JTE HCMUTE
ISSN: 2615-9740

JOURNAL OF TECHNICAL EDUCATION SCIENCE
Ho Chi Minh City University of Technology and Education
Website: https://jte.edu.vn
Email: jte@hcmute.edu.vn

The Formulation of an Anti-Aging Serum With Liposomes Containing Durian (*Durio zibethinus* Murr.) Peel Extract

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ARTICLE INFO

Received: 19/05/2025
Revised: 05/10/2025
Accepted: 07/10/2025
Published: 28/11/2025

KEYWORDS

Anti-aging;
Durian peel extraction;
Polyphenolic compound;
Liposome;
Enhanced penetration.

ABSTRACT

Durian (*Durio zibethinus* Murr.) peel is considered a food byproduct, although it is a good source of bioactive compounds for anti-aging skincare products. In this research, a Vietnamese durian was collected, and its white peel was extracted by ethanol and hexane to utilize the bioactive compounds for green cosmetic development. The total flavonoid content and total phenolic content were 857.13 ± 80.91 µg QE/g dried peel and 6549.58 ± 884.32 µg GAE/g dried peel, respectively. Subsequently, this extract was encapsulated by a liposome nanocarrier by thin film hydration for deeper skin penetration, which was physically characterized by size and zeta potential. The size of plain liposome was 102.9 nm (PDI 0.210) along with the stable monodispersibility by zeta potential of -31.40 mV while the diameter of extract-loaded liposome was 250.0-280.0 nm with low zeta potential values. On the other hand, the stability of the extract-loaded liposome was also investigated. The result showed the extract-loaded liposome expanded its size after storing at 4°C, 25°C and 40 °C, at both PBS 7.4 and 5.5, within one-month storage. Finally, an anti-aging serum containing extract-loaded liposomes was formulated. Under an optical microscope, the emulsion showed a size of 10-50 µm, spherical, and monodisperse. However, the pH of the serum base and serum lipo 0.1% got an unstoppable increase at 4°C, 25°C and 40 °C within one-month storage. This information is necessary for the future contribution of durian byproducts as a rich source of bioactive compounds for green skincare products.

Doi: https://doi.org/10.54644/jte.2025.1908

1. Introduction

Green cosmetics are beauty and skincare products designed with environmental ecofriendliness, sustainability, and clinical efficacy, prioritizing the use of natural, organic, and ethically sourced ingredients while avoiding harmful ones. Regarding the use of natural ingredients, fruit extract is emerging as an interesting candidate for skincare products because it satisfies the definition of green and sustainable cosmetics, bringing lasting therapeutic properties to the skin and improving customer experience. Durian (*Durio zibethinus* Murr.) is a kind of tropical fruit that is planted in Vietnam, Thailand, Malaysia, Indonesia, etc. Although durian meat has an important role in food with nutrition, durian skin usually seems to be a food byproduct that may cause environmental concerns owing to improper uses. Therefore, there is a need to use this byproduct as a beneficial ingredient for skincare because it contains natural compounds such as flavonoids, phenolic compounds, tannins, and saponins, which are antioxidants [1].

Light, heat, ionizing radiation, and chemical agents can initiate the aging process of our skin. Generally, inflammation is a protective physiological response to an external stimulus, to eliminate and/or limit the spread of the injurious agent. The development of inflammation is usually initiated by

a wide range of toxic oxidative reactions in the body, which result from free radicals and highly reactive oxygen species (ROS). Free radicals, such as superoxide ion (O_2^-), hydroxyl (HO), hydroperoxyl (HO_2), peroxyl (ROO), and alkoxyl (RO) as well as non-radicals such as ozone (O_3) and hydrogen peroxide (H_2O_2), are highly reactive species with an unpaired electron in the outer shell of their molecules which originate from the metabolism of oxygen as well as byproducts of the various physiological reactions. Another terminology that can initiate the inflammatory response is oxidative stress, which is created by the imbalance between free radicals and antioxidants of the cells. As a result, their complications are aging, atherosclerosis, arthritis, cancer, brain stroke, diabetes, Parkinson's disease…ROS stimulates the inflammation process through the upregulation of COX-2, synthesis of prostaglandin E2, and skin erythema induction. Though aging cannot be prevented, however, it is made to progress gracefully, healthily, and positively. The endogenous and exogenous antioxidants can be used to support the body's defense against various free radical-associated pathologies. Regarding exogenous antioxidants, they can be vitamin C, vitamin D, vitamin E, vitamin K, flavonoids, and phenolic compounds, which are present in various tropical fruits and plants [2].

Although natural bioactives have potential in preventing our skin from aging, they are prone to decomposition or oxidation by external stimuli, thus decreasing their efficacy [3]. Additionally, the skin barrier causes significant obstacles for these active compounds to go through. Therefore, nanotechnology has been presented to improve this difficulty by encapsulating them into a nanoscale and delivering them to deeper skin layers to complete their efficacy. Liposomes are closed concentric phospholipid vesicles with an aqueous core surrounded by a lipophilic membrane, which are beneficial for either hydrophobic or hydrophilic actives, facilitating the fusion of active compounds with different layers of the skin. Liposomes are non-toxic, non-immunogenic, biocompatible, and biodegradable, which are potentially suitable for transepidermal delivery.

In this research, we made efforts to create liposomes to carry durian peel extract and promote this nanosystem to an anti-aging serum. First, the durian peel extract was prepared to calculate the amount of total flavonoid content (TFC), total phenolic content (TPC), and DPPH radical scavenging. Secondly, this extract was encapsulated by liposomes consisting of lecithin and cholesterol, characterized by size and zeta potential, along with the encapsulation rate of both TFC and TPC. Lastly, an anti-aging serum containing durian peel extract-loaded liposomes was developed with some physical stability over time. This investigation has a potential application of natural byproducts for skincare to comply with the future green cosmetics.

2. Materials and Methods

2.1. Materials

The raw material was durian (*Durio zibethinus*) purchased from agricultural stores in Thu Duc City, Ho Chi Minh City, in January to February 2025. The selected durians had to be fresh, with dark green skin, sharp thorns, and no signs of decay, fermentation, or damage as depicted in Figure 1a. The durian peel used for extraction is the middle peel separated from the spike peel and the inner peel in contact with the fruit flesh with a small knife (Figure 1b). They were dried at 40-45 ^oC for 1-2 days (Figure 1c). Finally, obtaining the middle peel, which is opaque yellow white, smells like tree sap, and is rich in total flavonoid content and total polyphenol content. This middle peel can be processed to extract beneficial compounds that may contribute to various health benefits, including antioxidant properties.

Figure 1. *a) Fresh durian peel; b) The durian peel has been separated; c) Dried durian peel*

The selection process ensured that only the durians met the quality, and criteria were peeled and extracted. The durian variety used for this study was Durian (*Durio zibethinus*) Ri 6 grown in Tien Giang Province, Vietnam, which was genetically surveyed based on barcoded DNA and ISSR molecular markers [4].

Lecithin and Cholesterol were purchased from Merck, Germany. Anhydrous sodium carbonate, 99% Potassium acetate, and Aluminum chloride were purchased from Xilong, China. Quercetin dihydrate 95% was sourced from Merck, Germany. L-ascorbic acid with 99% purity was obtained from Fischer, while DPPH with 97% purity was obtained from Cool Chemistry Science and Technology, Beijing, China. Chloroform, methanol, and acetone were obtained from Xilong, China. Double-distilled water was obtained from the Institute of Advanced Technology without additional filtration.

The serum formulation's ingredients are Glycerin, Xanthan gum, Olivem 1000, Almond oil, Vitamin E, and Geogard ECT were from local Chinese manufacturers.

2.2. Durian peel extraction

After purchase, the outer green spiny shell and the white rind in contact with the fruit flesh of *Durio sp.* were manually removed using a knife to obtain the central white core. This white core portion was subsequently dried using convection drying at a stable temperature of 40–45°C, with the convection valve adjusted to 40% from 24 to 48 hours, until low moisture content and firm structural integrity were achieved. This drying process resulted in a significant mass reduction, with the final dry weight of the endocarp constituting approximately 4.76% (0.721 kg) compared to the initial fresh weight (15.13 kg), indicating substantial water removal.

The completely dried core material was finely ground into powder with a moisture content of 8.312%. Sequential extraction was performed via maceration using ethanol and hexane (1:1 volume ratio) as solvents at ambient temperature. Specifically, 5 g of finely ground durian core powder was initially extracted with 25 mL of ethanol, ensuring uniform dispersion and continuous stirring for 30 minutes. The same solid residue was subsequently re-extracted with approximately 25 mL of hexane (>99%) under similar stirring conditions. This extraction procedure with both solvents was repeated three times to optimize the recovery of target compounds.

The extract mixture from both solvents was clarified by vacuum filtration through quantitative filter paper with a pore size of 3 µm (Figure 2a and b). The resulting filtrate (in Figure 2c), deep yellow, was concentrated using a Buchi R-300 rotary vacuum evaporator (operating conditions: 40°C, 200 mbar, rotation speed 100 rpm) with condenser temperature maintained at 5°C. The concentrated extract was further purified of remaining particulate matter by filtration through a 0.45 µm hydrophobic syringe filter. The final extract was stored at 4–5°C, protected from light.

The total extract volume obtained after concentration ranged from 7.0 to 7.5 mL per 5 g of initial dry powder, corresponding to an extraction yield of approximately 1.4 –1.5 mL/g dry matter or 1 mL per 21 g of fresh rind.

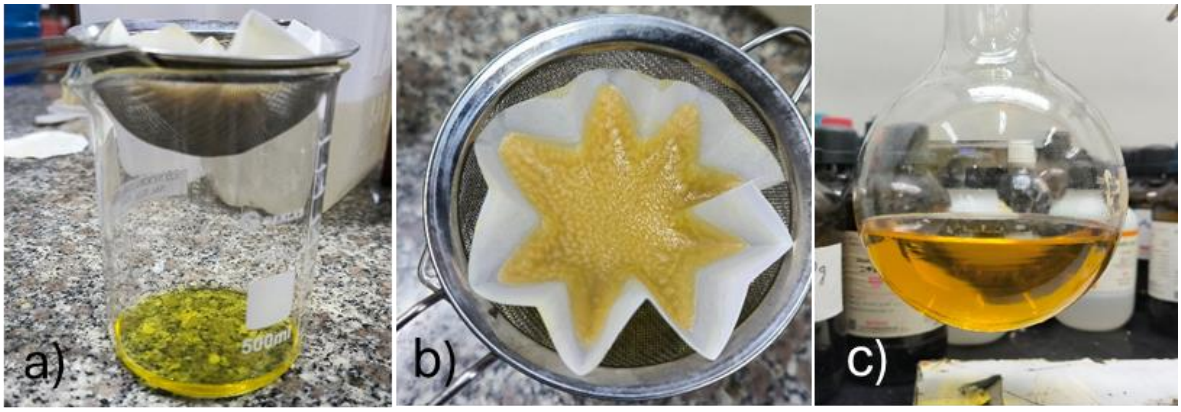

Figure 2. *Durian peel extraction: a) paper filtration design, b) the remaining residue, and c) the yellow filtrate was put into a round flask for vacuum evaporation.*

2.3. Total Phenolic content (TPC), Total Flavonoid content (TFC), and DPPH antioxidant activity

After extracting the bioactive compounds from durian peel, the resultant was calculated as the total phenolic and flavonoid content, called TPC and TFC, respectively. The procedure was done in our previous article [5].

2.3.1. Total phenolic content

Briefly, regarding TPC, gallic acid was dissolved in methanol to create a concentration of 100 µg/mL. This solution was diluted to a range of standard concentrations at 0.78125, 1.5625, 3.125, 6.25, 12.5, 25, 50, and 100 µg/mL of gallic acid. Afterward, 0.5 mL of these solutions was added 2.5 mL of 10% Folin-Ciocalteu reagent, mixed, and left in the dark for 10 minutes. Finally, 2 mL of Na_2CO_3 7.5% solution was added to each of the mixtures and shaken to obtain a homogeneous solution. Let them in the dark for 60 minutes and measure the absorbance at 765 nm by Jasco V-770 UV-Vis spectrophotometry.

0.5 mL of the extract was added 2.5 mL of 10% Folin-Ciocalteu reagent, followed by the same steps as above. The calculation was triplicate and defined by using the following formula:

$$TPC = \frac{C \times K \times V}{m \times (1 - \%MC_S)} \quad (1)$$

Herein,

- TPC: Total Polyphenol content (µg GAE (Gallic acid equivalents)/g extract),
- C: the concentration obtained from the standard curve (µg/mL),
- V: the volume of extract solution (mL),
- K: the dilution factor (No dilution, K = 1),
- m: the mass of extract in volume V (g).
- $\%MC_S$: Moisture content of sample (%).

2.3.2. Total flavonoid content

For TFC, a range of quercetin standard solutions of 10, 20, 40, 60, 80, and 100 µg/mL in methanol was prepared. Afterward, 0.5 mL of these solutions were added 1.5 mL of methanol, vortexed to become homogenous. After 5 minutes, 0.1 mL of $AlCl_3$ 10% was added to them and left free for 6 minutes. Finally, 0.1 mL CH_3COOK 1M solution was inserted, and 45 minutes later, these solutions were measured for their absorbance at the wavelength 415 nm by Jasco V-770 UV-Vis spectrophotometry.

0.5 mL of the extract was added 1.5 mL of methanol, followed by the same steps as above. The calculation was triplicate and defined by using the following formula:

$$TFC = \frac{C \times K \times V}{m \times (1 - \%MC_S)} \quad (2)$$

Herein,

- TFC: Total Flavonoid content (µg QE (Quercetin equivalents)/g extract),
- C: the concentration obtained from the standard curve (µg/mL),
- V: the volume of extract solution (mL),
- K: the dilution factor (No dilution, K = 1),
- m: the mass of extract in volume V (g).
- $\%MC_S$: Moisture content of sample (%).

2.3.3. DPPH scavenging ability

The durian peel extract and extract-loaded liposome had a range of concentration of 31.25-1000 µg/mL polyphenolic content equivalent. Then, 100 µL of these solutions were added to a 3 mL DPPH 0.1 mM solution. The negative control contains only MeOH and DPPH, while the positive control

contains ascorbic acid. Incubate the samples in the dark room for 30 minutes and measure the absorbance at 517 nm by Jasco V-770 UV-Vis spectrophotometry. Antioxidant activity (%) is calculated as:

$$\textbf{Antioxidant activity } (\%) = \left(\frac{A_0 - A_t}{A_0} \right) \times 100 \quad (3)$$

Herein:

- A_0: Absorbance value of the standard DPPH sample
- A_t: Absorbance value of the test sample

2.4. Durian peel extract-loaded liposomes

2.4.1. Procedure

Liposomes were synthesized by the thin film hydration method [6], [7] using Tween 80 as an edge activator, which destabilizes the lipid shell and increases the elasticity of the vesicles [8]. On the other hand, Tween 80 also gives rise to the formation of unilamellar vesicles [9]. The phospholipid is the main component of the liposome, while cholesterol helps to decrease the fluidity and water permeability of the liposomes by its arrangement in the bilayer [9]. First, 117.0 mg lecithin and 35.6 mg cholesterol were dissolved in 3 mL of chloroform, and vortexed to obtain a homogenous mixture. Afterward, this mixture was transferred to the 250 mL round-bottom flask and vacuum evaporated at a rotation speed of 100 rpm, temperature at 60 ^{o}C under pressure of 450 mbar in 40 minutes (Buchi R-300 rotary vacuum evaporator). As for the durian peel extract-loaded liposome, 0.5 mL of durian peel extract was diluted with 9.49 mL PBS 7.4 and 10 µL Tween 80, and vortexed to get the homogenous solution. The thin film lipid was hydrated at room temperature to obtain 10 mL of milky suspension. This liposomal suspension was homogenized within 3 minutes by an amplitude of 40% to reduce the size of the medicated liposomes, followed by storing at 4 $^{\circ}$C for one day before dialysis to remove the free extract.

The dialysis method was applied to purify liposomal suspension. First, 10 mL of unwashed liposomes was put into a dialysis bag of 3.5 kDa, which was fixed with a dialysis tubing closure and placed in 50 mL of water (release medium) at room temperature under magnetic stirring for 6 hours. At time intervals of 0.25, 0.5, 1, 2, 3, 4, 5, and 6 hours, 5 mL of the dialysate was taken out to calculate the concentration of free flavonoids and phenolic compounds (as depicted at ***2.3.1*** and ***2.3.2***) and another 5 mL of fresh release medium was added to the chamber to maintain the total volume of 50 mL.

The plain liposome preparation was carried out in the same way, except for hydrating by using 10 mL of PBS 7.4 containing 0.1% of Tween 80.

2.4.2. Evaluation of the stability of liposome particles

The purified liposomes containing durian peel extract were diluted by both PBS 7.4 and PBS 5.5 (1:100 volume ratio) and stored at room temperature (RT 25 ± 2 ◦C and 60% relative humidity), in a climatic chamber (40 ± 2 ◦C and 75% relative humidity) and under refrigeration (RE 4 ± 2 ◦C), and they were analyzed at 0, 15, and 30 days. The parameters analyzed were mean vesicle diameter, polydispersity index, and zeta potential by Zetasizer Pro-Blue (serial number MAL1253395), England [3].

2.5. Serum containing durian peel extract-loaded liposomes preparation

2.5.1. The formulation of serum

The composition of the serum was designed as previously described in Table 1 [5].

Table 1. *The formulation of serum-based and serum-containing durian peel extract-loaded liposomes preparation.*

Phase	% w/w	Ingredient
A	To 100%	Water
B	2.5	Glycerin

	0.3	Xanthan gum
C	3.0	Olivem 1000
	5.0	Almond oil
D	2.5	Glycerin
	0.0%, 0.1%	Durian peel extract-loaded liposomes
E	0.2	Vitamin E
	0.9	Geogard ECT
	pH adjustment	

Table 1 shows the composition of the serum with and without durian peel extract-loaded liposomes. First, mix glycerin and xanthan gum in phase B to form a paste. Add phase B to phase A, stirring vigorously to swell the xanthan gum. Phase C was prepared by mixing its components. Both phase A/B and phase C were heated separately to 75 °C until complete homogenization. When air bubbles were observed forming at the bottom of the glass beaker of phase A/B, phase C was gradually added into phase A/B. The mixture was stirred continuously to create a uniform, milky white emulsion. After cooling the formulation to below 40 °C, phases D and E were added and mixed thoroughly into the system. The pH of the final product was adjusted to a target range of 5.3–5.8 by tromethamine and citric acid.

2.5.2. Physicochemical characteristics of the serum base and serum lipo 0.1%

Physical observations by color, odor, skin irritation, appearance, and phase separation were made against the base serum and serums containing tomato extract.

Skin irritation test: The experiment was conducted by a group of 20 volunteers at the Institute of Advanced Technology in Ho Chi Minh City. Approximately 0.5g of the serum was applied to the hand 2 times per day to evaluate the swelling, itchiness, or redness [10].

Homogeneity: weight 5g serum base and serum lipo 0.1%, place them in centrifugal tubes, and centrifuge at 3,000 rpm for 30 minutes for 3 cycles at room temperature [11].

2.5.3. Stability of the serum base and serum lipo 0.1%

pH measurement was conducted every 10 days within 1 month to assess the change in pH of the samples stored at room temperature (RT 25 ± 2 ◦C and 60% relative humid), in a climatic chamber (40 ± 2 ◦C and 75% relative humidity), and under refrigeration (RE 4 ± 2 ◦C) [10].

Optical microscopy: a small amount of serum base and serum lipo 0.1% was spread onto a glass slide. Their size and shape were visualized by an optical microscope (IM-5/Optika, Italy) at 4X magnification [5].

3. Results and Discussion

3.1. The characterization of durian peel extract

The durian peel was extracted with ethanol and hexane, followed by vacuum evaporation to collect its bioactive compounds and evaluate the concentration of total polyphenol and flavonoid content (TPC and TFC). Herein, Figure 3a depicts the calibration curve of gallic acid is y = 0.0105x + 0.0348 (R^2 = 0.9981), and Figure 3b expresses the calibration curve of quercetin is y = 0.01953x - 0.05327 (R^2 = 0.9975). Hence, the total polyphenol and flavonoid were 6549.58 ± 884.32 µg GAE/g dried peel and 857.13 ± 80.91 µg QE/g dried peel, respectively. A research group from Thailand has extracted the active compounds from the peel of their local durians called Chanee and Monthong, of which the TPC were 3576.74 ± 259.99 mg GAE/g extract and 3471.98 ± 141.06 mg GAE/g extract [12].

Moreover, Figure 3c shows the DPPH scavenger of the durian extract, extract-loaded liposome, and positive control ascorbic acid. Herein, ascorbic acid expressed the highest DPPH scavenging ability, durian extract also had its ability in antioxidation owing to its high content of polyphenolic compounds,

while the extract-loaded liposome showed a potential antioxidant. This data supports the possibility of using an extract-loaded liposome for skincare products.

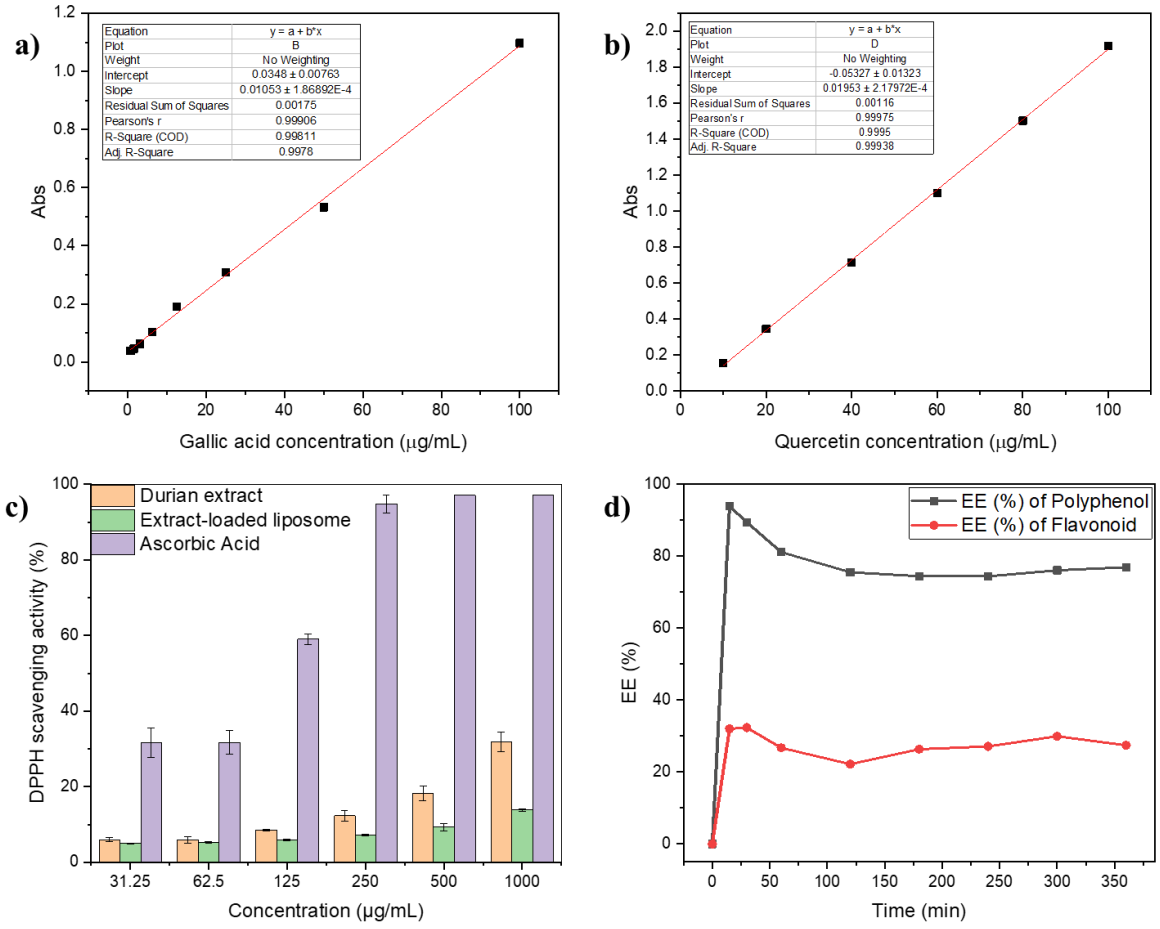

Figure 3. *The calibration curve of a) Gallic acid and b) Quercetin; c) The DPPH scavenging ability of durian peel extract, and d) The graph expresses the encapsulation rate of phenolic compounds and flavonoids by dialyzing the liposomes over time.*

3.2. The durian peel extract-loaded liposomes

It is important to determine the encapsulation rate of liposomes toward durian extract. As Figure 3d performed, the encapsulation rate over time is determined by the dialysis technique. This method uses a semi-permeable membrane to diffuse the small molecules from liposomal suspensions, in which the small molecules pass through the pores of the dialysis bag to the outside medium, while the large molecules' movement is restricted. Several factors affect dialysis performance, such as the low molecular weight compounds, the appropriate pore size of the membrane, and the dialysis medium. Regarding dialysis medium, it is chosen based on the solubility of the compounds, which means that compounds should be soluble in the chosen medium. Another aspect of dialysis medium, its osmotic pressure should be consistent with that of liposome-contained suspensions; otherwise, the structure of liposomes may be disrupted, leading to the leakage of drugs from liposomes [13].

At the early stage of dialysis, the excessive extract would penetrate through the membrane until there was no further free extract remaining in the dialysis bag; thus the encapsulation rate would be high and reduced to a stable value, and the purification would reach the state of equilibrium. Herein, regarding total phenolic content (TPC), after 15 min, the encapsulation rate was more than 90% and gradually reduced to 75.53% at 120 min, then it was stable until 6 hours. Total flavonoid content (TFC) has a similar trend; after 15 min of washing, the entrapment rate was 32% and gradually reduced to 22.18% at 120 min, then it was stable until 6 hours. Thus, the encapsulation rates of TPC and TFC were 75.53% and 22.18%, respectively.

Figure 4 summarizes the stability of durian peel extract-loaded liposomes at pH 7.4 and 5.5 after 0 days, 15 days, and 30 days storage at 4 ºC, 25 ºC and 40 ˚C [3]. The size of the plain liposome was 102.9 nm (PDI 0.210), zeta potential was -31.40 mV. After encapsulating the extract, the size of the liposome containing the extract was larger than the plain carrier, which indicates the presence of the extract inside the nanocarrier. Starting at day 0, we had three sizes of 268.0, 271.6, and 280.3 nm after diluting with PBS 7.4, and another three sizes of 255.6, 272.3, and 286.8 nm after diluting with PBS 5.5.

During the stability test, at both pH 7.4 and 5.5, the lowest and largest sizes were respectively at 4ºC and 40 ˚C at all time intervals. Besides, except for cold storage at 4 ˚C, the size of liposomes has a noticeable increase in their size over time. This phenomenon was due to the fusion and aggregation of liposomes, which indicated that 25 ºC is not conducive to maintaining the stability of extract-loaded liposomes; the accelerated testing at 40 ºC has also revealed this instability [7]. In brief, at pH 7.4, the size of 4ºC-liposome was remarkably stable, which means that the particles remained monodisperse and intact during the study, but the size of 25 ˚C- and 40 ˚C-liposome expanded from 271.6 to 304.9 nm (PDI from 0.209 to 0.308), 280.3-365.9 nm (PDI from 0.273 to 0.443), respectively. Besides, at pH 5.5, the size of 4ºC-liposome was slightly varied but still stable, the size of 25 ˚C- and 40 ˚C-liposome escalated from 272.3 to 340.1 nm (PDI from 0.222 to 0.225), 286.8-411.5 nm (PDI from 0.177 to 0.416), respectively. Regarding zeta potential, the 4ºC-liposome and 40 ˚C-liposome had a trend to raise their stability over time for all pHs. However, 25ºC-liposome had a trend to decrease and then increase its value over time at all pHs.

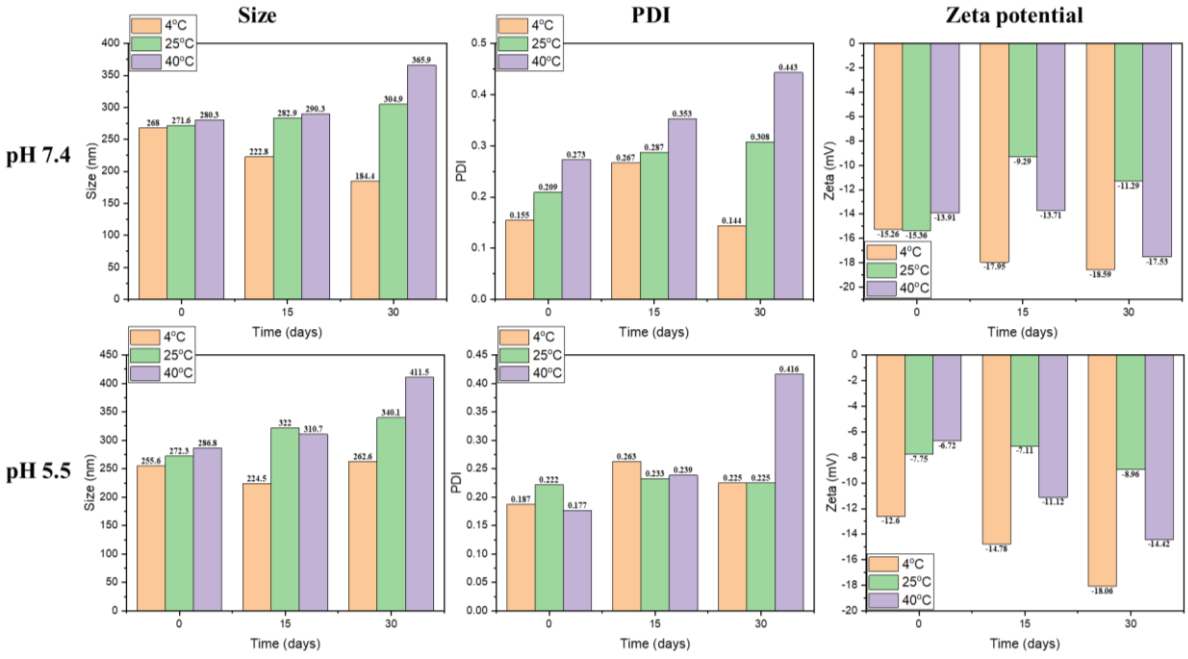

Figure 4. *The stability in terms of size, PDI, and zeta potential of liposomes containing durian peel extract at PBS buffers of pH 7.4 and 5.5, which were stored at 4 ˚C, 25ºC and 40 ˚C within 1 month.*

3.3. Evaluation of serum containing durian peel extract

After obtaining the medicated liposomes, the anti-aging serum was created and characterized by the related physical test and stability assessment. Skincare products are a type of emulsion, which could be an oil-in-water emulsion or water-in-oil emulsion, based on the customer's demands. An oil-in-water emulsion is currently present in most personal care products owing to the acceptable after-use feeling. However, this emulsion has a microscale size, which makes it difficult to penetrate the skin epidermis and penetrate deeper layers, reducing the effectiveness of the products. Thus, we have inserted the medicated liposomes into the serum base at a concentration of 0.1% (w/w) and carried out the physical stability test to evaluate the ability of commercialization of the serum. Table 2 showed the serum base was semi-solid, milky in form, without any odor owing to no fragrances or essential oils. On the other hand, serum base has a pH of 5.62, which is compatible with skin acidity and leaves no irritation. In

addition, the serum base was a homogenous oil-in-water emulsion which was stable with no phase separation after centrifugation at 3,000 rpm in an hour (data not shown). Likewise, serum containing 0.1% of durian peel extract-loaded liposome also gave the milky form of odorless semi-solid emulsion, which is greatly compatible with the skin barrier by its pH of 5.45. This product is a type of homogeneous oil-in-water emulsion that was stable after centrifugation at 3,000 rpm for an hour by no phase separation.

Subsequently, the serum base and serum lipo 0.1% were assessed for their pH variation within 1 month at different temperatures, which were shown in Figure 5. Originally, the pH of serum base and serum lipo 0.1% were 5.62 and 5.45, respectively. There was a trend in increasing the pH of all samples at all storage temperatures after 1 month. Regarding the serum base, after 10 days, the pH at 4 ^{o}C was 5.77, followed by 6.35 after another 10 days and reached 6.75 on the day of 30th day. The pH of the sample at 25 $^{\circ}$C was stable after 10 days, followed by an increase to 6.75 after 30 days, while another was stored at 40^{o}C also accelerated the pH from 5.62 to 6.53 after 1 month. Regarding serum lipo 0.1%, the sample, which was stored at 4 ^{o}C has an enhanced pH from 5.45 to 5.72 after 10 days, followed by a significant rise to 6.65 after 1 month storage. The samples stored at both 25 ^{o}C and 40 $^{\circ}$C reached their pHs at 6.67 and 6.77 after 1 month, respectively. Although the pHs grew after 1-month storage, they were still compatible with skin pH 4.5-7 [10]; however, the reason for this pH enhancement should be clarified for potential risk prevention.

Table 2. *The appearance of the serum base and serum containing durian peel extract-loaded liposomes preparation.*

Parameter	Serum base	Serum lipo 0.1%
Organoleptic	Semi-solid, milky form, odorless	Semi-solid, milky form, odorless
Homogeneity	Homogenous	Homogenous
pH	5.62	5.45
Type	Oil-in-water	Oil-in-water
Stability	Stable	Stable
Skin irritation	No	No

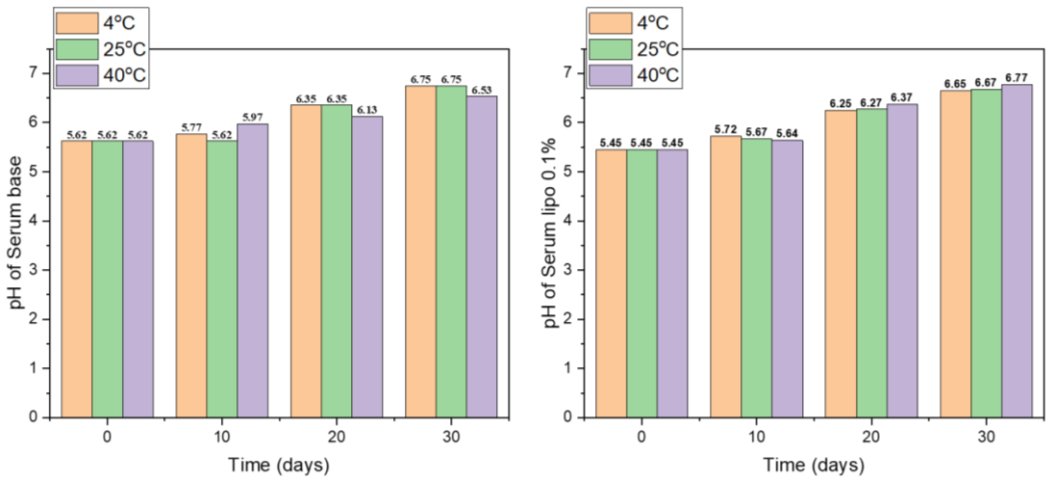

Figure 5. *The pH of serum base and serum containing 0.1% of durian extract-loaded liposomes at 4 ^{o}C, 25 ^{o}C, and 40 $^{\circ}$C within 1 month.*

Under an optical microscope, we can observe the clear morphology of the emulsion. By using 4X magnification, all the graphs in Figure 6 had a scale bar of 50 µm. At all the storage temperatures, both serum base and serum lipo 0.1% were present as spherical particles with a size from 10-50 µm. It seems like the storage temperatures didn't distort or damage the structure of all samples. There were many

reasons for this conclusion, for instance, the right input of emulsifiers, the appropriate oil/water phase ratio, the suitable rheological modifier, or the accurate handling process. This data proved the stability of the serum over time and showed potential commercialization for the customers. However, at the magnification, we cannot observe the presence of the liposome because its size was nanoscale, as depicted in Figure 4; thus, we need to use another method for capturing the respective morphology of the liposome, such as SEM or TEM measurement.

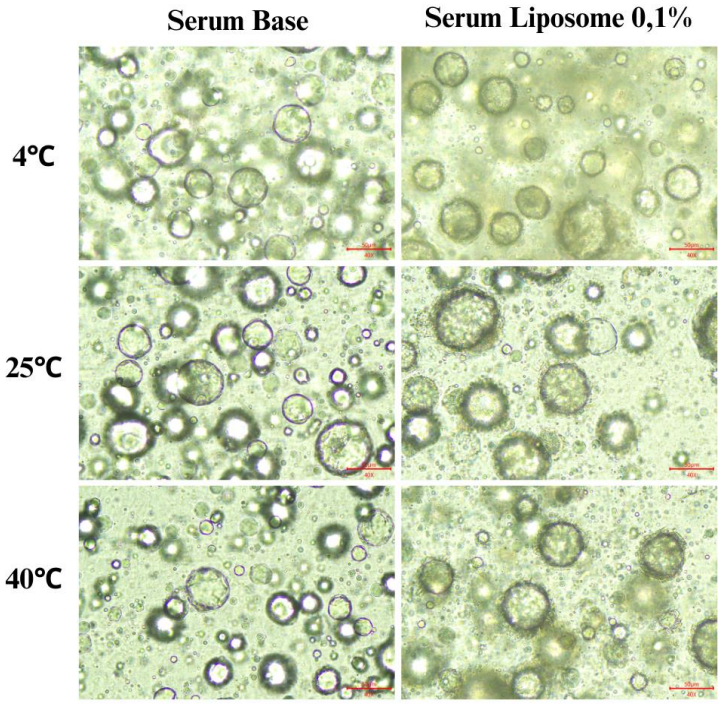

Figure 6. *The optical pictures of serum base and serum containing 0.1% of durian peel extract-loaded liposomes at 4 ˚C, 25 ºC, and 40 ˚C after 1 month (the scale bar is 50 µm).*

4. Conclusions

The study described the process of extracting the durian peel extract, encapsulating it in liposomes, and creating a serum containing this nanosystem for future anti-gagging application. The extract expressed the potential anti-aging effect with a high amount of bioactives. Liposome carrying extract also showed a suitable size and zeta potential for topical delivery, along with appropriate stability for 1 month at different temperatures and pHs. Regarding serum lipo 0.1%, it showed a milky stable homogenous emulsion without any irritations to the skin with a range of size from 10-50 µm by optical microscope; however, the stability of pH was increased after storing at different temperatures within 1 month. This study should be further carried out to define the possibility of practical application by long-term stability test, microbial test, and *in vitro-in vivo* proficiency.

Acknowledgments

This research was completed successfully with the participation of members from the Vietnam Academy of Science and Technology-Institute of Advanced Technology, Ho Chi Minh University of Technical Education, Ton Duc Thang University, and Ho Chi Minh University of Technology. Many thanks for our contributions and efforts.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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