibiting an increase in antioxidant activity proportional to the concentration. The IC50 value of this extract is 3.14 grams per 100 milliliters, indicating a commendable antioxidant capacity. Bioactive substances like as anthocyanins, polyphenols, vitamin C, and flavonoids, which have strong antioxidant properties, are abundant in the skin of red dragon fruit. The skin of the dragon fruit has

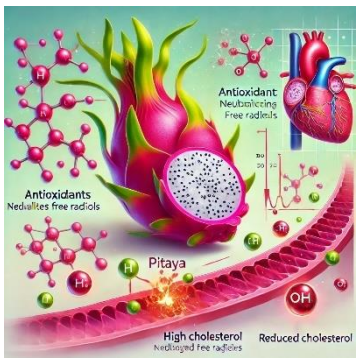
more antioxidant activity than the flesh. Thus, to counteract oxidative damage brought on by free radicals, red dragon fruit peel may be used as a natural antioxidant source (Niah & Helda, 2016).



Hylocereus polyrhizus memiliki potensi antioksidan yang signifikan. Ekstrak kulit buah naga merah memakai metode supercritical carbon dioxide menunjukkan aktivitas peredam radikal bebas yang baik dengan nilai IC50 sebesar 0,83 mg/mL. Hal ini menunjukkan kemampuan tinggi dalam menetralkan radikal bebas. Komponen utama dari ekstrak ini meliputi β-amyrin (15,87%), α-amyrin (13,90%), γ-sitosterol (9,35%), dan oktakosan (12,2%). Aktivitas antioksidan ekstrak ini terutama disebabkan oleh kandungan polifenol yang tinggi, yang memiliki kemampuan donor hidrogen untuk menangkap radikal bebas. Aktivitas ini bersifat tergantung dosis, menunjukkan efektivitas yang meningkat dengan konsentrasi ekstrak yang lebih tinggi. Dengan hasil tersebut, ekstrak kulit buah naga merah memiliki potensi guna dilakukan pengembangan sebagai sumber antioksidan alami yang dapat mendukung kesehatan manusia dan mencegah kerusakan oksidatif (Luo, Cai, Peng, Liu, & Yang, 2014).

3.2 Cholesterol-Lowering Effects

Red dragon fruit peel has a lot of potential for lowering total cholesterol levels. By inhibiting the activity of the HMG-CoA reductase enzyme, which is essential for the synthesis of cholesterol, the flavonoid content in red dragon fruit peel acts as a strong antioxidant. Additionally, the red dragon fruit's skin is rich in phenolic chemicals and fiber, which contribute to cholesterol reduction by preventing free radical oxidation, a primary factor in elevated cholesterol levels.



A research administered a beverage composed of red dragon fruit peel powder and soybeans to Sprague Dawley rats exhibiting hypercholesterolemia. The beverage was administered at a dosage of 12.8 ml/kg body weight each day for a duration of 14 days. The findings indicated an 18.45% reduction in total cholesterol levels within the therapy group. The reduction resulted from the combination between flavonoids in red dragon fruit peel and isoflavones in soybeans, which together reduce cholesterol synthesis, increase bile acid excretion, and increase HDL levels (good cholesterol).

This study confirms that red dragon fruit peel has the potential to be used as a non-pharmacological therapy to lower cholesterol levels. The combination with soy also enhances its therapeutic benefits, as soy contains the protein β-conglycinin, which helps prevent cholesterol absorption in the intestine. Thus, red dragon fruit skin-based drinks can be developed as a natural alternative to manage cholesterol levels and prevent complications related to hypercholesterolemia, such as coronary heart disease (Suryana, Putri, Rosiana, & Arum, 2024).

Tocotrienol, dietary fiber, and vitamin C are among the healthy substances found in the peel of the red dragon fruit (Hylocereus polyrhizus) that help lower cholesterol levels. The HMG-CoA reductase enzyme is inhibited by tocotrienol, regulating the cholesterol biosynthesis pathway in the liver and thereby diminishing cholesterol production. The fiber content binds bile acids in the intestines, compelling the liver to use more cholesterol for the synthesis of new bile acids. Moreover, vitamin C functions as an antioxidant, inhibiting LDL oxidation, the first stage in the development of atherosclerotic plaque.

The action mechanism of dragon fruit skin in cholesterol reduction entails decreasing LDL (low-density lipoprotein) or detrimental cholesterol, while enhancing HDL (high-density lipoprotein) or beneficial cholesterol. Inhibition of the cholesterol synthesis pathway by tocotrienol and the effect of fiber on the removal of excess cholesterol support the reduction of LDL levels. Meanwhile, increasing HDL helps clean cholesterol from the walls of blood vessels, which contributes to cardiovascular health. According to research, eating the peel of red dragon fruit may raise HDL levels while lowering LDL and total cholesterol. According to a study conducted on mice, applying a certain amount of red dragon fruit skin over the course of 21 days significantly decreased cholesterol levels by 34.8 mg/dL. Additional human trials have shown comparable results, indicating that the intake of red dragon fruit skin juice lowered cholesterol levels in persons with hypercholesterolemia (Nugraheni, Putriningtyas, Fernando, & Bintari, 2023).

The medical condition known as hyperlipidemia, which is caused by abnormalities in blood lipid metabolism, is characterized by decreased HDL and increased levels of total cholesterol, triglycerides, and LDL. This study shows that nata de coco and dragon fruit skin extract (Hylocereus polyrhizus) may increase HDL, reduce LDL, and lower cholesterol. Chemical components included in dragon fruit skin extract, including flavonoids, polyphenols, vitamin C, vitamin E, and vitamin A, function as antioxidants to counteract free radicals. Blood sugar levels are controlled by proteins, carbs, water, calcium, phosphorus, and magnesium. The fiber in nata de coco aids in lowering blood levels of LDL and total cholesterol. A fall in total cholesterol levels is probably what caused the LDL cholesterol levels to drop. LDL is a low-density lipoprotein characterized by elevated amounts of cholesterol and cholesterol esters. Consequently, if the blood total cholesterol level is low, the serum LDL cholesterol level is similarly low.

The ability of fiber to reduce L.DI levels in the blood with several mechanisms. The first mechanism is that fiber is able to bind bile acids so that they cannot be absorbed and recirculated. Fiber that binds bile acids then enters the large intestine to be degraded and excreted. Secondly, fiber may redirect the buildup of bile acids from cholic acid to chenodeoxycholic acid. Chenodeoxycholic acid may inhibit HMG CoA reductase, an enzyme involved in cholesterol manufacturing, hence reducing blood cholesterol and LDL levels. Third, fiber-degrading bacteria in the gut may generate propionate or other short-chain fatty acids that limit the formation of fatty acids and/or cholesterol, hence reducing LDL levels in the body. The reduction in LDL levels may be attributed to the antioxidant properties of vitamin C found in red dragon fruit extract. Vitamin C is a water-soluble vitamin that may only neutralize free radicals in aqueous environments. Vitamin C has the capacity to inhibit free radicals that target lipids. This vitamin acts as a free radical scavenger, directly interacting with superoxide and hydroxyl anions, along with different lipid hydroperoxides. Its role as a chain-breaking antioxidant, vitamin C can regenerate the reduced form of vitamin E. Vitamin C also acts as a secondary antioxidant. Administration of vitamin C significantly reduced total serum cholesterol levels in hyperlepidemic mice. In addition, increasing the dose of vitamin C significantly reduced total serum cholesterol levels in mice. Moreover, dragon fruit skin is abundant in beta-carotene. Beta-carotene is a provitamin A that undergoes conversion to vitamin A. This vitamin A is beneficial for metabolic processes. Beta-carotene serves as an antioxidant that neutralizes free radicals inside the human body.

Beta-carotene's antioxidant properties derive from its capacity to stabilize carbon-centered radicals. Beta-carotene is efficient at low oxygen concentrations, therefore complementing the antioxidant characteristics of high oxygen levels. Low-density lipoprotein values. Cholesterol levels may drastically drop due to active compounds like niacin (vitamin B3), which diminishes VLDL formation, thereby lowering IDL and LDL levels. Vitamin C facilitates the hydroxylation reaction involved in bile acid synthesis, thereby enhancing the excretion of anthraquinone cholesterol. This results in a laxative effect that accelerates intestinal transit and inhibits cholesterol absorption, ultimately reducing the cholesterol levels in the bloodstream. Fiber (acemannan polysaccharide, lignin) impedes the intestinal absorption of fat, hence decreasing the cholesterol that enters the bloodstream. Flavonoid chemicals included in dragon fruit skin contribute to the reduction of LDL

cholesterol levels. Flavonoids are recognized for their ability to reduce cholesterol levels since they serve as cofactors for the cholesterol esterase enzyme. Furthermore, flavonoids may enhance bile excretion by activating the cytochrome P-450 enzyme. The cytochrome P-450 enzyme binds several constituents in bile, therefore reducing blood cholesterol levels. The antioxidant compounds in red dragon fruit skin are believed to lower blood cholesterol by inhibiting the HMG-CoA reductase enzyme, which reduces cholesterol synthesis and increases LDL receptor expression in liver cell membranes and extrahepatic tissues, resulting in decreased total cholesterol levels. Consequently, the levels of LDL, which transports lipids in the blood, also diminish. Furthermore, polyphenols have antioxidant properties that may neutralize free radicals by providing the missing electrons they require (Valentina, 2011 in (Watuguly, Uniarti, & Nindatu, 2019). Anthocyanins lower cholesterol by increasing the number of LDL receptors, so that cholesterol catabolism occurs more. Consequently, anthocyanins may reduce cholesterol and LDL levels. Anthocyanins have a strong affinity for one of the active sites of HMG-CoA reductase. Anthocyanins are polar chemicals that establish van der Waals interactions with one end of the HMG-CoA reductase chain, which is a common occurrence among various cholesterol-lowering compounds and LDL (Low Density Lipoprotein) in the body. This causes anthocyanins to be able to inhibit the working mechanism of HMG-Co Areductase from forming mevalonate (Valentina, 2011 in (Watuguly et al., 2019) The composition of dragon fruit skin that may enhance HDL levels. It is niacin and ascorbic acid. Ascorbic acid contributes to cholesterol metabolism by enhancing the rate of cholesterol excretion as bile acids, elevating HDL levels, and acting as a laxative, thereby promoting waste elimination. In HDI, ascorbic acid can reduce HDL oxidation by pro-oxidant substances. Niacin can reduce the rate of HDL catabolism, accompanied by increased synthesis of HDL2 subfractions, APO A-1, and APO A-2 so that HDL levels increase. Apo A-1 is the main apolipoprotein that makes up the HDL molecule. Apo A-1 is also the first apolipoprotein that helps make up the molecular structure of preß1-HDL or the earliest form of HDL synthesized by the body. and helps the influx of phospholipids and cholesterol from peripheral cells to preß1-HDL via the ABCAI transporter. Apo A-1 is also a cofactor for the LCAT enzyme which functions to convert cholesterol in preß2-HDL into cholesteryl ester, thus prefiz-HDL. transformed into HDL3. In addition, Apo A-1 helps (French et al., 2002 in Watuguly, Uniarti, & Nindatu, 2019).

In addition to being a cholesterol-lowering agent, red dragon fruit skin has additional benefits because it is rich in antioxidants such as flavonoids and ascorbic acid. This content supports blood vessel elasticity, improves the circulatory system, and protects the body from oxidative stress. With its high nutritional content, red dragon fruit skin has great potential to be developed as a natural functional ingredient in cholesterol management and prevention of cardiovascular disease.

3.3 Relevance to Chronic Diseases

Because of its strong antioxidant properties, the ethanol extract of red dragon fruit peel (Hylocereus polyrhizus) may help prevent and treat chronic disorders. Antioxidants are essential for reducing oxidative stress, which is defined as an imbalance between the body's ability to combat the negative effects of free radicals and their production. Numerous chronic diseases, including cancer, diabetes, and cardiovascular disease, are exacerbated by oxidative stress. Red dragon fruit's peel is rich in bioactive substances with antioxidant properties, such as flavonoids, polyphenols, and anthocyanins. DPPH (2,2-diphenyl-1-picrylhydrazyl) testing revealed that the extract from the peel of red dragon fruit has a significant ability to scavenge free radicals. This extract's excellent antioxidant efficacy was shown by its IC50 value of 3.14 grams/100 ml. The primary cause of chronic inflammation and early aging is oxidative damage, which this exercise may help shield body cells against. Furthermore, red dragon fruit peel's antioxidant capacity supports its ability to prevent oxidative stress-related problems including insulin resistance and atherosclerosis, which are the precursors of many chronic illnesses. With its natural properties and low side effects, red dragon fruit peel can be developed into an effective source of natural antioxidants to support health and prevent the progression of chronic diseases (Niah & Helda, 2016).

Supercritical carbon dioxide extract from red dragon fruit peel showed high ability in capturing free radicals with IC50 value of 0.83 mg/mL in DPPH test. This activity is related to the main content such as β-amyrin, α-amyrin, γ-sitosterol, and other triterpenoid compounds. Free radicals are primary instigators of several chronic illnesses, including cardiovascular disease, diabetes, and cancer. The bioactive constituents in red dragon fruit peel mitigate free radicals, avert oxidative cellular damage, and suppress the inflammatory processes often linked to the advancement of chronic illnesses. In addition, phytochemical content such as triterpenoids and steroids contribute to the protective effect on body tissues with anti-inflammatory, anti-proliferative, and immunomodulatory properties (Luo et al., 2014).

Red dragon fruit skin has the potential to help prevent and manage chronic diseases, especially those related to lipid metabolism disorders, such as hypercholesterolemia. Research shows that flavonoids and phenols contained in red dragon fruit skin act as powerful antioxidants that can lower total cholesterol levels. This mechanism occurs through inhibition of the HMG-CoA reductase enzyme, which is important in the process of cholesterol biosynthesis. The reduction in total cholesterol levels is significant in the treatment of chronic conditions like coronary heart disease (CHD). Hypercholesterolemia is a primary risk factor for coronary heart disease and associated cardiovascular problems. Red dragon fruit skin may mitigate cholesterol buildup in blood arteries, hence preventing atherosclerosis, by lowering total cholesterol and triglycerides while elevating HDL (high-density lipoprotein) levels. The antioxidant content of red dragon fruit skin, together its effects on lipid metabolism, might diminish oxidative stress levels, which are primary contributors to chronic inflammation and cellular damage associated with degenerative illnesses including type 2 diabetes and cancer. Consequently, the skin of red dragon fruit may be used as a natural functional element to enhance health and mitigate numerous chronic illnesses via lipid control mechanisms and antioxidant protection. (Suryana et al., 2024).

3.4 Limitations and Challenges

No testing of flavonoid types and color pigments contained in red dragon fruit skin infusion was carried out so that the decrease in flavonoid types, color pigments and fiber and vitamin C content that play a role in increasing HDL levels is unknown. In addition, no measurement of HDL levels in mice was carried out before standard feed was given so that the condition of the mice before the adaptation period was unknown. The duration of high cholesterol feed administration was not long enough so that hypertriglyceridemia conditions had not been achieved. (T W Siregar et al., 2020)

3.5 Implications and Future Research Prospects

Antioxidants included in dragon fruit peels aid in lowering the body's cholesterol levels. Red dragon fruit (Hylocereus polyrhizus) peels contain betacyanin, which is widely utilized as a natural pigment and antioxidant. A previous study showed that the antioxidant capacity of dragon fruit skin was higher than that of the meat's antioxidant content. The skin of dragon fruit has antioxidant qualities that may protect the body from the damaging effects of free radicals. It is possible to extract betacyanin from dragon fruit's skin. Direct use of this extract in food preparation is possible. However, there are limitations with respect to shelf life, storage flexibility, and transportation of liquid betacyanin extract. Powdering liquid extracts might increase their shelf life, save transportation costs, and make it easier to incorporate them into food products. Using a spray dryer for drying is one method of creating extract powder. A common method in industrial settings for turning liquid extracts into powder is spray drying. Another dehydration method for turning liquid extracts into powder is freeze-drying. By keeping the sample frozen, freeze-drying prevents temperature-sensitive ingredients including proteins, tastes, and colors from degrading. (Shofinita, D et al. 2021)

Offers phytochemicals such as antioxidant, antimicrobial, anticancer, and anti-aging properties, making the usage of dragon fruit commercially significant. Its nutrients provide nutraceutical properties that aid in the prevention of nutrition-related disorders and bolster the human immune system. Numerous nutraceutical qualities exist, including antioxidant, anti-diabetic, antibacterial, anti-cancer, anti-obesity, prebiotic activities, and wound healing capabilities. It is recognized as the hub of phytochemicals that enhance health and foster economic growth. The peel of Dragon Fruit is used for pectin and Betalains extraction, serving as a natural colorant in the food sector. Dragon fruit is extensively used in the food processing, nutraceutical, and cosmetic industries.

4. Conclusion

The peel of red dragon fruit (Hylocereus polyrhizus) has significant promise as a source of natural antioxidants that combat oxidative stress and serve as a cholesterol-lowering agent. Bioactive compounds, including anthocyanins, polyphenols, flavonoids, and vitamin C, has a significant capacity to neutralize free radicals, therefore aiding in the prevention of chronic illnesses such as coronary heart disease, diabetes, and cancer. The antioxidant efficacy of red dragon fruit skin surpasses that of the fruit pulp, rendering it a more advantageous option for advancement in pharmaceutical, nutraceutical, and food sector applications.

Flavonoids in red dragon fruit skin reduce cholesterol via blocking the HMG-CoA reductase enzyme, which is essential for cholesterol formation. Research indicates that the use of items derived from red dragon fruit skin, particularly beverages mixed with soy, may markedly decrease total cholesterol levels, elevate HDL (beneficial cholesterol), and diminish LDL (harmful cholesterol).

However, this study also faces several limitations, such as the lack of testing of specific flavonoid and color pigment content, as well as the relatively short duration of high-cholesterol feeding. For the future, further exploration of the formulation of red dragon fruit peel-based products is needed, including the development of extracts in powder form to extend shelf life and facilitate application in various products. Red dragon fruit peel has great potential as a natural functional ingredient to support health and prevent chronic diseases.

References

BORGES, A. C. A., & NISHIKITO, D. F. (2023). Anti-inflammatory, antioxidant, and other health effects of dragon fruit and potential delivery systems for its bioactive compounds.

Chumroenvidhayakul, S. (2022). Dietary fiber-rich powder from dragon fruit peel and its effects on nutrient digestion, intestinal function and food application (Doctoral dissertation, Chulalongkorn University).

Faadlilah, N., & Ardiaria, M. (2016). Efek pemberian seduhan kulit buah naga merah (Hylocereus polyrhizus) terhadap kadar HDL tikus Sprague Dawley dislipidemia. Journal of nutrition college, 5(4), 280-288.

Fadlilah, S. I. T. I., Sucipto, A., Khasanah, F., Setiawan, D., & Rahil, N. H. (2020). Dragon fruit (Hylocereuspolyrhizus) effectively reduces fasting blood sugar levels and blood pressure on excessive nutritional status. Pak. J. Med. Health Sci, 14, 1405-1412.

Fadlilah, S. I. T. I., Sucipto, A., Khasanah, F., Setiawan, D., & Rahil, N. H. (2020). Dragon fruit (Hylocereuspolyrhizus) effectively reduces fasting blood sugar levels and blood pressure on excessive nutritional status. Pak. J. Med. Health Sci, 14, 1405-1412.

Fadlilah, S., Sucipto, A., Judha, M., Amestiasih, T., Nekada, C. D. Y., Mindarsih, E., & Pramana, C. (2021). Red Dragon Fruit (Hylocereus Polyrhizus) to Reduce Cholesterol Level in People With Excessive Nutritional Status. Indian Journal of Forensic Medicine & Toxicology, 15(4), 2557-2565.

Hariyanti, R., Pamela, V. Y., & Kusumasari, S. (2021). Review Jurnal: Aktivitas Antioksidan Pada Beberapa Produk Berbahan Dasar Kulit Buah Naga Merah. JITIPARI (JurnalIlmiahTeknologi dan IndustriPangan UNISRI), 6(1), 41-48.

Harshitha, S., YV, N. G., Tom, A. V., SP, L. K., & KS, M. K. (2024). A Comprehensive Analysis of Nutritional Profile, Cultivation Techniques, and Therapeutic Potential of Dragon Fruit (Hylocereus spp.). Journal of Pharma Insights and Research, 2(5), 075-094.

Haveni, D., Mastura, M., & Sari, R. P. (2019). Ekstrak Etanol Kulit Buah Naga Super Merah (Hylocereus Costaricensis) Sebagai Anti Oksidan dengan Menggunakan Metode DPPH. KATALIS: Jurnal Penelitian Kimia dan Pendidikan Kimia, 2(2), 30-37.

Hendra, R., Masdeatresa, L., Abdulah, R., & Haryani, Y. (2020, June). Red dragon peel (Hylocereus polyrhizus) as antioxidant source. In AIP Conference Proceedings (Vol. 2243, No. 1). AIP Publishing.

Kiranmai, M. (2022). Review of exotic fruit: Nutritional composition, nutraceutical properties and food application of Dragon fruit (Hylocereus spp.). The Pharma Innovation Journal, 11(6), 613-622.

Lourith, N., & Kanlayavattanakul, M. (2013). Antioxidant and stability of dragon fruit peel colour. Agro Food Industry Hi Tech, 24(3), 56-58.

Luo, H., Cai, Y., Peng, Z., Liu, T., & Yang, S. (2014). Chemical composition and in vitro evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide extracts of pitaya (dragon fruit) peel. Chemistry Central Journal, 8, 1-7.

Luo, H., Cai, Y., Peng, Z., Liu, T., & Yang, S. (2014). Chemical composition and in vitro evaluation of the cytotoxic and antioxidant activities of supercritical carbon dioxide extracts of pitaya (dragon fruit) peel. Chemistry Central Journal, 8, 1-7.

Niah, R., & Helda, H. (2016). Aktivitas antioksidan ekstrak etanol kulit buah naga merah Daerah Pelaihari, Kalimantan Selatan dengan metode DPPH (2, 2-difenil-1-pikrilhidrazil). Jurnal Pharmascience, 3(2).

NIM, D. W. L. (2022). Uji Efek Antihiperlipidemia Ekstrak Etanol Kulit Buah Naga Merah (Hylocereus Monocanthus (Lem.) Terhadap Kadar Kolesterol Total Pada Tikus Putih Jantan Galur Wistar.

Nugraheni, K., Putriningtyas, N. D., Fernando, G. S. N., & Bintari, S. H. (2023). The Improvement of Lipid Profiles and Glucose Resistance of Hypercholesterolemic Rats using Tempeh Flour Based-Yoghurt Complemented with Red Pitaya Peel Extract. Biosaintifika: Journal of Biology & Biology Education, 15(3), 314-325.

Nugraheni, K., Putriningtyas, N. D., Fernando, G. S. N., & Bintari, S. H. (2023). The Improvement of Lipid Profiles and Glucose Resistance of Hypercholesterolemic Rats using Tempeh Flour Based-Yoghurt Complemented with Red Pitaya Peel Extract. Biosaintifika: Journal of Biology & Biology Education, 15(3), 314-325.

Panjaitan, R. G. P., & Amelia, S. (2022). Antihypercholesterolemic Power of Red Dragon Fruit (Hylocereus polyrhizus) Peel Extract. Pharmacognosy Journal, 14(3).

Shofinita, D., Bindar, Y., Dinnita, R. U., & Rizqi, F. (2021, April). Techno-economic Analysis: Antioxidant-Rich Natural Colorant Production from Dragon Fruit Peel. In IOP Conference Series: Materials Science and Engineering (Vol. 1143, No. 1, p. 012041). IOP Publishing.

Sigarlaki, E. D., & Tjiptaningrum, A. (2016). Pengaruh pemberian buah naga merah (Hylocereus polyrhizus) terhadap kadar kolesterol total. Medical Journal of Lampung University [MAJORITY], 5(5), 14-17.

Suryana, A. L., Putri, C. Y. K., Rosiana, N. M., & Arum, P. (2024). Soy and Dragon Fruit Functional Drink: The Potential to Reduce Cholesterol Total Levels in Hypercholesterolemic Sprague Dawley Rats. International Journal of Health and Information System, 2(1), 49-56.

Suryaningsih, S., Muslim, B., & Djali, M. (2021, March). The antioxidant activity of Roselle and dragon fruit peel functional drink in free radical inhibition. In Journal of Physics: Conference Series (Vol. 1836, No. 1, p. 012069). IOP Publishing.

Watuguly, T. W., Uniarti, A., & Nindatu, M. (2019). Aplikasi ekstrak kulit buah Naga Merah (Hylocereus polyrhizus) pada nata de coco dalam menurunkan kadar kolesterol total, LDL, dan meningkatkan HDL pada mencit (Mus musculus). Jurnal Profesi Medika: Jurnal Kedokteran dan Kesehatan, 13(1).

Werdiningsih, W., & Octavia, I. (2024). PENGARUH PEMBERIAN KULIT BUAH NAGA MERAH TERHADAP KADAR LDL TIKUS PUTIH DIINDUKSI DIET TINGGI LEMAK. Journal of Nursing and Health, 9(3, September), 287-292.

Zamzam, M. Y., Fayla, Y., & Anggraeni, Y. O. (2023). Uji Aktivitas Antioksidan Kombinasi Ekstrak Kulit Buah Naga Merah (Hylocereus polyrhizus) DAN EKSTRAK KUNYIT (Curcuma longa L.) Dengan Metode Dpph: Antioxidant Activity Test Combination Of Red Dragon Fruit Rind Extract (Hylocereus polyrhizus) And Turmeric Extract (Curcuma longa L.) With DPPH Method. Medical Sains: Jurnal Ilmiah Kefarmasian, 8(1), 85-96.

Zubaid, M., Abdulla, M. H., Salman, I. M., & Rathore, H. Effect of dragon fruit extract on oxidative stress and aortic stiffness in streptozotocin-induced diabetes in rats.