International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://www.theaspd.com/ijes.php

Formulation Development And Evaluation Of Azelaic Acid Face Serum

Vaibhav Khupase[1], Sujit A. Jadhav[2*], Khanderao R Jadhav[3], Rishikesh S Bachhav[4], Pravin P Gadakh[5], Dhanashri Chaudhari[6], Kapil Phulwani[7]

[1]Research Scholar, Department of Pharmaceutics, KCT's R.G Sapkal College of Pharmacy, Anjaneri, Nashik, Maharashtra, India.
[2*,3]Associate Professor, Department of Pharmaceutics, KCT's R.G Sapkal College of Pharmacy, Anjaneri, Nashik, Maharashtra, India.
[4]Professor, Department of pharmacology, KCT's R.G Sapkal College of Pharmacy, Anjaneri, Nashik, Maharashtra, India.
[5]Assistant professor,Department of Pharmaceutical Quality Assurance,KCT's R.G Sapkal College of Pharmacy, Anjaneri , Nashik,Maharashtra, India.
[6]Assistant professor,Department of pharmaceutical Chemistry, KCT's R.G Sapkal College of Pharmacy, Anjaneri , Nashik, Maharashtra ,India
7 Assistant professor, Department of pharmaceutics, KCT'S R G Sapkal college of Pharmacy Anjaneri Nashik Maharashtra India

***Corresponding Author:** Dr. Sujit Appasaheb Jadhav
*Department of Pharmaceutics, KCT's R.G Sapkal College of Pharmacy, Anjaneri, Nashik, Maharashtra, India.
Email- sujitpharma29@gmail.com,

Abstract :- *The aim of present study was to prepared a skin brightening face serum for better absorption. Face serum of azelaic acid was prepared by using xanthan gum and propylene glycole by simple mixture method. The prepared face serum were evaluated for pH, drug content, viscosity and spreadability. In vitro drug relese study was carried by using diffusion cell with dialysis membrane. The drug content and pH of the formulation were found to be satisfactory.*
The pH of the formulation found to be in the range of pH 4.99 to 5.45.The viscosity and spredability of the formulations were found to be satisfactory. Formulation F3 containing 0.03% Xanthan gum and 1.1% Propylene glycol showed highest drug release of 89.99 % . The developed formulations showed sustained release of drug up to 8 hrs. From in-vitro drug release studies.

Keywords:- *Azelaic Acid, Face Serum , Emulsion , Skin Brightening.*

1.INTRODUCTION:-

Transdermal drug delivery, when applied to healthy skin, is characterised as a separate, self-contained dosage form that releases the drug into the bloodstream at a regulated pace. In contrast to traditional topical drug delivery, transdermal drug delivery involves delivering a medication via the skin to provide a pharmacological effect throughout the body. [1]
Most topical drugs are assumed to be related to the skin in some way. Therefore, understanding the fundamental characteristics of the skin and its physiological functions is necessary when planning a topical treatment. The average adult's skin has a surface area of around 2 m^2, and about one-third of the blood that circulates throughout the body flows through it. [3]It is estimated that there are 40–70 hair follicles and 200–300 sweat ducts per square centimetre in the average human skin. The pH of the skin rises from 4 to 6. The pH of the skin's surface is affected by sweat and the fatty acids that sebum releases. [5]

Depending on the body part, the thickness of the stratified, keratinised squamous epithelium that makes up the epidermis, or outermost layer of skin, varies. The relatively waterproof layer, which is primarily composed of blood vessels, protects the deeper, more delicate parts of the skin. It is crucial to have a continuous venous plexus that receives blood flow from epidermal capillaries. [8] Moreover, very muscular arteriovenous anastomoses carry

blood directly from the small arteries in the body's most vulnerable regions—the hands, feet, and ears—to the plexus. One of the unique characteristics of dermatological pharmacology is its direct access to the skin as a target organ for diagnostic and treatment. The skin acts as a two-way barrier to prevent water and electrolyte loss or absorption. [9]

1.1 Skin Brightening:

Melanin, a pigment that shields the skin from UV radiation by preventing further production, is removed during the skin-brightening process. The market for skin-brightening cosmetics is growing quickly and doesn't seem to be slowing down. Age spots or liver spots on the hands, cheeks, or other areas exposed to the sun are common symptoms of hyperpigmentation. [13]

Pregnancy and other hormonal changes can cause melasma or chloasma spots, which are larger, darker patches of skin. The reduction of melanin synthesis does not produce a noticeable decrease in pigmentation for several weeks. This is caused by the ski's innate ability to regenerate every 28 days as well as the slow loss of pigmented cells over time. The complexion gets lighter and more even as a result of this process, which brings keratinocytes with less melanin to the surface. [17]

Using skin-brightening and nourishing treatments in conjunction with thorough cleansing and cutin removal is a simple way to lighten skin. According to reports, using deep cleaning chemicals is the easiest way to quickly brighten the skin. This year's new cosmetics, however, do more than just remove wrinkles; they also moisturise and brighten the face. [18] Because the active chemicals in skin-brightening treatments are absorbed by skin cells rather than penetrating the epidermis, dehydrated skin appears lifeless. Because it promotes skin lightening, skin moisturising is therefore an essential component of skin whitening. [20]

Therefore, adding moisturising ingredients to skin-brightening creams may increase how effective they are at whitening. [12]

1.2 Serum:

A specialist skincare product known for its light texture and concentrated formulation is called a cosmetic serum. Because it is meticulously developed to address specific skin concerns, it is a crucial part of a comprehensive skincare program. The formulation of a serum can be either water-based or oil-based, depending on the desired texture and the skin issue being addressed. A serum is characterised by a high concentration of chemically active substances. [13]

These ingredients are chosen for their efficacy in treating certain skin issues and are present in significantly higher quantities than those found in traditional skincare products. The active substances will be able to fully penetrate the skin and benefit the areas that most require them thanks to this high concentration. Using a serum is one of the most crucial steps in a beauty routine. It should be used after the washing and toning steps. [14] This is because, prior to using the serum, cleansers and toners make sure the skin is clear and prepared to absorb the active components. By adding an additional layer of moisture, the moisturiser amplifies the effects of the serum. [16]

2. MATERIAL AND METHODS :

Material: Azelaic acid was supplied as a gift sample by Asea Chemical Works in Jodhpur. All of the other substances used were of analytical purity.

Formulation of Face Serum :

Azelaic acid was carefully weighed and combined with propylene glycol. The mixture was continuously stirred with a magnetic stirrer while the temperature was maintained between 45 and 50°C to allow for complete drug solubilisation.

In a separate beaker, glycerin was dissolved in distilled water before EDTA was added as a chelating agent. [15] This solution was stirred until a clear and consistent mixture was obtained. To make the gel basis, xanthan gum was added to the remaining distilled water and manually agitated at a high speed to prevent lumps from forming. The dispersion was allowed to hydrate for 30 to 45 minutes until it attained a uniform gel consistency.

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://www.theaspd.com/ijes.php

The azelaic acid-propylene glycol solution was gradually added to the xanthan gum dispersion after thorough hydration, with steady stirring to ensure uniform drug dispersion. Glycerin and EDTA were added to the solution and properly stirred in order to obtain homogeneity. [15] To ensure even dispersion throughout the dosage form, benzyl alcohol was added to this base as a preservative and well mixed.
Finally, the formulation's pH was measured using a digital pH meter, and triethanolamine was added to bring it within the optimal skin-compatible range of 4.5 to 5.5. The final mixture was allowed to cool at room temperature after being gently stirred to release any trapped air. After reaching room temperature, the formulation was transferred into suitable containers and left there for further evaluation and stability testing.

Table 1: Formulation composition of face serum

Sr.no.	Ingredients	Quantity (gm)								
		F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**
1.	Azelaic acid	1	1	1	1	1	1	1	1	1
2.	Xanthan gum	0.03	0.03	0.03	0.05	0.05	0.05	0.07	0.07	0.07
3.	Propylene glycol	0.5	0.8	1.1	0.5	0.8	1.1	0.5	0.8	1.1
4.	Glycerine	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
5.	Benzyl alcohol	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
6.	EDTA	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
7.	Triethanolamine	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.	q.s.
8.	Distilled water	q.s. to make 10 gm in each batch								
Total weight of formulation		10 gm								

3. EVALUATION OF FACE SERUM :-

Physical evaluation:

Colour: Each batch of azelaic acid face serum produced was evaluated for colour. Increasing the quantities of xanthan gum and propylene glycol caused the formulations' hues to shift from white to off-white and rather murky. The results were reported in Table 8.

Odour: Each prepared batch was sniffed to assess its aroma, and it was found that each batch had a unique, mild odour that was appropriate for topical application. The results were reported in Table 8.

Consistency: Depending on the amount of xanthan gum used, the consistency of each batch of azelaic acid face serum varied. The texture of batches with less xanthan gum is smooth and spreadable, while batches with more xanthan gum have a thicker, slightly sticky texture. Table 8 mentioned the findings.

Phase separation: All nine batches of the Azelaic Acid face serum were examined for signs of phase separation during the initial formulation and after centrifugation at 3000 rpm for 15 minutes. The lack of phase separation in any batch demonstrated excellent emulsion stability and uniform dispersion of both aqueous and oil-soluble components.

Batches	Colour	Odour	Consistency	Phase separation Observed
F1	White	Mild	Smooth	No
F2	White	Mild	Smooth	No
F3	Off White	Mild	Smooth	No
F4	White	Mild	Smooth	No
F5	White	Mild	Smooth	No
F6	Off White	Mild	Smooth	No
F7	White	Mild	Slightly sticky	No
F8	Off White	Mild	Slightly sticky	No

F9	Off White	Mild	Slightly sticky	No

Table 2: Results for Physical evaluation

Determination of pH: The pH values of the nine batches of the azelaic acid face serum ranged from 4.99 to 5.45, which is within the ideal range of 4.5 to 6.0 for topical facial therapies. This ensures the best skin compatibility and lessens the chance of skin irritation during application. To enable effective pH control without compromising formulation stability, triethanolamine was used. [6]

Determination of Viscosity: Each of the nine batches of the Azelaic Acid face serum had its viscosity measured using a Brookfield viscometer. The data showed that the viscosity increased progressively as the concentration of xanthan gum, which acts as a gelling agent in the formulation, increased. Propylene glycol also slightly affected viscosity by increasing the solubility of azelaic acid and changing its flow, though not as much as xanthan gum. The viscosity values of every batch were within a tolerable range, ensuring a smooth application and a pleasing skin feel. [7]

Determination of Spreadability: Each prepared batch's spreadability was evaluated using the glass slide method, and it was determined to be between 6.8 and 8.5 gm.cm/sec. The results demonstrated a negative correlation between the serum's spreadability and viscosity. Batches with lower amounts of xanthan gum had higher spreadability ratings. However, batches with more xanthan gum had poorer spreadability due to their increased viscosity. [10]

UV-visible spectrophotometric analysis: The UV-visible spectrophotometric examination was carried out using the Japan V 550 from Jasco Corporation. A spectrophotometer and spectra manager software were used for the analysis. Phosphate buffer 6.8 pH was the solvent system used to calculate the λ max. The λ max was found to be 204 nm using 100 µg/ml of an azelaic acid sample (210 nm was used for UV analysis due to its lower baseline noise and higher consistency in phosphate buffer pH 6.8).

Figure 1: 100 PPM solution of Azelaic acid in Phosphate buffer 6.8 pH

FT-IR of Azelaic acid: The infrared spectra of azelaic acid was recorded using an FTIR spectrometer. Figure 2 showed the spectrum of infrared light. The unique functional groups identified in the FTIR spectra are shown in Table 2.

Figure 2: IR of Azelaic acid

Determination of Drug content: UV-Visible spectrophotometry at 210 nm was used to analyse the drug content of each of the nine batches of the Azelaic Acid face serum. The results indicated that the azelaic acid was evenly distributed throughout the formulation, with the drug content ranging from 98.7% to 101.5% in all formulations. [11]

In Vitro Drug Release Study (Franz diffusion method):

The in vitro drug release characteristics of each batch of azelaic acid face serum were evaluated in phosphate buffer pH 6.8 during an eight-hour period. The cumulative drug release at 8 hours, which ranged from 81.36% to 89.99%, showed that all formulations met the face serum requirement. When batches with higher concentrations of the penetration enhancer were compared to batches with lower quantities of the penetration enhancer and higher concentrations of the viscosity modifier, the former showed a notably higher level of drug release. [19]

atches	**H**	**Viscosity (cP)**	**Spreadability (gm.cm/sec)**	**Drug content** (%)
1	.45 ± 0.12	827 ± 31	8.5	98.8
2	.38 ± 0.18	963 ± 28	8.2	99.0
3	.21 ± 0.10	1104 ± 25	7.9	100.1

4	.34 ± 0.15	1232 ± 36	8.1	100.5
5	.25 ± 0.17	1501 ± 30	7.5	99.6
6	.10 ± 0.17	1723 ± 26	7.1	99.8
7	.17 ± 0.2	1809 ± 40	7.8	98.7
8	.05 ± 0.18	2299 ± 33	7.2	100.3
9	.99 ± 0.11	2148 ± 29	6.8	101.5

Table 3: Evaluation parameters of batches F1 -F9

Optimization of Azelaic acid face serum:

Utilising Design Expert 7.0 software, the impact of independent variables on the outcomes was examined. The experimental design pattern developed for nine possible batches of azelaic acid face serum is shown in Table 5. Several models, including Linear, 2FI, Quadratic, and Cubic, were suggested by the software and tested for analysis of variance (ANOVA). One factor and perturbation graphs were created for every dependent variable following the computation of regression polynomials.

Runs	**Factor1**	**Factor 2**	**Response 1**	**Response 2**
	A: % Xanthan gum	**B: % Propylene glycol**	**Viscosity (cP)**	**Drug release(%)**
1	0.7	8	2299	82.36
2	0.3	11	1104	89.99
3	0.3	5	827	85.41
4	0.3	8	963	87.89
5	0.5	11	1723	87.26
6	0.7	5	1809	81.36
7	0.5	8	1501	85.77
8	0.7	11	2148	86.22
9	0.5	5	1232	83.72

Table 4: The layout of the Actual Design

RESULT AND DISCUSSION

Each formulation's medication content was found to vary between 98.7 and 101.5 percent. The amount of azelaic acid was almost the same in each formulation. F9 displays the highest drug concentration.

The drug content was checked three times. The pH of the fluid was determined to be between 4.99 and 5.45 after all formulations were implanted. The spreadability of the formulation indicates that the drug is simple to administer. The spreadability of each formulation was found to vary between 6.8 and 8.5 gcm/sec.

In all of the previously stated formulations, viscosity increases as the concentration of polymers increases. The viscosity of the solution was determined to be between cps 827 to 2299.

F3 had the highest drug release of all of these formulations, at 89.99 percent. It was also observed that the release of medication decreases with increasing polymer content.

Figure 3: In vitro Drug release study

Results of Viscosity

The viscosity of the medication depends on the proportions of xanthan gum and propylene glycol in the formulation. As the proportion of xanthan gum increases, so does the viscosity. The higher amount of propylene glycol in the formulation is accompanied by an increase in viscosity. Xanthan gum affects viscosity more than propylene glycol because of its incredibly low P value.

International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 22s, 2025
https://www.theaspd.com/ijes.php

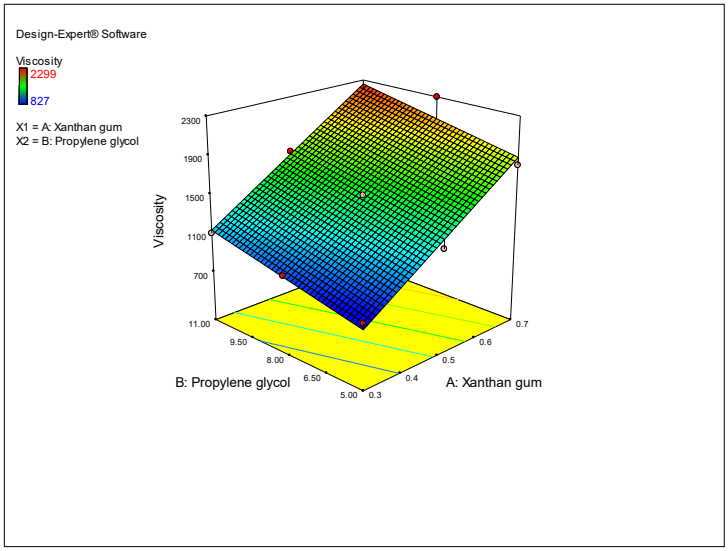

Figure 4: 3D plot for Viscosity

Results of drug release:

The formulation's proportions of xanthan gum and propylene glycol have an impact on the drug's release. As the proportion of xanthan gum increases, drug release decreases. As the proportion of propylene glycol in the formulation increases, so does drug release. Propylene glycol affects medication release more than xanthan gum since it has a significantly lower P value.

Determination of Globule size of Optimized batch:

The optimised batch (F3)'s globule size, as determined by dynamic light scattering (DLS), was 803.8 nm, indicating the formation of an evenly sized dispersion. The polydispersity index (PDI) was found to be 0.566.

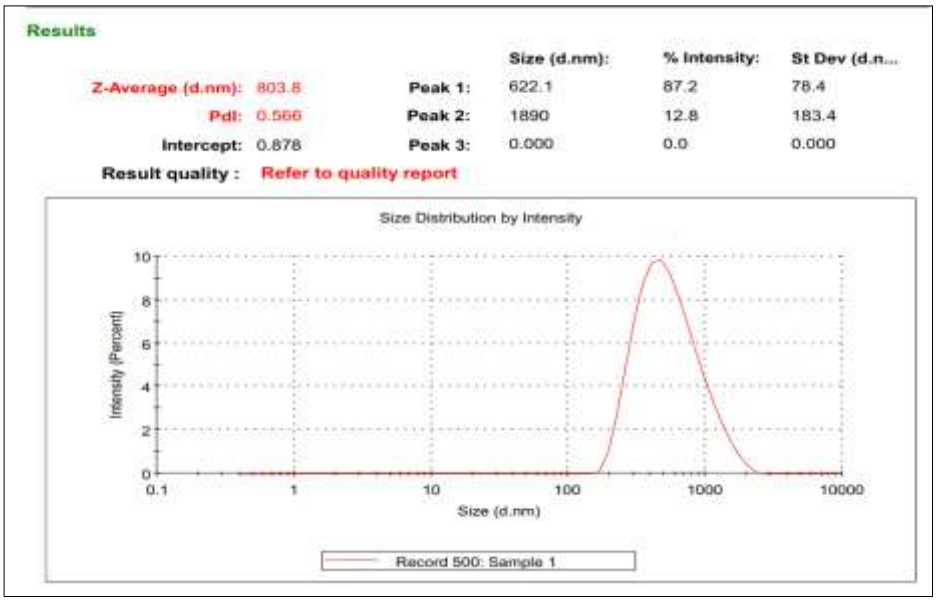

Figure 5: Globule size (F3 batch)

CONCLUSION:

The study successfully created and examined an azelaic acid face serum that shows promise in treating acne and other skin conditions. The formulation's exceptional physical characteristics, pH tolerance, and prolonged release capabilities made it suitable for repeated topical treatment.

Azelaic acid's incorporation into a serum base enhanced patient compliance due to its light texture and ease of

usage. Overall, the developed serum can be thought of as a good alternative to conventional azelaic acid gels or creams, while further clinical research could be required to confirm its therapeutic efficacy.

REFERENCES

1. Heinrich U, Tronnier H, Stahl W, Béjot M, Maurette JM. Antioxidant Supplements Improve Parameters Related To Skin Structure In Humans. Skin Pharmacol Physiol ;19:224-31.
2. Sonti S, Makino ET, Garruto JA, Gruber JV, Rao S, Mehta RC. Efficacy Of A Novel Treatment Serum In The Improvement Of Photodamaged Skin. Int J Cosmet Sci 2013;35:156-62.
3. Bhalla TC, Kumar V, Bhatia SK. Hydroxy Acids: Production And Applications. In: Advances In Industrial Biotechnology. Ch. 4. New Delhi: I K Internationl Publishing House Pvt Ltd.; 2011. P. 56-76.
4. Garre A, Narda M, Valderas-Martinez P, Piquero J, Granger C. Antiaging Effects Of A Novel Facial Serum Containing L-Ascorbic Acid, Proteoglycans, And Proteoglycan-Stimulating Tripeptide: *Ex Vivo* Skin Explant Studies And *In Vivo* Clinical Studies In Women. Clin Cosmet Investig Dermatol 2018;11:253-63.
5. Patil AR, Patil AR, Lovhare RB. Formulation And Evaluation Of Herbal Face Serum Containing *Aloe Vera* And *Aegle Marmelos*. Int Res J Modern Eng Technol Sci 2023;5:3727-38.
6. Anand V, Sharma H, Ram BS, Dubey DK. Performance Of Induction Motor And BLDC Motor And Design Of Induction Motor Driven Solar Electric Vehicle (IM-SEV).
7. Raab S, Yatskayer M, Lynch S, Manco M, Oresajo C. Clinical Evaluation Of A Multi-Modal Facial Serum That Addresses Hyaluronic Acid Levels In The Skin. J Drugs Dermatol 2017;16:884-90.
8. Moy M, Diaz I, Lesniak E, Giancola G. Peptide-Pro Complex Serum: Investigating Effects On Aged Skin. J Cosmet Dermatol 2023;22:267-74.
9. Wisniewski JD, Ellis DL, Lupo MP. Facial Rejuvenation: Combining Cosmeceuticals With Cosmetic Procedures. Cutis 2014;94:122-6.
10. Rivkin A, Green JB, Bruce S, Cox SE, Hevia O, Chawla S, *Et Al.* Safe And Effective Restoration Of Jawline Definition With Hyaluronic Acid Injectable Hel VYC-25L: Results From A Randomized Controlled Study. Aesthet Surg J 2024;10:Sjae147.
11. Gallaga Towns JE, Martínez Garza LI. Systematic Review Of The Comparison Of Hyaluronic Acid Against Calcium Hydroxiapatite In Facial Volume Replacement Therapy. Cien Latin Rev Cient Multidiscip 2024;8:5541-59.
12. Lee YI, Lee SG, Kim J, Choi S, Jung I, Lee JH. Proteoglycan Combined With Hyaluronic Acid And Hydrolyzed Collagen Restores The Skin Barrier In Mild Atopic Dermatitis And Dry, Eczema-Prone Skin: A Pilot Study. Int J Mol Sci 2021;22:10189.
13. Felix Bravo B, Bezerra De Menezes Penedo L, De Melo Carvalho R, Amante Miot H, Calomeni Elias M. Improvement Of Facial Skin Laxity By A Combined Technique With Hyaluronic Acid And Calcium Hydroxylapatite Fillers: A Clinical And Ultrasonography Analysis. J Drugs Dermatol 2022;21:102-6.
14. Kornhauser A, Coelho SG, Hearing VJ. Applications Of Hydroxy Acids: Classification, Mechanisms, And Photoactivity. Clin Cosmet Investig Dermatol 2010;3:135-42.
15. West BJ, Alabi I, Deng S. A Face Serum Containing Palmitoyl Tripeptide-38, Hydrolyzed Hyaluronic Acid, Bakuchiol And A Polyherbal And Vitamin Blend Improve Skin Quality. J Cosmet Dermatol Sci Appl 2021;11:237-52.
16. Kohakade S, Karodi R, Rajad S, Dange S, Jadhav V, Andhale K. Development And Evaluation Of Herbal Cosmetic Serum On Melasma-Aging Activity. A J New Zeal Herpetol 2023;12:1472-83.
17. West BJ, Alabi I, Deng S. A Face Serum Containing Palmitoyl Tripeptide-38, Hydrolyzed Hyaluronic Acid, Bakuchiol And A Polyherbal And Vitamin Blend Improves Skin Quality. J Cosmet Dermatol Sci Appl 2021;11:237-52.
18. Thakre AD. Formulation And Development Of De Pigment Serum Incorporating Fruits Extract. Int J Innov Sci Res Technol 2017;2:330-82.
19. Patidar M, Deshmukh N, Mandloi N, Patidar B. Phytosome Of Gingerol Oil, *Carica Papaya* Pulp Extract And *Aloe Vera* Gel. World J Pharm Res 2023;12:726-40.
20. Surini S, Mubarak H, Ramadan D. Cosmetic Serum Containing Grape (*Vitis Vinifera* L.) Seed Extract Phytosome: Formulation And *In Vitro* Penetration Study. J Young Pharm 2018;10:51-5.