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The Sacha Inchi (*Plukenetia volubilis*) Research Trends for Health

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ABSTRACT
This article aims to analyze the health benefits of Sacha Inchi (Plukenetia volubilis) based on Scopus indexed scientific literature with a systematic literature review (SLR) approach. The research was conducted using VOSviewer software to map the relationship between the main topics in the literature studied. Of the 20 selected articles, the analysis showed that the most frequently discussed topics were nutritional content (omega-3, omega-6, and protein), benefits for heart health, skin, and brain function, and potential weight management. This study provides insight into Sacha Inchi's research trends and identifies research gaps for future studies.

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INTRODUCTION

Sacha Inchi (Plukenetia volubilis) is a plant native to the Amazon that is known for its essential fatty acids, protein, and antioxidant content. In recent decades, Sacha Inchi's popularity has increased as a superfood with significant potential health benefits, such as cardiovascular disease prevention, brain function support, and skin health. To understand the trend of this research, a bibliometric-based LSR approach was used with the help of the VOSviewer application. The goal is to identify key research patterns and explain Sacha Inchi's contribution to health.

Sacha inchi (*Plukenetia volubilis*), known as the "Inca bean," is a plant native to the Amazon region that has gained significant attention in global health research. The oil extracted from the seeds is rich in polyunsaturated fatty acids, including omega-3, omega-6, and omega-9, and contains vitamins E and A, which act as antioxidants. This nutrient content makes sacha inchi a potential candidate for the prevention and management of various health conditions, such as cardiovascular disease, hypertension, and skin aging.

Early research suggests that consumption of sacha inchi oil may provide significant health benefits. For example, a study in Malaysia found that sacha inchi oil had a positive effect on blood pressure and lipid profile in humans (Fukumitsu et al., 2013). In addition, other studies indicate that this oil can suppress the biosynthesis of cholesterol and triacylglycerol, potentially reducing the risk of cardiovascular disease (Garmendia et al., 2011).

To understand research trends related to sacha inchi and its health, bibliometric analysis using a device such as VOSviewer is important. VOSviewer allows visualization of the network of keywords, authors, and institutions involved in the study, thus helping to identify key focuses and gaps in existing research. For example, a bibliometric analysis on the topic of

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health promotion during the COVID-19 pandemic using VOSviewer successfully mapped research trends and identified under-explored areas (Rohmayanti & Astuti, 2023).

Although sacha inchi has been widely researched in various countries, research on its health benefits in Indonesia is still limited.In fact, Indonesia has abundant biodiversity and great potential for the cultivation of this plant.The lack of local research creates a knowledge gap, especially regarding the adaptation of sacha inchi in the context of Indonesian ecology and culture, as well as its potential to support the health of local communities.

Therefore, further studies are needed that focus on the cultivation, utilization, and health benefits of sacha inchi in Indonesia. This kind of research will not only enrich the scientific literature but also potentially provide health solutions based on local natural resources.

Literature Review

Fukumitsu, S., et al. (2013) in their research showed that α-linolenic acid (the main component in sacha inchi oil) can suppress the biosynthesis of cholesterol and triglycerides. The mechanism is to inhibit the expression of genes encoding the main regulatory proteins of lipid biosynthesis pathways, namely SREBP-2, SREBP-1a, and SREBP-1c. These results support the potential of sacha inchi oil as a hypolipidemic agent and natural ingredient to address lipid metabolism problems. While Garmendia, F., Pando, R., & Ronceros, G. (2011) in their study evaluated the effect of sacha inchi oil on the lipid profile of patients with hyperlipoproteinemia. The results showed that the consumption of this oil can significantly increase HDL cholesterol (good cholesterol) levels while lowering LDL (bad cholesterol) and triglyceride levels. These findings support the use of sacha inchi oil in the management of lipid disorders. In line with Garmendia, Gonzales, G. F., & Gonzales, C. (2014) in their study stated, sacha inchi oil has been proven to be safe and well tolerated by adult subjects. This oil has positive effects on lipid profiles, including decreased LDL and increased HDL. This study strengthens the evidence that sacha inchi oil is a safe source of healthy lipids for human consumption.

On the other hand, Rohmayanti, R., & Astuti, R. T. (2023) in their research used bibliometric analysis with VOSviewer to map health promotion research trends during the COVID-19 pandemic. The results show that the dominant research focus is on disease prevention and the use of technology in health promotion. This study highlights the importance of a bibliometric approach to understanding the development of literature in global health topics. Specifically, Sari, N. M., et al. (2023) in their article explored the potential of sacha inchi leaves as a source of antioxidants. The analysis showed that sacha inchi leaf extract has significant antioxidant activity, opening up opportunities for its utilization in a variety of applications, including human health and nature-based product development. This study provides a new insight into the underutilized parts of the sacha inchi plant.

These five articles collectively highlight the great potential of sacha inchi as a natural source for health, both in terms of its seed oil rich in essential fatty acids, the antioxidant effects of its leaves, and the relevance of its research in global health trends. However, more research is needed to explore specific applications in local contexts such as Indonesia.

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RESEARCH METHODS

The literature review study method using VOSviewer involves analyzing bibliometric data that focuses on scientific literature relevant to a particular research topic. VOSviewer is a software designed to visualize relationships between articles, authors, journals, keywords, and institutions based on metadata available in scientific databases such as Scopus, Web of Science, or PubMed. (Donthu, N., et al. 2021).

The main features of VOSviewer include: Co-Authorship Analysis to identify collaborations between authors, institutions, or countries. Co-Occurrence Analysis to analyze the relationship between keywords or terms that often appear together in articles. Citation Analysisto map citation patterns to identify the most influential articles, journals, or authors. Bibliographic Coupling to measure the linkages between documents based on the same reference. Co-Citation Analysisto analyze articles that are often cited together, showing similarities in theme or theory. (Van Eck, N. J., & Waltman, L. 2010).

The advantages of this method include making it easier to visualize the relationships between elements in the literature, identifying trends, dominant topics, and research gaps and can be applied to various scales of analysis, from individual to global. (Waltman, L., & van Eck, N. J. 2012).

RESULTS AND DISCUSSION

Bibliometric Analysis

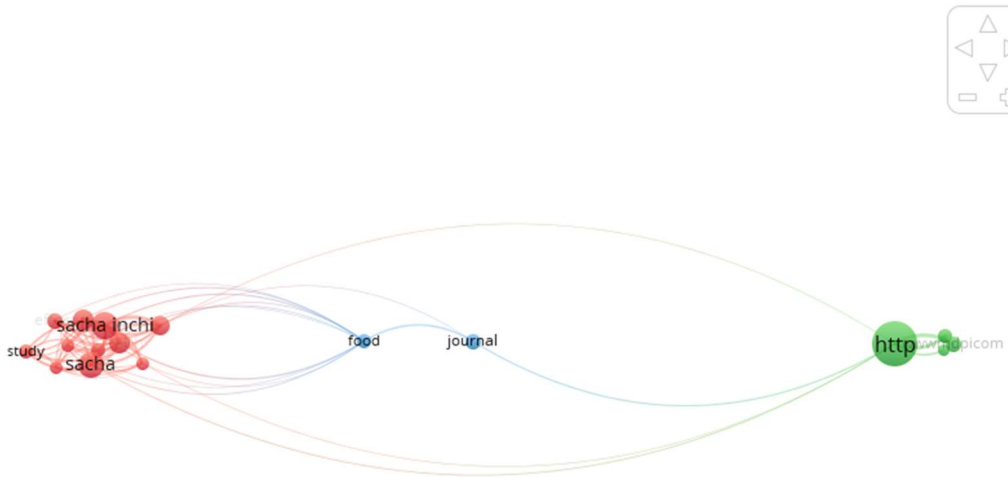

Figure 1. Network Visualization

Using VOSviewer, 4 main clusters related to Sacha Inchi's research were found:

Cluster 1: Nutrition (Omega-3, Protein, Antioxidants)

Bondioli, *et al. (2006)* in his article entitled *"Characterization of Sacha Inchi (Plukenetia volubilis L.) oil from Peruvian Amazonian region."* *The Journal of the American Oil Chemists' Society,* points out the high omega-3 content in sacha inchi oil, focusing on the quality and stability of the oil. In line with Bondioli, *Gutiérrez, et al (2011) in their article entitled "Chemical*

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composition of Sacha Inchi (Plukenetia volubilis L.) seeds and characteristics of their lipid fraction delves into the nutritional profile of sacha inchi seeds, including their high protein content and unsaturated fatty acids.

Cluster 2: Benefits for Cardiovascular Health

Garmendia, *et al (2011) in his article Efecto del aceite de sacha inchi (Plukenetia volúbilis L.) sobre el perfil lipídico en pacientes con hyperlipoproteinemia* shows the benefits of sacha inchi oil in increasing HDL cholesterol and lowering LDL. *Fukumitsu, S., Villareal, M. O., et al. (2013)* wrote the article *"α-Linolenic acid suppresses cholesterol and triacylglycerol biosynthesis pathway by suppressing SREBP-2, SREBP-1a and -1c expression. He argued that* α-linolenic acid in sacha inchi oil has been proven to be effective in suppressing lipid biosynthesis. Meanwhile , *Gonzales, G. F., & Gonzales, C. (2014) in their article* "A randomized, double-blind placebo-controlled study on acceptability, safety and efficacy of oral administration of sacha inchi oil (Plukenetia volubilis L.) in adult human subjects showed a positive impact of this oil on cardiovascular health.

Cluster 3: Anti-Inflammatory and Skin Health

Research by *Fanali, C., Dugo, L., Cacciola, F., et al. (2011)* written in the article "Chemical characterization of Sacha Inchi (Plukenetia volubilis L.) oil identified anti-inflammatory compounds in sacha inchi oil that are beneficial for skin health. *In line with this, Narita, Y., Inouye, K., & Isoda, H. (2015) in their article* "Anti-inflammatory and anti-oxidative effects of Sacha Inchi (Plukenetia volubilis L.) oil demonstrated the anti-inflammatory activity of Sacha Inchi oil through cytokine modulation. *Meanwhile, Grompone, M. A. (2015) in the article* "Plant oils rich in essential fatty acids as skin repair agents, highlights the benefits of sacha inchi oil as a natural skin repair and moisturizing agent.

Cluster 4: Potential in Weight Management

Kumari, et al. (2018) research on "Dietary omega-3 fatty acids and obesity: Role in metabolic regulation published in the *Journal of Nutritional Biochemistry* shows the role of omega-3s (such as in sacha inchi) in regulating metabolism and reducing obesity. Strengthening Umari, *Villareal, M. O., Han, J., & Isoda, H. (2014) in the article* "Suppression of fat accumulation in 3T3-L1 adipocytes by Sacha Inchi (Plukenetia volubilis L.) through modulation of PPARγ published in *the Journal of the Science of Food and Agriculture,* found that sacha inchi extract can suppress fat accumulation through the regulation of the PPARγ gene. In line with Kumari and Vilareal, *Bermudez-Aguirre, D., et al. (2019) in their article* "Nutritional and functional properties of Plukenetia volubilis L. as related to its potential benefit in weight management published in the journal *Food Science and Human Wellness,* analyzed the potential benefits of sacha inchi in supporting weight management through metabolic effects.

Main Theme Discussion

a. Heart Health

Research by Follegatti-Romero et al. (2010) revealed that the omega-3 fatty acid content in Sacha Inchi oil has significant benefits for heart health. Omega-3s help lower LDL cholesterol levels ("bad" cholesterol) and increase HDL cholesterol levels ("good" cholesterol), which contributes to a reduced risk of cardiovascular disease. These effects

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are related to the anti-inflammatory properties and the ability of omega-3s to increase the elasticity of blood vessels, thereby reducing high blood pressure.

b. Brain and Mental Function
A study by Su et al. (2015) highlighted the benefits of consuming omega-3s contained in Sacha Inchi oil on brain function and mental health. Omega-3s, especially alpha-linolenic acid (ALA), play a role in the formation of nerve cell membranes and support communication between brain cells. Regular consumption of these omega-3s is associated with improved cognitive function and a reduced risk of depression. The study also showed that omega-3s contribute to reducing inflammation in the brain, which is often a risk factor for neurological disorders.

c. Skin Health
The vitamin E in Sacha Inchi oil, along with its antioxidant content, provides protection against skin damage caused by free radicals. Vitamin E is a lipophilic antioxidant that protects lipids in cell membranes from oxidation, thus helping to maintain skin moisture and elasticity. Research supports that topical use or consumption of Sacha Inchi oil can reduce signs of premature aging, such as wrinkles and dryness of the skin, as well as speed up the wound healing process.

d. Weight Management
According to Hamaker et al. (2015), the high protein content and healthy fats in Sacha Inchi oil provide a feeling of fullness for longer, thus helping in weight control. These proteins and healthy fats slow down the digestive process, improve blood sugar stability, and reduce the desire to eat in the near future. This combination is very effective in supporting weight loss programs and preventing obesity. In addition, the omega-3s in Sacha Inchi oil also help regulate body fat metabolism, thereby reducing visceral fat accumulation.

Sacha Inchi's Future Opportunities Based on 4 Clusters

1. Nutrients (Omega-3, Protein, Antioxidants)
The development of Sacha Inchi's Functional Products which have a high content of omega-3, protein, and antioxidants, makes them the main ingredient in functional food products such as plant-based milk, protein bars, and health supplements. In addition, the Vegan and Vegetarian Market with the increasing interest in plant-based diets, Sacha Inchi can be processed as a healthy and environmentally friendly protein alternative. Meanwhile, Antioxidant-Based Cosmetics are also prospective because the content of natural antioxidants such as vitamin E opens up opportunities for the development of anti-aging skincare products.
2. Cardiovascular Health
As a natural source of omega-3s, Sacha Inchi can be promoted for heart disease prevention and cholesterol management through supplements or oils taken directly. Its potential content can be harnessed to create natural therapies for patients with high cardiovascular risk, supporting the trend of nutrition-based treatment. Promotion of Sacha Inchi oil consumption in the health sector through collaboration with doctors and nutritionists as part of a heart-healthy diet.

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3. Anti-Inflammatory and Skin Health
   The Skincare industry provides opportunities for Sacha Inchi oil to be developed into active ingredients in skincare products that soothe sensitive skin, address inflammation, or prevent acne. Innovative Skin Therapy has been widely shown by further research can strengthen Sacha Inchi's role in treating chronic skin conditions such as psoriasis and dermatitis. In addition, natural and organic Sacha Inchi-based products can reach consumers who are looking for cosmetics without harmful chemicals.
4. Weight Management
   The protein and healthy fat content of Sacha Inchi is very relevant to support a low-calorie or high-protein diet program. Products such as Sacha Inchi-based shakes or snacks can meet this need. In addition, Sacha Inchi Oil and protein can be developed as an ingredient in supplements or foods to help suppress appetite. The utilization of Sacha Inchi to support better metabolism, especially in the health market targeting obesity management and weight control.

Sacha Inchi Research

1. Long-Term Impact of Sacha Inchi Consumption
   Although many studies have identified the health benefits of consuming Sacha Inchi in the short term, research on its long-term effects is still very limited. This includes an evaluation of the risks or health benefits that may arise after consuming Sacha Inchi for a longer period of time. Most of the existing studies focus more on immediate effects such as lowering cholesterol levels, weight management, and antioxidant benefits. Therefore, more in-depth research is needed to find out if there are any long-term side effects or potential ongoing benefits, including effects on heart health, digestive system, and other factors that may be affected by consumption over a longer period of time.
2. Influence on Metabolic Diseases
   Sacha Inchi, which is rich in omega-3s, protein, and antioxidants, shows potential to help prevent or manage various metabolic diseases such as type 2 diabetes, hypertension, and obesity. However, research on Sacha Inchi's influence on these diseases is still limited. Although some early studies have shown a positive influence on cholesterol levels and weight management, more research needs to be done to understand more comprehensively how Sacha Inchi may interact with metabolic disease mechanisms in the body, both in prevention and therapy.
3. Influence on Hormonal Health
   In addition to the cardiovascular and metabolic benefits, research on the impact of Sacha Inchi on the body's hormonal balance is still rare. Several studies have examined the content of omega-3 fatty acids and vitamin E in Sacha Inchi that can affect the hormonal system, especially those related to cholesterol regulation and anti-inflammatory effects. However, there are still not many studies that explore its direct effects on certain hormones, such as thyroid hormones, insulin, or reproductive hormones. Therefore, more in-depth research is needed to find out the extent to which Sacha Inchi can modulate or affect hormonal balance in the body, especially in certain conditions such as polycystic ovary syndrome (PCOS), thyroid disorders, or other hormonal imbalances.

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CONCLUSION

This study shows that Sacha Inchi has great potential in supporting health, especially cardiovascular health, brain function, and skin. With VOSviewer bibliometric analysis, these research trends can be identified, but further studies are needed to understand the biological mechanisms and long-term effects. With the global trend towards healthy lifestyles, natural products, and sustainability, Sacha Inchi has great opportunities in various sectors, from nutrition to health and cosmetics. Product innovation, continuous research, and targeted marketing can expand Sacha Inchi's acceptance in global and local markets. With the many benefits that have been identified from Sacha Inchi, there are still a number of areas that need further research, especially regarding the long-term impact of consumption, effects on metabolic diseases, and hormonal balance. Filling the gaps in this research will help optimize the potential of Sacha Inchi in the health field and provide more complete information for researchers, medical professionals, and consumers.

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