



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Review Article

Synthetic Polymers Used in Cosmetic

Yogita patil*, Kirmani, Dr. Rajendra Kawade

Nandkumar Shinde college of pharmacy, vaijapur Pincode :- 423701.

ARTICLE INFO

Published: 28 Nov. 2024

Keywords:

cosmetics, dashing design,
Polymers , copolymer ,
polysaccharides.

DOI:

10.5281/zenodo.14235705

ABSTRACT

Synthetic polymers have become an indispensable component in the formulation of various cosmetic products, including skincare, haircare, and color cosmetics. This review aims to provide a comprehensive overview of the commonly used synthetic polymers in cosmetics, their applications, and safety profiles. Polymers such as polyacrylates, polyvinylpyrrolidone (PVP), polyethylene (PE), and polypropylene (PP) are widely employed as film-formers, thickening agents, and stabilizer. The benefits of these polymers, including improved product texture, enhanced durability, and controlled release of active ingredients, are discussed. However, concerns regarding the potential toxicity, biodegradability, and environmental impact of these synthetic polymers are also addressed. Regulatory frameworks governing the use of synthetic polymers in cosmetics across different regions, including the EU, US, and Asia, are reviewed. Future directions for research and development of safer, more sustainable synthetic polymers in cosmetics are highlighted. In this review, Natural, semi-synthetic and synthetic polymers are banded considering their exemplifications. The exemplifications of synthetic polymers used in cosmetics has been explained with their advantages and disadvantages.

INTRODUCTION

21st century, cosmetic and personal care industries have been increasing rapidly. The global cosmetics Market is projected to register a compound annual growth rate of 4.3 % during the forecast.(1) The use of plastic products is increasing everywhere in the world. This is because plastic products last a long time are very strong do not react with living things and can keep

things safe inside them. People like using plastic because it is convenient and useful. However it is important to be aware of the impact of plastic on the environment and try to reduce our use of plastic whenever possible.(2) Cosmetics are product's that we use on our skin lips , hair and nails as well as on teeth and even inside our mouth .These products can include things like makeup, lotions, and toothpaste. The European commission has a

*Corresponding Author: Yogita patil

Address Nandkumar Shinde college of pharmacy, vaijapur Pincode :- 423701.

Email : yogitap851@gmail.com

Relevant conflicts of interest/financial disclosures: 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.



specific definition for cosmetics which helps to regulate the industry and ensure that product are safe for consumers to use. It's important to be aware of what were putting on our bodies so we can make informed choices about the products we use.(3)The production of plastic has been increasing rapidly since 1950 when it was reported at 1. 7 million tons. By 2018 global plastic production had reached 360 million tons with Asia contributing 51% of the total amount. This exponential growth in plastic production has led to environmental concerns due to the large amount of plastic waste generated. It is important for us to find sustainable solutions to reduce plastic usage and increase recycling efforts to protect our planet.(4)

Polymers are an important class of raw accoutrements of ornamental phrasings, being essential in the product of high- performance products. They're classified as synthetic,semi-synthetic, or natural(5)(Figure 1) macromolecules composed of numerous repeating units(monomers) generally arranged in the form of a chain. In cosmetics phrasings, its structural diversity is used to promote a variety of functions as rheology modifiers, thickeners, froth stabilizers and destabilizer, emulsifier, fixative, exertion and film formers.(6)

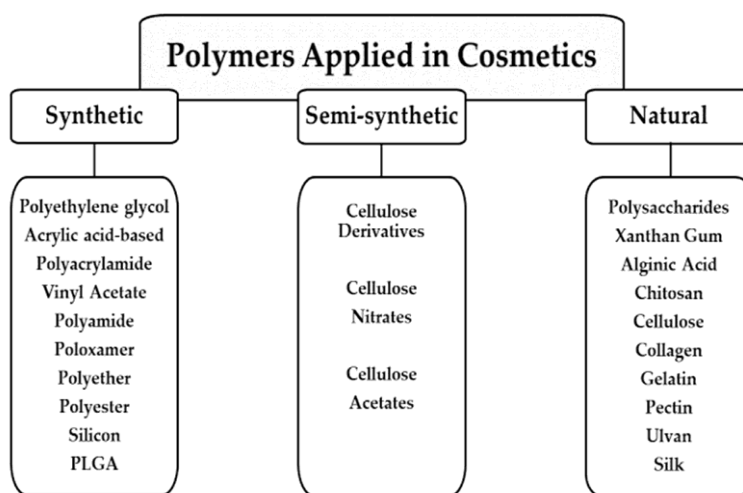


figure :- (1) Types of polymers applied Cosmetics .

Polymers :-

Any of a class of materials, either natural or artificial, made up of multiples of smaller chemical units termed monomers, or macromolecules, is referred to as a polymer. Numerous minerals and man-made paraphernalia are based on polymers, which also comprise a wide variety of paraphernalia found in living things. An unknown number of monomer units Is denoted by the term polymer. It is sometimes referred to as a high polymer when there are genuinely a lot of monomers. Monomers with the same molecular weight, structure, and chemical composition are not the only possible polymers. Most natural and artificial polymers still consist of two or more

distinct kinds of monomers; these polymers are called copolymers.

❖ **Natural Polymers :-**

Natural polymers are commonly used in cosmetics because they are safe for our bodies and the environment. They are also popular with consumers and can be used in a variety of beauty products like makeup skin care and hair care. These natural polymers can also act as stabilizers and modifiers in cosmetic formulations making them versatile and valuable ingredients in the beauty industry (10,11)Polysaccharides are a type of natural polymer that are commonly used in various products Some examples of polysaccharides include starc

h ,xanthan gum ,guar gum ,carrageenan alginate pectin, gelatine ,agar ,collagen and hyaluronic acid. These substances are important in many industries such as food production and pharmaceuticals due to their unique properties and functions. Overall polysaccharides play a significant role in the development of numerous everyday products that we use.(12)The use of starch combined with natural polymers like chitosan has been found to have antioxidative properties when applied to the skin. This combination has been utilized for various activities and benefits for the skin. Researchers have studied the effects of this compound and have found positive results in terms of its antioxidant release and overall impact on the skin. The use of these natural ingredients together show promise in skincare products and treatments. (13)

Examples:- xanthan gum , cellulose, collagen, gelatin, silk etc.

❖ **Semi- synthetic polymers:-**

Cellulose ethers and cellulose esters are two types of substances that are made from cellulose which is a natural material found in plants. These substances have different properties and can be used in various ways. Cellulose derivatives can change the thickness of a liquid can be used to make thin films that are flexible when heated and can resist breaking down when exposed to things like heat or bacteria. These properties make cellulose derivatives useful in a wide range of applications from food additives to pharmaceuticals.(14)Aung and colleagues (2019) created dissolving microneedles by combining different types of polymers both synthetic and natural to help deliver alpha_arbutin for skin lightening. The goal of their research was to find a more effective way to deliver the skinlightening ingredient through the skin barrier. By using a combination of polymers they were able to create microneedles that dissolve into the skin allowing the alphaarbutin to penetrate the skin more efficiently. This s

tudy could potentially lead to new and improved methods for treating skin pigmentation issues.((15)

Examples :- cellulose derivatives, cellulose acetate, cellulose nitrate etc.

❖ **Synthetic Polymers :-**

Manufactured polymers are ubiquitous in society as materials and bundling materials,In development, and in pharmaceutical, among numerous other fundamental applications. ManufacturedPolymers are a exceedingly flexible and differing gather of substances, numerous of which haveBeen expressly connected in medicate conveyance, for case, solubilizing specialists, nanoparticulateArrangement, surface alteration, sedate carriers, symptomatic imaging operators, and inserts (16) In expansion, a few of these polymers appear numerous organic exercises in their claim right (e.g. Antitumor, anti-microbial, antiviral, and antithrombotic exercises, as well as hindrance of efflux pumps such as P-glycoprotein) .(17) Engineered polymers are characterized as polymers that are falsely created in laboratories, also known as fabricated polymers(8). They're classified as thermoplastic and Thermoset polymers and elastomers. A many illustrations of finagled polymers are polyethylene(PE), polystyrene(PS), polyamides(Dad), poly(vinyl chloride)(PVC), polytetrafluoroethylene(PTFE), polyisoprene(PI), phenol formaldehyde epoxies, and multitudinous others. Polymers Made from finagled substances(monomers) determined from petroleum oil painting are regularly created in a controlled terrain, and their chine naturally comprises carbon – carbon Bonds.(18) Synthetic polymers are appealing for use as an excipient in cosmetic formulations due to their versatility. Designed to meet the specific needs of certain tasks. A common characteristic is that they are typically less expensive than natural polymers and can be manufactured on a large scale. A vast size

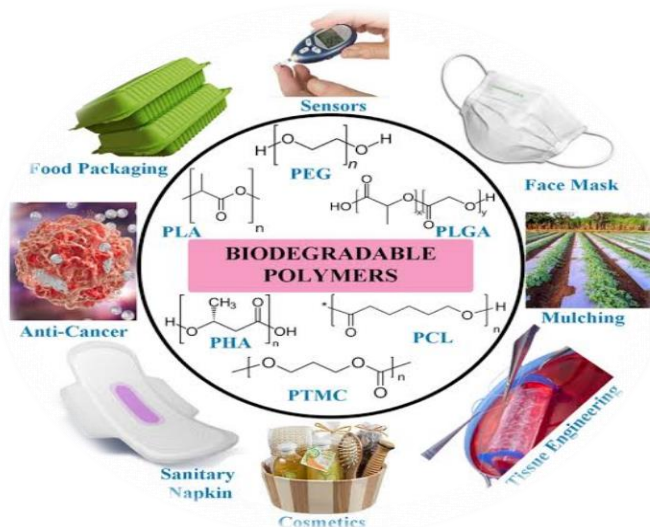


with consistency, and possess a lengthy expiration date. Synthetic polymers are typically the most frequently used. Discovered in beauty products are polymers based on acrylic acid, polyacrylamides, silicone, and homopolymers and copolymers based on alkylene oxide. (19)

Examples :- vinyl acetate, polyester, silicone, poloxamer, polyester etc.

Used of polymers in personal care and cosmetics :-

- Film formers in hair fixatives , mascaras, nail enamels and color cosmetics.
- Thickeners and rheology modifiers and emulsion stabilizers , gels , blinders, hair columns and hair relaxers.
- Emulsifiers in lotion, sunscreens , and hair-colorants.
- Moisturizers for skin .
- Waterproof in sunscreen and makeup.



Synthetic polymers used in cosmetics are:-

1. Polyethylene glycol
2. Acrylic acid – based
3. Polyacrylamide
4. Vinyl Acetate
5. Polyamide
6. Poloxamer
7. Polyether
8. Polyester
9. Silicon
10. PLGA.

1) Polyethylene glycol :-

PEGs, short for polyethylene glycol, are chemicals used in cosmetics. They come from petrochemistry and are used extensively in non-organic cosmetics, while some people try to say that they are “natural” ingredients. Many cosmetics contain petroleum-based substances called polyethylene glycols (PEGs), which include

- . Softeners
- Moisture- carriers
- Cream based
- Surfactants
- Emulsifiers
- Cleansing agents
- Humectants
- Skin conditioner
- Thickeners
- Solvents.

polyethylene used in many cosmetic products, including:-Moisturizers, Shampoos, Conditioners, Body washes, Gels, Mousses, Styling products, After-shave balms, Creams, and Lipstick.

Advantages :-

- PEGs can offer stability.
- Non toxic
- Readily available

- Effectiveness
- Application benefits.
- (<https://www.sciencedirect.com>)

Disadvantages :-

- Health risk
- Skin irritation
- Allergic reactions (<https://www.artcosmetics.it>)

2) Acrylic acid based :-

Acrylic acid based polymers are also known as acrylate polymers or polyacrylates. They are known for being transparent, elastic, and resistant to breakage. (20) Acrylic acid is a compound that can cause skin, eye, and respiratory tract irritation. Exposure can also lead to corrosion, burns, eye and lung damage, coughing, wheezing, laryngitis, shortness of breath, headache, nausea, and vomiting. (21) Acrylic acid based polymers are used in cosmetics for a variety of purposes, including: Film-forming :Acrylates copolymer is a synthetic polymer that can add water resistance, smooth skin, and improve texture. It can be used in liquid makeup, sunscreens, and skin care products.

Texturing :- Acrylic copolymers can be used to create unique textures in cosmetics and skin care products. (22)

Adhesives: To attach fake eyelashes and nails, ethyl acrylate is utilised as an adhesive.

Molding :- The ability of methyl and ethyl methacrylates to form and stick to natural nails is known as moulding.

Acrylic acid-based polymer is most commonly used in :- Eye shadows, mascara, eyebrow pencil and lipsticks.

Advantages :-

- Adhesive strength
- Biodegradability
- Light weight
- Non - toxic
- Mechanical strength

Disadvantages :-

- Bone cement
- Tissue engineering

3) Polyacrylamide :-

Small amounts of unreacted acrylamide are present in polyacrylamide.[3] 23

While some of the leftover acrylamide can be removed from water-based solutions, it is more challenging to remove acrylamide from solid forms. There will probably be some acrylamide left over in both situations.(24) Polyacrylamide's use doubled between 1989 and 2002 due to its desirable qualities as a thickener and lubricant for cosmetics. (25) It is also used in the construction of dams, tunnels, and sewers, as well as in the treatment of water, sewage, and waste, oil recovery, ore processing, papermaking, permanent-press fabrics, dye synthesis, and contact lenses (Habermann 2002).(26) The polyacrylamide serve in cosmetic products as a thickening or suspending agent. When it dries, it leaves a thick layer on the skin, hair, and nails. It aids in the binding of materials in products that take the form of compacted tablets or cakes.(27) Polyacrylamide is a polymer used in many cosmetics and personal care products , including:-

- . Hair care products:- helps hair to hold its style by preventing it from absorbing moisture.
- .Skin cleanser, moisturizer, lotions and creams:- Acts as a film former , suspending and emollient .
- . Self- tanning products :- Used in self-tanning products
- . Makeup:- used in makeup
- .Nail care products:- Used in nail care products.

Polyacrylamide polymer most commonly used in:- moisturizer, cleansers, nail polish , lip gloss and sunscreens and shampoos

Advantages:-

- Film former
- Heavy oil recovery



- Boiler water additive

4) Vinyl Acetate:-

Vinyl acetate is a material used in cosmetics and personal hygiene products as a fixative, binder, and emulsion stabiliser:(28)

Binder: Keeps ingredients in cakes or broken tablets fresh.

Emulsion stabiliser: Stops emulsions from separating into their component water and oil.

Fixative: Helps keep hair in style by preventing it from absorbing moisture

Vinyl acetate is a colourless liquid with a strong odour. It is a Class 1B flammable liquid that can irritate the skin and eyes. Blisters, severe irritation, and chemical damage are possible outcomes.(29)

Vinyl acetate polymer most commonly used in:-

Hair care products, eye makeup, skin care products and nail polish etc.

Advantages:-

- Low cost
- Doesn't damage equipment
- Provides transparent glue lines

Disadvantages:-

- PVA glue is not waterproof
- This glue may cause eye and skin irritation.

5) polyamide:-

Polyamide works well with a variety of oils, where it contributes to improved structure. This ingredient's molecular weight prevents skin penetration. Because of its water and transfer-resistant qualities, which extend wear time, this is frequently used in sunscreens, lipsticks, lip glosses, and eye shows. Polyamide polymer mostly used in :-Sunscreen, lipstick, eyeshadow etc.

Advantages :-I

- Cost effective
- Durable
- Good sound insulator
- Use in noise reduction

Disadvantages:-

- It absorbs lot of water .

- Many polyamide get degrade when it comes in contact with light or UV radiation.

6) Poloxamer :-

Poloxamer is a synthetic polymer that finds application in cosmetics as an emulsifying agent, solubilising agent, surfactant, and cleansing agent. By lowering the surface tension of the material to be emulsified, this aids in the formation of emulsions and facilitates the dissolution of other substances in a solvent that would otherwise be insoluble. It also helps to cleanse the skin and hair by allowing water to mix with oil and debris so that they may be washed off.(30)

Poloxamer polymer is most commonly used in:-

skin cleansers, bath products, shampoos, hair conditioner, mouth wash and eye makeup remover etc.

Advantages :-

- Poloxamers can improve the solubility of drugs.
- Poloxamers can increase the chemical and physical stability of drugs
- This are non- toxic and Non – irritant
- Poloxamers have good drug release characteristics .

7) Polyether:

Polyether polymers are used in a variety of cosmetics, including:

Skin care products:- Sunscreen-containing self-tanning creams contain polyether-1. Without exposure to sunlight, these creams darken the skin by combining with the skin's own amino acids.(31)

Toothpastes:- Polyethylene glycols (PEGs) are used in toothpastes. PEG 600, also known as Carbowax 600, is a water-soluble, semisolid PEG that is used in toothpastes. (32)Polyether's are also used in other products, such as:

Pharmaceuticals: Polyether's are used as excipients in pharmaceutical products.

Lubricating coatings: Polyether's are used as lubricating coatings. (33)



Epoxy resins: Polyether's are used to make epoxy resins, which are used as coatings and adhesives. (34)

Phenoxy resins: Polyether are used to make phenoxy resins, which are used as metal primers. (35)

Penton: Penton is a chlorine-containing polyether that is used to line storage tanks. (36)

Polyether polymer is most commonly used in:- shampoos , conditioners, shaving cream and skin care products etc.

8) Polyester:-

Polyester-5 is a film former used in cosmetics, such as mascara, foundation, and hair pomade.(37)

Polymers are used in cosmetics for a variety of purposes, including:

Thickening and gelling: Polymers like polyethylene glycols (PEGs) and carbomers are used to thicken shampoos, conditioners, creams, and lotions. (38)

Fixative: Polymers like polyimide-1, polyquaternium-11, and PVP/VA copolymers are used in sprays, lotions, gels, and foams to help fix hair in place. (39)

Conditioning: Polymers like polyquaternium-6, polyquaternium-7, and polyquaternium-11 improve skin feel and hair manageability. (40)

Emulsifier and waterproofer: Polymers are used in sunscreens, lotions, and makeup.

Rheology modifier: Polymers are used in gels.

Pigment disperser: Polymers are used in cosmetics.

Emulsion stabilizer: Polymers are used in cosmetics.

✓ **Polyester polymer most commonly used in:-** shampoo, conditioner, styling products, hair removal products, foundation and hair pomade.(41)

Advantages:-

- **Durability:** Polyester is resistant to stretching, shrinking, and wrinkling, which helps it retain its shape and appearance over time.

- **Color consistency:** Polyester masterbatch ensures consistent and uniform coloration in textiles, plastics, and other materials.(42)
- **Dries quickly:** Polyester dries very quickly, making it ideal for outerwear.
- **Stain resistant:** Polyester is highly stain resistant, making it very easy to clean.
- **Takes dyes easily:** Polyester fiber takes dyes (colors) easily. (43)

9) Silicon:-

Silicone polymers are soft, durable, and free from harmful chemicals. They have a strong and stable siloxane bond and are nontoxic, noncarcinogenic, and hypoallergic.

Silicone polymers are used in many cosmetics, including hair products, skin creams, deodorants, and sunscreens: (44)

Hair products:-

Silicone is a common ingredient in shampoos, conditioners, and hair serums. It can make hair look shinier and healthier, add volume, and control frizz.

Skin creams:-

Silicone compounds are used in various skin care products, including moisturizers.

Deodorants:-

Silicone mixtures containing decamethylcyclopentasiloxane are used in deodorants.

Sunscreens:-

Dimethicone, a silicone-based polymer, can be used in sunscreens to absorb ultraviolet light.

- ✓ **Silicon polymer most commonly used in:-** Lipstick, Creams, Makeup, Shampoo, Hair care products, Deodorants, Antiperspirants, and Lotions. 45)

Advantages :-

- **Skin feel:** Silicone can give skin a smooth, velvety texture.
- **Hydration:** Silicone can help lock in moisture and prevent dryness and flaking.



- **Hair protection:** Silicone can protect hair from heat damage and give it a glossy appearance.
- **Sunscreen booster:** Silicone can help boost the effectiveness of sunscreens.
- **Stability:** Silicone is stable and doesn't easily separate, disintegrate, or deteriorate.

Compatibility: Silicone doesn't react chemically with other cosmetic ingredients.

- **Cost:** Silicone is affordable for most consumers.

CONCLUSION:-

Different types of polymers such as natural semi-synthetic synthetic and modified derivatives have unique properties that can be beneficial for skin dental hair and nail care. These polymers can also work well with active compounds used in the cosmetic industry. By understanding the distinct characteristics of each type of polymer researchers and developers can create more effective and innovative products for various beauty and personal care needs. Polymer characterization is important because it helps us understand the specific qualities of a polymer that are most important for its intended use. By accurately determining the characteristics of a polymer such as its strength flexibility and chemical resistance we can choose the right material for a particular application. This ensures that the polymer will perform well and meet the requirements of the task at hand. Overall polymer characterization is crucial for selecting the right material for a specific purpose. Polymers are complex materials that can be used for a wide range of purposes so it's important to understand their various characteristics. This means looking at not just how they physically and chemically behave but also how they interact with biological systems and the environment. By studying these different aspects we can ensure that polymers are safe to use in various applications from medical devices to environmental protection. Ultimately this comprehensive approach helps us make informed decisions about the

best ways to use polymers in a way that benefits both people and the planet.

REFERENCES

1. Allied Market Research. Available online: <https://www.alliedmarketresearch.com/> (accessed on 12 August 2020).
2. Cosmetics Info. Available online: <https://cosmeticsinfo.org/Regulation-in-eu> (accessed on 12 August 2020).
3. Dias-Ferreira, J.; Fernandes, A.R.; Soriano, J.L.; Naveros, B.C.; Severino, P.; da Silva, C.F.; Souto, E.B. Chapter
4. Skin rejuvenation: Biopolymers applied to UV sunscreens and sheet masks. In *Biopolymer Membrane and Films*; de Moraes, M.A., da Silva, C.F., Vieira, R.S., Eds.; Elsevier: Amsterdam, The Netherlands, 2020;
5. Goddard, E.D.; Gruber, J.V. *Principles of Polymer Science and Technology in Cosmetics and Personal Care*; CRC press : Boca Raton , FL , USA , 1999.
6. Shrivastava, A. *Introduction to Plastics Engineering*; William Andrew Publishing: Boston, MA, USA, 2018; pp. 1–16 AvailableOnline:<https://www.sciencedirect.com/science/article/pii/B9780323395007000010> (accessed on 15 March 2024).
7. Dias-Ferreira, J.; Fernandes, A.R.; Soriano, J.L.; Naveros, B.C.; Severino, P.; da Silva, C.F.; Souto, E.B. Chapter 13—Skin rejuvenation: Biopolymers applied to UV sunscreens and sheet masks. In *Biopolymer Membranes and Films*; de Moraes, M.A., da Silva, C.F., Vieira, R.S., Eds.; Elsevier: Amsterdam, The Netherlands, 2020; pp. 309–330. [Google Scholar] [CrossRef]
8. Gawade, R.P.; Chinke, S.L.; Alegaonkar, P.S. Chapter 17—Polymers in cosmetics. In *Polymer Science and Innovative Applications*; AlMaadeed, M.A.A., Ponnamma, D., Carignano, M.A., Eds.;



- Elsevier: Amsterdam, The Netherlands, 2020; pp. 545–565. [Google Scholar] [CrossRef]
9. Severino, P.; Fangueiro, J.F.; Chaud, M.V.; Cordeiro, J.; Silva, A.M.; Souto, E.B. Chapter 1—Advances in nanobiomaterials for topical administrations: New galenic and cosmetic formulations. In *Nanobiomaterials in Galenic Formulations and Cosmetics*; Grumezescu, A.M., Ed.; William Andrew Publishing: Norwich, NY, USA, 2016; pp. 1–23. [Google Scholar] [CrossRef]
 10. Goddard, E.D.; Gruber, J.V. *Principles of Polymer Science and Technology in Cosmetics and Personal Care*; CRC Press: Boca Raton, FL, USA, 1999. [Google Scholar]
 11. Patil, A.; Ferritto, M.S. Polymers for personal care and cosmetics: Overview. In *Polymers for Personal Care and Cosmetics*; ACS Publications: Washington, DC, USA, 2013; pp. 3–11.
 12. Lochhead, R.Y. *The Role of Polymers in Cosmetics: Recent Trends*; ACS Publications: Washington, DC, USA, 2007.
 13. Viyoch, J.; Patcharaworakulchai, P.; Songmek, R.; Pimsan, V.; Wittaya-Areekul, S. Formulation and Development of a patch containing tamarind fruit extract by using the blended chitosan-starch as a Rate-controlling matrix. *Int. J. Cosmet. Sci.* 2003, 25, 113–125. [CrossRef].
 14. Germershaus, O.; Lühmann, T.; Rybak, J.C.; Ritzer, J.; Meinel, L. Application of natural and semi-synthetic Polymers for the delivery of sensitive drugs. *Int. Mater. Rev.* 2015, 60, 101–131. [CrossRef].
 15. Aung, N.N.; Ngawhirunpat, T.; Rojanarata, T.; Patrojanasophon, P.; Opanasopit, P.; Pamornpathomkul, B. HPMC/PVP Dissolving Microneedles: A Promising Delivery Platform to Promote Trans-Epidermal Delivery Of Alpha-Arbutin for Skin Lightening. *AAPS PharmSciTech* 2019, 21, 25. [CrossRef] [PubMed].
 16. Cao, S.; Ivanov, T.; de Souza Melchior, M.; Landfester, K.; Caire da Silva, L. Controlled Membrane Transport in Polymeric Biomimetic Nanoreactors. *ChemBioChem* 2023, 24, 202200718.
 17. Hunter, A.; Moghimi, S.M. Therapeutic Synthetic Polymers: A Game of Russian Roulette? *Drug Discov. Today* 2002, 7, 998–1001.
 18. Zhang, Y.; Yu, X.; Cheng, Z. Research on the Application of Synthetic Polymer Materials in Contemporary Public Art. *Polymers* 2022, 14, 1208. [CrossRef] [PubMed].
 19. Goddard, E.D.; Gruber, J.V. *Principles of Polymer Science and Technology in Cosmetics and Personal Care*; CRC Press: Boca Raton, FL, USA, 1999.
 20. Aung, N.N.; Ngawhirunpat, T.; Rojanarata, T.; Patrojanasophon, P.; Opanasopit, P.; Pamornpathomkul, B. HPMC/PVP Dissolving Microneedles: A Promising Delivery Platform to Promote Trans-Epidermal Delivery of Alpha-Arbutin for Skin Lightening. *AAPS PharmSciTech* 2019, 21, 25. [Google Scholar]
 21. Klein, M.; Poverenov, E. Natural biopolymer-based hydrogels for use in food and agriculture. *J. Sci. Food Agric.* 2020, 100, 2337–2347.
 22. Patil, A.; Ferritto, M.S. Polymers for personal care and cosmetics: Overview. In *Polymers for Personal Care and Cosmetics*; ACS Publications: Washington, DC, USA, 2013; pp. 3–11.
 23. European Commission (1999). Opinion of the Scientific Committee on Cosmetic Products and Non-Food Products intended for Consumers concerning ACRYLAMIDE RESIDUES IN COSMETICS adopted by the plenary session of the SCCNFP of 30



- September 1999. Available online: http://ec.europa.eu/health/scientific_committees/consumer_safety/opinions/sccnfp_opinions_97_04/sccp_out95_en.htm. Accessed April 21, 2022.
24. Andersen, FA (2005). Amended final report on the safety assessment of polyacrylamide and acrylamide residues in cosmetics. *International journal of toxicology*, 24, 21-50.
25. Aranaz, I.; Acosta, N.; Civera, C.; Elorza, B.; Mingo, J.; Castro, C.; Gandía, M.D.I.L.; Heras Caballero, A. Cosmetics and cosmeceutical applications of chitin, chitosan and their derivatives. *Polymers* 2018, 10, 213.
26. Habermann CE. 2002. Acrylamide. In *Kirk-Othmer Encyclopedia of Chemical Technology*, vol. 1. Online edition. New York: John Wiley & Sons. Pp. 288-304
27. Garcia-Godoy F. Hicks J. M. Maintaining the integrity of the enamel surface: the role of dental biofilm, saliva, and preventive agents in enamel demineralization and remineralization *J. Am. Dent. Assoc.*, JADA 2008 139 25S 34S Google Scholar
28. Singhal R. Mishra A. Nagpal A. K. Mathur G. N. *J. Polym. Mater.* 2009 26 239.
29. Hill, R. M. *Silicone Surfactants; Surfactant Science Series; Marcel Dekker: New York, 1999; Vol. 86. Google Scholar*
30. Petroff, L. J.; Snow, S. A. In *Silicone Surface Science; Owen, M. J., Dvornic, P. R. , Eds.; Springer: New York, 2012; Chapter 9.*
31. Garaud, J. L. In *Inorganic Polymers; De Jaeger, R., Gleria, M. , Eds.; Nova Sciences Publisher: New York, 2007; Chapter 16. Google Scholar*
32. Jachowicz J. McMullen R. Prettypaul D. Alteration of skin mechanics by thin polymer films *Skin Res. Technol.* 2008 14 312 319
33. Kamenova, K.; Haladjova, E.; Grancharov, G.; Kyulavska, M.; Tzankova, V.; Aluani, D.; Yoncheva, K.; Pispas, S.; Petrov, P. Co-Assembly of Block Copolymers as a Tool for Developing Novel Micellar Carriers of Insulin for Controlled Drug Delivery. *Eur. Polym. J.* 2018, 104, 1–9.
34. Borisova, D.; Haladjova, E.; Kyulavska, M.; Petrov, P.; Pispas, S.; Stoitsova, S.; Paunova-Krasteva, T. Application of Cationic Polymer Micelles for the Dispersal of Bacterial Biofilms. *Eng. Life Sci.* 2018, 18, 943–948.
35. Haladjova, E.; Toncheva-Moncheva, N.; Apostolova, M.D.; Trzexx Dworak, A.; Petrov, P.; Dimitrov, I.; Rangelov, S.; Tsvetanov, C.B. Polymeric Nanoparticle Engineering: From Temperature-Responsive Polymer Mesoglobules to Gene Delivery Systems. *Biomacromolecules* 2014, 15, 4377–4395.
36. Chang, C.; Ginn, B.; Livingston, N.K.; Yao, Z.; Slavin, B.; King, M.W.; Chung, S.; Mao, H.-Q. 1.4.6—Medical Fibers and Biotextiles. In *Biomaterials Science; Academic Press: Cambridge, MA, USA, 2020; pp. 575–600.* Available online: <https://www.sciencedirect.com/science/article/pii/B9780128161371000386>
37. Grethe, T. Biodegradable Synthetic Polymers in Textiles— What Lies beyond PLA and Medical Applications? A Review. *Tekstilec* 2021, 64, 33–47.
38. Sikder, A.; Pearce, A.K.; Parkinson, S.J.; Napier, R.; O'Reilly, R.K. Recent Trends in Advanced Polymer Materials in Agriculture Related Applications. *ACS Appl. Polym. Mater.* 2021, 3, 1203–1217.
39. Austin, H.P.; Allen, M.D.; Donohoe, B.S.; Rorrer, N.A.; Kearns, F.L.; Silveira, R.L.; Pollard, B.C.; Dominick, G.; Duman, R.; El Omari, K.; et al. Characterization and Engineering of a Plastic-Degrading Aromatic Polyesterase. *Proc. Natl. Acad. Sci. USA* 2018, 115, E4350–E4357.

40. Ma, S.; Fu, S.; Yang, H.; He, P.; Sun, Z.; Duan, X.; Jia, D.; Colombo, P.; Zhou, Y. Exploiting Bifunctional 3D-Printed Geopolymers for Efficient Cesium Removal and Immobilization: An Approach for Hazardous Waste Management. *J. Clean. Prod.* 2024, 437, 140599.
41. Satchanska, G.; Topalova, Y.; Dimkov, R.; Groudeva, V.; Petrov, P.; Tsvetanov, C.; Selenska-Pobell, S.; Golovinsky, E. Phenol Degradation by Environmental Bacteria Entrapped in Cryogels. *Biotechnol. Biotechnol. Equip.* 2015, 29, 514–521. [
42. Schöpfer, L.; Schnepf, U.; Marhan, S.; Brümmer, F.; Kandeler, E.; Pagel, H. Hydrolyzable Microplastics in Soil—Low Biodegradation but Formation of a Specific Microbial Habitat? *Biol. Fertil. Soils* 2022, 58, 471–486. <https://www.mdpi.com/2073-4360/16/8/1159>
43. Sander, M.; Kohler, H.-P.E.; McNeill, K. Assessing the Environmental Transformation of Nanoplastic through ¹³C-Labelled Polymers. *Nat. Nanotechnol.* 2019, 14, 301–303.
44. Boaventura, N.F.; Sousa, T.F.d.P.; Casagrande, M.D.T. The Application of an Eco-Friendly Synthetic Polymer as a Sandy Soil Stabilizer. *Polymers* 2023, 15, 4626.
45. Nelson, T.F.; Baumgartner, R.; Jaggi, M.; Bernasconi, S.M.; Battagliarin, G.; Sinkel, C.; Künkel, A.; Kohler, H.-P.E.; McNeill, K.; Sander, M. Biodegradation of Poly (Butylene Succinate) in Soil Laboratory Incubations Assessed by Stable Carbon Isotope Labelling. *Nat. Commun.* 2022, 13, 5691.
46. Eubeler, J.P.; Zok, S.; Bernhard, M.; Knepper, T.P. Environmental Biodegradation of Synthetic Polymers I. Test Methodologies and Procedures. *TrAC Trends Anal. Chem.* 2009, 28, 1057–1072.
47. Choubey, R.; Sonker, N.; Bajpai, J.; Jain, P.; Singh, A. Synthesis of Polymer Nanomaterials, Mechanisms, and Their Structural Control. In *Advances in Polymeric Nanomaterials for Biomedical Applications*; Elsevier: Amsterdam, The Netherlands, 2021; pp. 41–63.
48. McDonald, S.M.; Yang, Q.; Hsu, Y.-H.; Nikam, S.P.; Hu, Z.; Wang, Z.; Asheghali, D.; Yen, T.; Dobrynin, A.V.; Rogers, J.A.; et al. Resorbable Barrier Polymers for Flexible Bioelectronics. *Nat. Commun.* 2023, 14, 7299.
- Feist, J.D.; Lee, D.C.; Xia, Y. A Versatile Approach for the Synthesis of Degradable Polymers via Controlled Ring-Opening Metathesis Copolymerization. *Nat. Chem.* 2022, 14, 53–58

HOW TO CITE: Yogita patil*, Kirmani, Dr. Rajendra Kawade, Synthetic Polymers Used in Cosmetic, *Int. J. of Pharm. Sci.*, 2024, Vol 2, Issue 11, 1544-1554. <https://doi.org/10.5281/zenodo.14235705>