Asian Interdisciplinary and Sustainability Review

Original Research Article

Received: 11 October 2023 **Revised:** 15 December 2023 **Accepted:** 24 December 2023

DEVELOPING AND UPGRADING THE LINGZHI LOCAL HERB AS THE COMMERCIAL PRODUCTS BY DUAL EXTRACTION METHOD

Nantharat NAMBURI[1], Kwanrutai SAELIM[1], Sirichai NAMBURI[1], Amart SULONG[1], Sukrita RAKSUDJARIT[1], Chanthana SUSAWAENGSUP[2] and Shinawatra JUNCHAIRASSAMEE[3]

1 Yala Rajabhat University, Thailand; nantharat.n@yru.ac.th (N. N.); kwanrutai.s@yru.ac.th (K. S.); sirichai.n@yru.ac.th (S. N.); amart.s@yru.ac.th (A. S.); sukrita.r@yru.ac.th (S. R.)

2 Maejo University Phrae Campus, Thailand; c.susawaengsup@gmail.com

3 Independent Researcher, Thailand; hannshyane@gmail.com

Handling Editor:
Professor Dr.Kittisak JERMSITTIPARSERT University of City Island, Cyprus
(This article belongs to the Theme 2: Science and Technology for Sustainable Development)

Reviewers:
1) Professor Dr.Roy Rillera MARZO MSU, Malaysia
2) Assistant Professor Dr.Sasaphon MOONGVICHA RMUTP, Thailand
3) Registered Pharmacists Dr.Worathat THITIKORNPONG CU, Thailand

Abstract

The objective of this research is to develop the Lingzhi local herbal as a commercial product. The research design selected for this study is mixed methods research. The target group for this study is the Piyamit Tunnel 1 Community, located in Yala, Thailand. This is achieved through the development of a Lingzhi herbal product branded "PIYAMIT TUNNEL Kiri 1987." The research revealed that the dual extraction method yields the highest quantity of extract. Additionally, the examination of contamination of heavy metals and microorganisms in the Lingzhi mushroom extract, using the dual extraction method, confirms that they adhere to the standard criteria set by the Ministry of Public Health. This establishes Lingzhi mushroom extract as a suitable ingredient for dietary supplements, capable of being combined with extracts from other herbs known for their immune-stimulating properties. These additional ingredients primarily include Korean ginseng extract, wolfberry extract (Goji berry), cordyceps extract, Beta-glucan, and Citrus Bioflavonoid extract. The herbal packaging design has been developed to be a round bottle with a screw cap. As for the color of the bottle, it is a tea-colored bottle. The herbal mushroom product has received a Food and Drug Product Registration Number, which is 50-2-10764-5-0001.

Keywords: Product Development, Black Lingzhi Mushroom, Commercial Supplementary Food Product, Dual Extraction Method

Citation Information: Namburi, N., Saelim, K., Namburi, S., Sulong, A., Raksudjarit, S., Susawaengsup, C., & Junchairassamee, S. (2023). Developing and Upgrading the Lingzhi Local Herb as the Commercial Products by Dual Extraction Method. *Asian Interdisciplinary and Sustainability Review, 12*(2), 41-51. https://doi.org/10.14456/aisr.2023.5

Introduction

Lingzhi mushroom, scientifically known as *Ganoderma lucidum* (Leys. Ex Fr.) Karst., belongs to the Ganodermataceae family. This revered mushroom has been a staple in traditional Chinese medicine for over 4,000 years, featured in various medicinal recipes ranging from health tonics to elixirs, and even specific treatments for conditions such as hepatitis and high blood pressure. Its medicinal properties are primarily attributed to its flowers and spores. Numerous medical studies have reported the immune-stimulating effects of Lingzhi mushrooms in patients with conditions like lung cancer, colon cancer, and advanced stages of cancer. Additionally, it has demonstrated analgesic properties and is considered safe for use in patients with rheumatoid arthritis. Lingzhi has proven effective in treating patients with nervous system diseases, lower urinary tract issues, and shingles-related back pain. Furthermore, extensive research has unveiled a range of pharmacological effects associated with Lingzhi mushrooms. These include immune system stimulation of tumor and cancer growth, prevention of nerve degeneration, regulation of blood sugar levels, reduction of blood fat, and anti-oxidative as well as anti-inflammatory properties. The active extracts within Lingzhi mushrooms encompass substances from the polysaccharide group, terpenoid compounds, sterol group substances, unsaturated fatty acids, and protein substances (Soonthornchareonnon & Rueanwiset, 2008).

The “Betong Lingzhi Mushroom” stands as another remarkable discovery by the Malaya Community Group. Among Lingzhi mushrooms, the herbal variant from the Piyamit 1 community, known as the black Lingzhi mushroom, holds a distinguished reputation under Chinese medicinal principles for its exceptional properties. This particular variant occurs naturally in the Piyamit 1 community. Furthermore, the Lingzhi Mushroom contains crucial substances such as Triterpene, Nucleotide, Polysaccharide, Germania, and Ergosterol. These substances have properties that include anti-inflammatory, immune enhancement, antioxidant, anti-cancer, fat reduction, improved nervous system function, heart and blood vessel recovery, and antibacterial effects. These findings are consistent with the research of Gao et al. (2012), which indicates that Polysaccharide is a substance that enhances the body’s immune system. It stimulates the production of white blood cells, which is essential for fighting various infectious diseases and allergies in patients undergoing chemotherapy. Additionally, it can enhance the immune system, increase white blood cell production, alleviate allergy symptoms, reduce side effects from chemical therapy (including radiation) in cancer patients, and nourish the liver. Currently, Lingzhi mushrooms are typically available in dried and pickled forms, posing challenges in terms of portability and consumption for consumers. Therefore, there's a proposal for a new advancement in Lingzhi mushroom processing: the creation of capsules. This innovation would not only facilitate convenient storage and consumption but also enhance its nutritional value. Offering high-quality products plays a pivotal role in bolstering the product's image and elevating the profile of the local area. Moreover, a prevalent issue in numerous communities pertains to product designs that might not entirely align with consumer preferences. Recognizing the significance of product design in enhancing the quality of community products, the research team, guided by Sasongkoah et al.'s insights from 2008, thus the study and experimentation of extracts from black Lingzhi to produce healthy supplementary food efficiently led to the purpose of this research, which is developing Lingzhi local herbal products as viable commercial offerings.

Product Development Concept

Product development, as defined by Fuller in 1994, encompasses various objectives and broad coverage, all ultimately aiming for the creation of new products that generate profits. This process is integral for organizations seeking growth and enhancement. However, it's important to acknowledge that successful new product development is a complex endeavor,

demanding a diverse range of knowledge, processes, skills, tools, and techniques. Saneeworg (n.d.) identified that tablet supplementary food products could incorporate ingredients with higher concentration due to the production process, such as compression. This allowed for the addition of more nutrients in one tablet compared to the form of capsules or soft gels, while maintaining equal quantities. Furthermore, tablets could also have a longer shelf life. In a study by Soksawatmakin & Bunyahotra in 2013, the effectiveness of Lingzhi mushroom extract on the level of fatigue and quality of life in patients with chronic fatigue syndrome was examined. The research yielded promising results, indicating that Lingzhi mushroom extract could enhance Serum Cortisol levels, suggesting its efficiency in supporting the immune system and the HP A-axis. This mechanism likely contributes to symptom improvement and a reduction in disease severity. Notably, the key compounds within Lingzhi mushrooms include polysaccharides, found in the mushroom's cap, which stimulate the body's immune system, and triterpenoids, which have antihistamine properties beneficial in conditions like high blood pressure.

Triterpenoids are predominantly found in Lingzhi mushroom spores, which are easily dispersed. Hence, the processing of black Lingzhi mushroom products involves careful considerations, starting from upstream processes like purchasing, sorting, cleaning, and cutting. In the midstream, product processing has been enhanced using an electricity hot air oven system, designed to prevent spore dispersion and preserve the medicinal properties of Lingzhi mushrooms. The resulting products adhere to Thai Industrial Standards Institute 996/2005, ensuring quality for general consumers. The downstream phase involves the preparation of raw materials for advanced processing, requiring complex technology. Collaborating with a royal project possessing advanced technology, such as an ultrasonic system for bio-extraction, is essential. Two critical types of molecules in Lingzhi mushrooms, triterpenes (inhibitors of liver cancer, blood pressure regulators, and artery fat reducers) and nucleotides (relievers of pain, blood clot preventers, paralysis reducers, and virus growth inhibitors), are targeted for production, catering to tourists seeking specialized medicine. Consequently, the development and upgrading of local Lingzhi mushroom products in the Piyamit 1 community not only enhances their knowledge and processing capabilities but also produces unique, high-quality products compliant with FDA and community product standards (dried herbs 996/2005). This endeavor opens doors for future technology development, potentially establishing the community as a center for processing or extracting various herbs in the southern Thailand. Until today, the research team has not applied for approval from the US Food and Drug Administration, but there is a plan to request it further because they aim to expand the market abroad. Additionally, this product boasts better properties than local products in terms of health, such as ShanYaoKein herbal decoction for health, due to the higher concentration of extracts and the convenience of consumption.

Packaging Development Concept

Tongrungroj (2012) defined packaging as the various procedures involved in packaging, wrapping, and collecting products to ensure safe transportation. This process begins during production and continues until the products reach the consumers. Good packaging obtains a beautiful image and quality. Therefore, designing a package is considered a delicate thing. Significantly, it should consider the purposes of keeping and marketing to achieve a valuable, qualitative, and sustainable package. According to Serirat (1996), packaging refers to the various materials use, such as paper, plastic, glass, metal, and wood, to create containers for wrapping products. A well-designed package should be durable, aesthetically pleasing, proportionate, convey a positive brand image, include efficient communication elements, and satisfy customers. Additionally, Tangsasom (1994) stated that packaging encompasses the activities occurring throughout the marketing process, involving the use of various materials

to create containers or wrappers for products. The functions of packaging include protecting products from damage, maintaining quality, facilitating use, ensuring convenience in transportation, and serving as a tool for marketing communications.

From the definitions of packaging mentioned above, it can be concluded that The figures and characteristics of the box, package, or container serve the purpose of wrapping and protecting products to maintain their quality from the hands of producers to the hands of consumers, preventing damages during transportation. Additionally, packaging serves as a marketing promotion tool to stimulate purchases.

Stewart, as cited by Auti (2012), discussed the development of packaging designs, emphasizing the importance of selecting various elements thoughtfully to create distinctiveness in the product. This includes ensuring the appropriate use of color tones that match the product, achieving a balanced integration of images, effectively utilizing colors, and generating innovative ideas for visual design. Additionally, it involves creating either a realistic or miniature model as an illustrative example for packaging design. Ultimately, all this information is presented to the product owner for collaborative decision-making, leading to the production of market-ready products (Boonrawd & Sukanthasirikul, 2019). In the context of research findings, effective packaging serves the dual purpose of protecting the product and ensuring its preservation from the production site to the hands of the consumer. Packaging should also contribute added value to the product, thereby enhancing consumer satisfaction. To achieve this, successful packaging design must consider a multifaceted approach, which involves studying the outcomes of previous packaging utilization and addressing various issues encountered with similar packaging types in the market. These insights should inform the development of innovative packaging solutions. Moreover, packaging design should be guided by principles of artistic composition and current societal trends, influencing the choice of an appropriate printing process tailored to specific packaging needs. Once the new packaging design is finalized, it can be employed to package the product and is subjected to consumer use. Manufacturers and designers of packaging should maintain an ongoing process of monitoring and evaluating packaging performance to make improvements for the foreseeable future. These improvements should align with evolving societal trends and ensure competitiveness in the market. Crucially, environmental concerns must be a top priority in packaging design, aiming to minimize adverse environmental impacts (Wechbanyongrat, 2018).

Development of Nutritional Supplements from Lingzhi Mushrooms

Development of nutritional supplements from Lingzhi mushroom extract involves the following steps:

Step 1: Examine the raw materials employed in the research.

Step 2: Investigate the process of extracting substances from Lingzhi mushrooms. This research project has explored three methods for extracting substances from Lingzhi mushrooms: 1) Dual extraction method utilizing ethanol and water as solvents in a ratio of Lingzhi mushroom per ethanol per water as 1 : 1 0 : 1 0 , 2) Ultrasonic extraction method employing solvents consisting of 50 percent ethanol and water in a ratio of Lingzhi mushroom per 50% ethanol per water as 1: 1 0 : 1 0 , and 3) Microwave extraction utilizing solvents of 50 percent ethanol in a ratio of Lingzhi mushroom per 50% ethanol as 1:10 to yield a substantial amount of extract and essence.

Step 3: Choose Lingzhi mushroom extract for use as an ingredient in dietary supplements by selecting extracts that yield high volumes.

Step 4: Verify the quality of Lingzhi mushroom extract and establish its specifications. Conduct thorough checks for contaminants, heavy metals, which might happen during the

procedure of analysis, or microorganisms by sending extract samples for analysis. An analysis center at Standard is available for this purpose.
Step 5: Formulate the dietary supplement. In this research project, extracts from other herbs known for their immune-boosting properties were blended. These herbs are listed in the announcements provided by the Food and Drug Administration regarding approved names for use in dietary supplements.
Step 6: Select suitable packaging and design the package. For this commercial packaging of the local medicinal herb Lingzhi mushroom, preferences and input from consumers and academics were taken into consideration.
Step 7: Develop a brand name and design the label. The product's brand name and logo for the dietary supplement, derived from Lingzhi Mushroom Extract, were created. The original brand of the Piyamit 1 community group was used, and the label design for the product was executed by the company based on information from the research team.
Step 8: Apply for a food and drug product registration number. In the production process of dietary supplements, obtaining a registration number from the Food and Drug Administration is a necessary step.

Research Results and Discussion

Raw Material Inspection Results

This research project utilizes Lingzhi mushrooms, depicted in Picture 1, sourced from the Ban Piyamit 1 community in Betong District, Yala Province. These Lingzhi mushrooms occur naturally and being free from chemicals. Residents of the village gather and meticulously select Lingzhi mushrooms to wash by clean water, cut into pieces, and dried them before entering the extracting process. This practicing process acquires the Good Agricultural Practices (GAP).


Mushroom Stalks


Mushroom Flowers

Figure 1 Lingzhi Mushrooms

Results of Extraction of Substances from Lingzhi Mushrooms

The research conducted the process from Lingzhi mushroom in three extracting processes: 1) dual extraction method, 2) ultrasonic extraction, and 3) microwave extraction. The extraction results shown in Table 1 were as follows:

Table 1 Physical characteristics and percentage of Lingzhi mushroom extracts from different extraction methods

Extraction Method	Solvent	Extract Percentage	Physical Characteristics
*Dual extraction	Ethanol and water	*5.47 ± 1.22	Dark brown powder
Ultrasonic extraction	50% Ethanol	3.60 ± 0.53	Dark brown powder
Ultrasonic extraction	Water	3.47 ± 0.81	Dark brown powder
Microwave extraction	50% Ethanol	1.87 ± 0.50	Dark brown powder

When comparing the amounts of Lingzhi mushroom extracts obtained using different extraction methods, as shown in Table 1, it was revealed that the Dual extraction method yielded the highest amount of extract, totaling 5.47% ± 1.22. This was followed by Lingzhi mushroom extracts obtained through the Ultrasonic extraction method using a solvent comprising 50% ethanol and water, which resulted in 3.60% ± 0.53 and 3.47% ± 0.81, respectively. Notably, the Microwave extraction method produced the least amount of extract, accounting for only 1.87% ± 0.50. Regarding the physical characteristics of the extracts obtained via the Dual extraction method, the Ultrasonic extraction method, and the Microwave extraction method, they all exhibited the same dark brown powder consistency, as depicted in Figure 2. This is consistent with the findings of Ngakham (2017), who observed that ethanol-based extracts tend to have a somewhat sticky and dense texture, forming dark brown clumps, while aqueous extracts are typically crumbly and exhibit the same dark brown color.

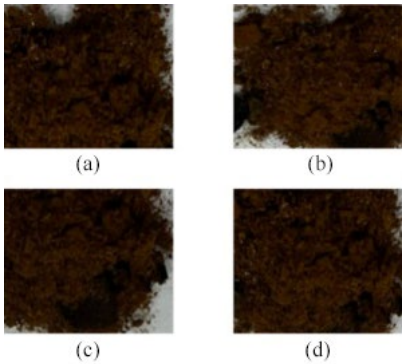

Figure 2 Physical Characteristics of Lingzhi mushroom extracts from the Dual extraction method (a), Ultrasonic extraction method using 50% ethanol (b) and water (c), and Microwave extraction method (d).

The study on the extraction process from Lingzhi mushrooms in the study on the extraction process from Lingzhi mushrooms to obtain crucial substances, water, and ethanol were chosen as solvents. Ethanol was considered to have low toxicity and could be eliminated better than other solvents, making it safe for consumers. Therefore, water and ethanol are commonly used in the extraction process for obtaining crucial substances from Lingzhi mushrooms and other herbs. Additionally, these solvents are allowed for registration in the attachment on the announcement of the Food and Drug Administration (FDA). For the extraction process, it revealed that the dual extraction method, utilizing ethanol and water solvents, yielded the highest amount of extract. As a result, the research team opted for the dual extraction technology in the production of dietary supplements, making it accessible to the community in a user-friendly design that doesn't demand advanced technological expertise. This approach is well-suited for initiating the development and processing of products within the community.

Results of Quality Inspection of Lingzhi Mushroom Extracts

The research examined the quality of black Lingzhi mushroom powder, focusing on the contamination of heavy metals and the number of microorganisms, yeast, and mold. The extraction results are presented in Table 2 as follows:

Table 2 Results of analysis of inspection of heavy metal contamination and microorganisms in the extract

Test items	Test results	Ministry of Public Health Announcement
Arsenic (AS)	0.88 mg/kg	Not more than 2 mg/kg
Cadmium (Cd)	0.12 mg/kg	Not more than 0.3 mg/kg
Lead (Pb)	0.34 mg/kg	Not more than 1 mg/kg
Mercury (Hg)	<0.018 mg/kg	Not more than 0.5 mg/kg
Total aerobic plate count	<10 cfu/g	Not more than 5 x 10^4 cfu/g
Total yeast and molds plate count	<10 cfu/g	Not more than 5 x 10^2 cfu/g

The quality inspection of Lingzhi mushroom extracts involved sending samples to the Central Laboratory (Thailand) Company Limited for analysis. This analysis aimed to detect any heavy metal contamination and microorganisms, ensuring the safety of the extracts and certifying that the products either contained no heavy metals or had levels lower than the maximum allowable in edible foods, as stipulated in the Ministry of Public Health's announcement on Standards for food with contaminants (Issue 414, 2020). In assessing the quality of the Lingzhi mushroom extract, the criteria for maximum allowable amounts were utilized, measured in milligrams per kilogram. For ready-to-eat dietary supplements, the criteria were as follows: not more than 2 milligrams per kilogram for inorganic arsenic (As) or total arsenic, not more than 0.30 milligrams per kilogram for cadmium (Cd), not more than 1 milligram per kilogram for lead (Pb), and not more than 0.5 milligrams per kilogram for mercury (Hg). The results of the heavy metal contamination analysis indicated the following levels: arsenic (As) at 0.88 milligrams per kilogram, cadmium (Cd) at 0.12 milligrams per kilogram, lead (Pb) at 0.34 milligrams per kilogram, and mercury (Hg) at less than 0.018 milligrams per kilogram. These values were found to be within the standard criteria set forth by the Ministry of Public Health (Issue 414, 2020). Furthermore, the examination of Total Aerobic Microbial Count (cfu/g or cfu/ml) and total yeast and mold count (cfu/g or cfu/ml) revealed counts of less than 10 cfu/g for both, by the standards outlined in the Ministry of Public Health's announcement regarding purity values and other critical characteristics for registered herbal product recipes in 2021, as detailed in Table 3. This aligns with the findings of Buachun & Sunthornsart (2015), who observed that traditional medicine samples did not exceed the maximum allowable levels of contamination set by the World Health Organization for food or products intended for consumption.

Results of Formulation Dietary Supplements

In this research project, the formulation of dietary supplements included extracts from various herbs known for their immune-boosting properties, all of which are listed in the Announcement of the Food and Drug Administration specifying approved names for use in dietary supplements. Each tablet, sized at 500 milligrams, contains the following extracts: (1) Lingzhi mushroom extract, weight 10 mg (2) Korean ginseng extract, weight 50 mg (3) wolfberry extract (Goji berry), weight 50 mg (4) Cordyceps extract, weight 50 mg, (5) Beta-glucan, weight 50 mg, and (6) Citrus Bioflavonoid extract, weight 50 mg. For each of the herbal extracts integrated into the food supplement product alongside Lingzhi mushroom, a certificate of analysis (COA) is available. The quantities of Lingzhi mushroom extract and other herbal extracts are all within the criteria established by the Food and Drug Administration for permissible names in dietary supplements. These have been thoroughly tested for pelleting. The product's pellet characteristics are illustrated in Figure 3.

Figure 3 Dietary supplements from Lingzhi mushroom extract mixed with other herbs

Results of Packaging Selection and Package Design

The selection of the herbal packaging design was based on feedback gathered from consumers and experts. It was determined that a round bottle with a screw cap was the optimal choice. This design was favored for its convenience in usage, ease of handling, and portability. Regarding the color of the packaging, the majority of the target group preferred a tea-colored glass bottle since it can reduce the light that might harm the products within the bottle. Moreover, it can endure high heat and protect against the absorption of gas and steam effectively. This choice serves the dual purpose of reducing potential harm from light exposure to the product inside and offering good resistance to high temperatures, while also effectively preventing the penetration of gas and steam. This can be observed in Figure 4. This is consistent with Hiranyachawalit (2017) who emphasized that for dietary supplements to be user-friendly, the packaging must be designed for easy opening and closing, resistant to bending or deformation, and sized to fit comfortably in the hand—not too small or too large.

Figure 4 Packaging Design

Results of Using Brand Names and Label Designs

The product brand name and logo for the dietary supplement derived from Lingzhi mushroom extract have adopted the original brand name of the Piyamit 1 community group, namely "PIYAMIT TUNNEL Kiri 1987," as depicted in Figure 5. This name holds significant recognition, especially among tourists, which instills trust in the sourcing of raw materials for Lingzhi mushrooms used in the production process. The label design for the product, inclusive of packaging designs, product sizes, product name, logo or brand, essential components, properties, usage instructions, warnings, manufacturer's name and location, FDA number, and manufacturing and expiration dates, has been meticulously crafted by the designated company based on information provided by the research team. This can be observed in Figure 6. This is consistent with Iemcharoen (2008), who found that black lettering on a white background, or white lettering on a dark background, enhances the visibility of text on a product. Adequate spacing between letters contributes to improved legibility, and for shorter product names, it aids in memorability. In terms of packaging,

utilizing contrasting colors is advisable, and opting for distinctive hues aids in easy recognition.

Figure 5 Brand On dietary supplements from Lingzhi mushroom extract

Figure 6 Label Design on dietary supplement products

Food and Drug Product Registration

Requesting food and drug product registration numbers from the Food and Drug Administration: For the supplementary food product from Lingzhi mushroom, the product was approved from the Food and Drug Administration, which is 50-2-10764-5-0001.

Conclusion

Black Lingzhi mushroom is a well-known variety according to the principles of traditional Chinese medicine, renowned for its exceptional properties among all Lingzhi mushrooms. The black Lingzhi mushroom found in the Piyamit community 1 occurs naturally. In light of this, the development of a local Lingzhi mushroom herbal product has been undertaken as a commercial venture under the brand name 'PIYAMIT TUNNEL Kiri 1987.' This product has been created through the processing of Lingzhi mushroom extract into capsule form using the dual extraction method, chosen for its ability to yield the highest extract content. The rigorous testing for heavy metal contamination and microorganisms has demonstrated compliance with the standards set forth by the Ministry of Public Health. Therefore, Lingzhi mushroom extract can be utilized as an ingredient in dietary supplements, either alone or in combination with other herbal extracts known for their immune-boosting properties. The herbal product's packaging has been thoughtfully designed as a round bottle with a screw cap, chosen for its user-friendliness and ease of portability. The bottle's tea-colored hue serves a dual purpose, reducing the potential harm from light exposure to the products inside and enhancing resistance to environmental factors. Finally, the herbal mushroom product received a food and drug registration number, which is 6 5 4 4 8 5 4 , allowing the community to produce products that can be sold to tourists to contribute to career creation and long-term income.

References

Auti, J. (2012). *Packaging Development for Chiangmai Organic Agricultural Coop's Organic Brown Rice*. Master of Business Administration Thesis, Maejo University.

Boonrawd, M., & Sukanthasirikul, K. (2019). The Effect of Product Innovation and Service Process Innovation on Marketing Performance of 3 to 4 Stars Hotel Businesses in Thailand. *NRRU Community Research Journal, 13*(3), 225-236.

Buachun, N., & Sunthornsart, P. (2015). Determination of Heavy Metals and Contamination of Microorganism in Traditional Drugs. *VRU Research and Development Journal Science and Technology, 10*(1), 78-95.

Fuller, G. (1994). *New Product Development from Concept to Marketplace*. Florida: CRC Press.

Fuller, G. (2004). *New Food Product Development*. 2nd ed. Florida: CRC Press.

Gao, P., Hirano, T., Chen, Z., Yasuhara, T., Nakata, Y., & Sugimoto, A. (2012). Isolation and identification of C-19 fatty acids with anti-tumor activity from the spores of Ganoderma lucidum (reishi mushroom). *Fitoterapia, 83*(3), 490-499.

Hiranyachawalit, S. (2017). The Study and Development of Packaging Design for Senior Population: A Case Study of Osteoarthritis Prevention and Cure Dietary Supplement. *Veridian E-Journal, 10*(3), 390-412.

Iemcharoen, W. (2008). *Designing for Communication of Medicine Package Label for Low Vision Persons: A Case Study in the Northern School for the Blind, Chiang Mai Province*. Master of Arts Thesis, Chiang Mai University.

Ngakham, J. (2017). Evaluation of Anti-metastatic Effects of Ganoderma lucidum Extracts on Human Mammary Carcinoma Cell Line; MCF-7. *Thai Journal of Toxicology, 32*(2), 73-86.

Saneeworg, K. (n.d.). *Supplementary Food Product*. Retrieved from https://aova.co.th/drink betterthancapsule/.

Sasongkoah, T., Maha-in, K., & Numahun, P. (2008). *Designing and Development of Package Patterns Products from Surin Silk*. Bangkok: Rajamangala University of Technology Phra Nakhon.

Serirat, S. (1996). *Consumer Behavior*. Bangkok: Visit Pattana Publishing.

Soksawatmakin, S., & Bunyahotra, W. (2013). *Due to fatigue level and quality of life in patients with chronic fatigue syndrome*. Retrieved from https://anti-aging.mfu.ac.th/ File-_PDF/research56/Proceeding56_40.pdf.

Soonthornchareonnon, N., & Rueanwiset, N. (2008). *Quality of Thai Medicinal Ingredients from Research to Sustainable Development*. Bangkok: Concept Medicus Co., Ltd.

Stewart, B. (2007). *Packaging Design*. London: Laurence King.

Tangsasom, S. (1994). *Customer satisfaction in receiving the services of Krung Thai Bank Company Limited*. Master's Thesis, National Institute of Development Administration.

Tongrungroj, S. (2012). *Packaging Design*. Bangkok: Wadsilp.

Wechbanyongrat, P. (2018). Eco-friendly packaging design. *Information Journal, 17*(1), 37-48.

Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.