

Chapter 9:

Formulating Halal Cosmetics: Role of Lipids, Compliance Challenges, and Technological Innovations

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Halal cosmetics are designed to meet Islamic and ethical standards, responding to the demand for products that are pure, safe and environmentally friendly. Lipids play an important role in these formulations, serving as essential components for skin hydration, enhancing the skin barrier, and overall product functionality. These lipids are derived from a variety of sources, including plants, animals and microbes. Ensuring the halal-compliance of these lipids is a critical consideration. This chapter explores the use of halal lipids in cosmetics, focusing on their sources, physicochemical properties, functions and compliance with halal standards. Sources of halal lipids, including plant-based options like olive and palm oils, and challenges in replacing non-halal animal derived components, are thoroughly examined. Innovation in halal lipids use, such as creating structured lipids, emulsification techniques and encapsulation methods, are presented as ways to improve product performance and meet evolving consumer expectations. Advanced extraction, purification and processing techniques are highlighted to enhance lipid quality while adhering to halal requirements. The discussion extends to sustainable practices in sourcing halal lipids and the environmental impact of their production, alongside the regulatory frameworks guiding halal certification. Looking to the future, the chapter calls for more research into microbial-derived halal lipids and the development of advanced methods to verify ingredient compliance. By combining religious, ethical and scientific perspectives, this chapter offers a clear framework for advancing halal cosmetics and providing insights into how the industry can grow sustainably while meeting the diverse needs of consumers.

1 Introduction to Halal Cosmetics

Over the last few decades, halal markets across key market sectors such as food and personal wellness have been experiencing significant global growth and are now becoming more mainstream in predominantly non-Muslim majority countries (Sobari et al., 2022). This growth is due to a surge in the Muslim population, a growing level of awareness and consciousness among both Muslims and non-Muslims of halal-related products, and the endorsement of various international authorities. Due to the high growth in the consumption of consumer goods among halal users, whether based on religious or health considerations, religiously induced halal markets are observed to be one of the key catalysts accelerating the development and growth of halal-related products. The global halal-savvy generation recognizes the significance of a wide range of modern products that are not only permissible from authorized food sources but also manufactured via a known and acceptable source, such as compliant, pure, traceable, preapproved, and consumable (Fachrurrozie et al., 2023).

Most of the existing literature has focused on halal status and issues concerning personal care, preventive healthcare, food and beverages, financial management, and medicine. However, with the increasing demand from Muslim consumers for halal cosmetics and personal care products globally, very little information is available on these aspects (Febriandika et al., 2023). The beauty and personal wellness industry has acknowledged the market demand and has developed various cost-effective international branding strategies. Market players have been creating Islamic branding products, such as halal makeup and halal cosmetics, to meet the persistently increasing demand for halal personal care products across various consumer segments. With the increasing consumer awareness of halal and the array of products, it is important for the industry to also deliver that sense of assurance and value to the consumers (Jayanto et



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al., 2024). The development of halal ingredients is a potential move to address the issue of halal status and provide assurance for Muslim consumers. The rearrangement and sourcing of ingredients and chemicals utilized in the creation of products, from rearranging and converting haram components to halal, may resolve potential doubts among repeat users who purchase products with the hope that the products have been developed to meet Islamic standards. (Ordóñez de Pablos et al., 2024).



Figure 9.1: Halal cosmetics prioritize the use of ethically sourced, non-toxic, and permissible ingredients, providing consumers with products that are both safe and aligned with their values.

2 Growing Market for Halal Cosmetics

The global Halal market for personal care and cosmetics products has developed rapidly over the last two decades with the growing Muslim population and increasing disposable income in Muslim-majority countries, including the Middle East, Asia, and Africa. The demand is further fueled by increasing awareness among Muslims to use products that are in compliance with their faith. Out of various Halal segments in food, pharmaceuticals, and personal care products, promoting the Halal property has offered enormous attraction to cosmetic products. The Halal cosmetics sector is a market driven by the principles of justice, honesty, environmental sustainability, and veterinary welfare, which shows there is substantial room for their development. Currently, around US\$90 billion in sales are generated annually from products that meet these criteria. The estimated global market for Halal beauty care is expected to range between US\$16 billion and US\$22 billion, growing at a compound annual rate of 15% (Mokhtar et al., 2021).

The production of cosmetics and personal care products that are compliant with Halal practices is driven by increased consumer demand for cruelty-free products. Research has shown that ethics or ethical considerations play a main role next to religion and health as driving factors behind the demand for Halal. This is a system of life that represents a separate set of principles based on religious doctrine in Islam, comprising a combination of faith, morality, and good deeds leading a pious life, without desire and consideration to the earnest significant religion, including law, ethical standards, and the environment. Islam is not only a religious identity but can also be referred to as a lifestyle. In order to respect the Islamic way of life, acquiring and using commodities for everyday activities while eliminating those considered haram is essential. The Halal market has been recognized not just as a religious group of people but also by scientific and technical research as precepts for healthy and quality products for consumers that apply to all humanity. Halal beauty is characterized as being pure, safe, and hygienic. This ensures that the ingredients

and the final product do not have any contact with any ingredient or service that may have been defined as haram (Hanifasari *et al.*, 2024).

3 Lipids in Cosmetics and Personal Care Products

As part of the skin physiology and barrier function, lipids have been used in cosmetics to improve skin conditions. The occlusive and emollient properties of lipids reduce transdermal water loss, hydrate the skin, and replenish the lamellar structure, giving the skin suppleness, elasticity, and smoothness. Halal lipids are needed for the formulation of halal cosmetics and personal care products, and this chapter assists the stakeholders involved in halal ecosystems, including halal pharmaceuticals and nutraceuticals. In this chapter, the potential sources of halal lipids, mainly the food supply chain, and the lipid composition of different sources are presented (Khan *et al.*, 2021).

Lipids are important components of various cosmetics and personal care products, making up 30–70% of the formulations. They can act as occlusive, emollient, and conditioning agents in skin care and hair care products (Pavlou *et al.*, 2021). As part of the skin physiology and barrier function, lipids have been used to improve skin conditions and properties such as viscosity, perspective, spreadability, and slip, which are dominated by the lipid component. Makeup products use lipids as pigment dispersants, binders for powders, and emollients for colour quality and smoothness. Despite these excellent properties, there is a growing trend of consumers demanding the use of naturally sourced ingredients in personal care products, especially after health scandals related to synthetic and animal-derived ingredients. Due to religious obligations, Muslim consumers require cosmetics made of halal ingredients. The majority of lipids commonly used in cosmetic formulations are derived from animal sources, which are considered non-halal ingredients for the formulation of halal cosmetics (Dini & Laneri, 2021).

3.1 Types of Lipids Used

For the development of halal cosmetics, one has to understand which lipids are used and which are exclusively found in animals. Generally, other than capillary, insulating, and those sebum-related compounds that the skin naturally produces, the remaining lipids found in the stratum corneum would be ceramides, cholesterol, and fatty acids. In developing surfactants, body and consistency enhancers, and thickeners in cosmetic products, fatty acid derivatives, glyceryl and sorbitan esters, and ethoxylated fatty alcohol begin as fatty acids and ethoxylated glycerides and sorbitan. Both these groups of lipids can be animal-based if the halal nature is not confirmed (Mortas *et al.*, 2022).

Ceramides are a key lipid that is essential in maintaining a healthy and good functional appearance of the skin as well as the barrier function. Finding a suitable replacement that is both halal-sourced and possesses the same functional ability is vital when animal-derived ceramide is to be substituted. Alternatively, halal ceramides or their plant-derived equivalents can be synthesized in the laboratory. Cholesterol is another key steroid that originates from animal-based products. Due to its water-absorbing ability and its provision of additional treatment by improving the skin penetration capacity of the barrier shrinkage enhancer, it also holds an important position in personal care products (Li *et al.*, 2020).

3.2 Functions and Benefits of Lipids

The lipids used in cosmetics also function in a number of ways that lead to the benefits of the application of a cosmetic. These functions are often related to the physicochemical properties commonly observed in different types of lipids, such as solid fat content, phase transitions, molecular packing, and lipid organization. Formulation specialists are able to manipulate the varying properties of the numerous plant and animal lipids used in the manufacture of cosmetic products in order to promote the efficacy and benefits of the final derived cosmetic product. By examining the chemistry and various aesthetic and performance benefits provided by using specific base lipids or speciality lipids, including naturally derived speciality lipids and substances used as lipid constituents of known and claimed benefits, a number of skin and hair care areas can be covered, such as the formation of emollients for softening the skin and

moisturizers for retaining skin moisture and preventing evaporation of the same, the formation of occlusive or waterproof films, temporary wrinkle refiners, skin or hair protectants, sunscreens, and permeation enhancers (J. Ahmad, 2021).

These plant and animal lipids are widely used for their high price per gram of lipid, which is utilized for potential high-value cosmetics. Marine lipids from the tropical seas are known to produce long-lasting softness on the skin. Due to the fact that these types of tropical oils are composed of a high percentage of saturated fatty acids, the crystal matrix organization at skin temperature provides the product with a melting quality, moisturizing the skin with long-lasting emollient properties. In addition, tropical marine lipids play an important role in structuring solids for the formulation of anhydrous stick products. Pork lard is also a type of natural vegetable fat originating from a pig source that has been developed to form water-in-oil and water-in-silicone emulsions as carrier systems for various skin conditioning agents, and its ingredient also provides the resulting emulsion with good spreadability on the skin (S. G. Fonseca, 2021).

4 Halal Certification in the Cosmetics Industry

The growth of the halal industry has resulted in an increased level of success. Concerning the cosmetics industry, Malaysia, Indonesia, and the Middle Eastern countries have contributed to double-digit growth, with third-party halal certification bodies also benefiting. This offered a golden opportunity for the briefing about certification and recognition. At this preliminary stage, the only requirement is to declare honestly that the cosmetic products are halal. As the product penetrates the market, the demand for halal verification will also create pressure to involve third parties in controlling halal ingredients. Generating halal knowledge will be necessary. This chapter aims to contribute to and extend the knowledge of halal cosmetics to all levels. To establish cosmetic companies that produce their products using halal-valued propositions, a proactive government is needed, and the enhancement of a systemic application is also necessary (Yusuf, 2023).

4.1 Importance of Halal Certification Limitations

There are a set of standards in the manufacturing and handling of halal cosmetics that, in order to be declared halal, must contain only halal ingredients. It is therefore clear that halal compliance is key, principally in an increasingly diverse consumer landscape for personal care and beauty products, and the Muslim population, which will increase in the near future (Nordin & Wan Mohamed Radzi, 2021).

The term 'halal certificate' has become a significant issue in today's global trade. Halal certification is the process conducted to inspect, verify, and approve the production and intake of halal products by the licensed halal certification body in accordance with the halal standard that complies with Islamic law. The certificate is current proof that brands and products are accepted, and should a brand establish that the goods meet the requirements of the regulatory board conducting the audit, it can be placed on its website, point of sale, or in brand advertising its halal-approved identity. Halal certification is essential mostly for meat products, dairy products, packed food, canned food, raw food materials, food ingredients and processing aids, food additives, health supplements, and processed food, but also with consideration for personal care products. (Nordin & Wan, 2021; Latiff, 2020).

4.2 Certification Bodies and Processes source

Provide Halal certification is a voluntary independent assessment to confirm that products or services comply with Halal religious requirements according to Islamic law, or Shari'ah. Certification processes differ but should ideally cover an assessment, approving a production process, and reviews or audits. The implementation of Halal certification for raw materials and cosmetics follows a process. A certification body provides details about the standards, requirements, and Halal assurance systems in a Code of Practice. A company that wants a product (cosmetics) to be Halal certified requests information from the certification body and an application is required for those who are interested. The product owner makes a formal application for Halal certification, usually in the form of a letter and completing the form known as

"applicant information requirements." (Wijaya & Priantina, 2024). Documentation evidence of compliance with Halal requirements is provided via a checklist and an effective test that the product meets Islamic requirements. The company provides and records the necessary documentation and tests. The certification body makes a certification decision. If the evidence provided shows the product meets Islamic laws and the other requirements, the company's achievements are communicated to the company owner, so the company informs its prescribers and clients. Information must be provided to all those with whom the organization has relationships and who have reason to require such information. The product is now considered to be Halal, and the company can use the certification mark. Results are subject to ongoing monitoring. If requirements are not met, the certification can be cancelled. All criteria and procedural requirements for each type of audit and review are in the certification body's programs, procedures, and standards. (Tan and Husny, 2020).

5 Sources of Halal Lipids

This section discusses the potential sources of halal lipids that may be used in the formulation of cosmetics and personal care products. There are several known halal lipids that are already being used in cosmetic and personal care formulations, and they are derived from sources that are permissible according to Islamic shariah. Some of these examples include olive oil, jojoba oil, palm oil, beeswax, sunflower oil, and perilla oil, which are mainly used to formulate various lipid-based products. Moreover, the use of non-halal lipids could affect the overall product acceptability. Therefore, there are significant limitations in halal preparation, especially for lipid-based cosmetic and personal care formulations. It may be due to the lack of sources, high cost, or more complex extraction and purification procedures involved (Payyadhah *et al.*, 2023; Baki, 2022).

There are additional types of oils or fats that are considered halal, such as camel hump fat, goat tallow, animal fat, dolphin oil, shark oil, mahi-mahi oil, sunflower oil, corn oil, walnut oil, hazelnut oil, safflower oil, canola oil, grape seed oil, sesame oil, cottonseed oil, soy oil, pumpkin seed oil, flaxseed oil, peanut oil, mustard seed oil, chamomile fat, bayberry seed oil, water lily seed oil, spirulina oil, chia seed oil, inca inchi, and several types of okra oil. However, not all of the oils mentioned above are widely used in the formulation of cosmetic products. The lower number of commercialized products and lack of availability of halal-certified ingredients are considered the main contributing factors to the lesser interest of the industry, especially in the development of formulated products using other known halal lipid sources (Baptista-Silva *et al.*, 2020; Calvo *et al.*, 2020).

5.1 Plant-based Lipids

The long-term stability of any natural oil is dependent on the level of saturated fats. Saturated fats are relatively stable, while unsaturated fats are more vulnerable to oxidative processes. The primary type of unsaturated fats—whether they contain oleic, linoleic, or linolenic acid—will determine their stability. The natural oils that are popular with the personal care industry include sunflower, safflower, rapeseed, corn, soybean, rice bran, and hemp seed oils. Solid lipids, such as palm oil and palm kernel oil, are also used (Patel *et al.*, 2020; Sharma *et al.*, 2022).

Palm oil and its fractions are the most applied, given the physical and functional attributes that they provide for both the aesthetic and functional performance of skin care, hair care, oral care, and sun care products. Palm oil contains a high concentration of beta-carotene and high levels of lipophilic active ingredients, alpha-tocopherol, and tocotrienols. Lauric acid, a fatty acid that contains antimicrobial properties, is also present at high levels in palm kernel oil. With the expanding sector, our focus is on attempting to identify and utilize other vegetable sources to cater to the increasing demand for halal products (Edo *et al.*, 2022).

5.2 Animal-derived Lipids

The use of animal-derived lipids as an ingredient in cosmetics and personal care products brings its own story, especially for the halal market segment. In the manufacture of numerous personal care and cosmetic products, animal fatty derivatives such as glycerides, cholesterol, squalene, animal ceramides, and fatty alcohols are widely used. The application of cosmetics containing animal-derived ingredients is always under debate. Even manufacturers have recognized and declared that the development of beauty products is halal-certified so that they can be marketed to a wider number of consumers in the international market. Additionally, a number of forms and sources of lubricants are manufactured for use in preparation processes for different products. Halal-certified plant-derived lubricants can be utilized. Their application in emulsification, solubilization, and thickening processes is somewhat limited with respect to their animal-derived counterparts (Cheng et al., 2024; De Luca et al., 2021).

Animal-derived lipids can be sourced from sheep, cattle, and goats. It is against halal guidelines to limit the application of these materials. A variety of materials can be utilized in the manufacture of various cosmetics and personal care products. To name a few, glycerol obtained from animal fat can be applied in creams as a moisturizer, cholesterol sourced from sheep wool can be applied as a skin conditioning agent, squalene obtained from shark liver oil can be applied as a skin moisturizer, animal ceramides sourced from the lipid of sheep's wool can be used as a repasser and as a skin synthetic agent in skin care processes, and fatty alcohols from animal fats when oxidized can be utilized to render porous. It is an anti-foaming agent, a surfactant that can be used as a thickening agent. Of both of these components, the animal-derived supporter contracts are recognized due to their respected and unambiguous origin (Ye et al., 2023; Priyashantha, 2024).

6 Extraction and Processing of Halal Lipids of Halal Lipids

Oils and fats of animal, plant, and microbial origins have been utilized in industries such as food, cosmetics, and pharmaceuticals. The demand for halal ingredients in these industries is increasing. The development of halal or permissible lipids for use in halal products catering to Muslim consumers may be a good opportunity. Nevertheless, the rules and regulations of halal for pharmaceuticals and cosmetics are less stringent than those in the food industry. Furthermore, as halal certification is not regulated worldwide, general applied regulations, as well as the products, may vary between countries or religious bodies. Therefore, the opening of halal cosmeceuticals and their ingredients is vast. This review addresses the use of halal lipids as alternative cosmetic and personal care ingredients for the Muslim market (Dalir et al., 2020; Nordin & Wan Mohamed Radzi, 2021). Extraction and processing of halal cosmetics and personal care ingredients are key to the topic of the development of Muslim-friendly lipids. The extraction of halal lipids should be done in a halal manner, particularly for animals. As Muslims are allowed by Islamic law to utilize halal and toyyiban substances, the need to sacrifice animals using the Islamic way is predominant in research that requires animal-derived lipids. The extraction should also maximize the removal of undesirable components such as alcohol and non-halal components to attain the pure halal lipid for application. Nevertheless, the irreversible combination between lipid and non-lipid components in ingredients such as animal-derived lysophospholipid limits such purification processes. The selection of processing techniques for halal lipids follows the goal of extracting high-quality and safe ingredients as proposed by the Good Manufacturing Practice. Processes like purification are essential to enhance the quality of halal ingredients; yet, not all purification processes are accepted by the Islamic jurisdiction due to the creation of novelty between the chains of lipids and components. Standard procedures are needed to homogenize the protocols for the extraction and processing of halal lipids (Mavani et al., 2025).

6.1 Methods of Extraction

Halal-derived lipids are an essential constituent of a wide range of both personal care formulations and cosmetics. These lipid ingredients are derived from a number of sources of halal origin. The demand for

halal products has continued to expand across the world, particularly in personal care and cosmetic arenas. The significance of using halal raw materials in any product is to guarantee it does not contain impurities or substances that may be harmful to consumers. Halal lipids have grown in the production of both personal care and cosmetic products. While many studies have reported different methods of extracting halal lipids with their efficiency, few have presented comprehensive information or a comparison of these methods in a single article. The desired active ingredients of the lipids are the principal consideration for using the different halal lipid extraction methods. This chapter discusses the appropriate methods used to produce halal lipids for specific desired active lipids. (Moosavi-Movahedi *et al.*, 2021; Nur Azira Tukiran & Raihanah Badrul Hisham, 2024).

There are three methods identified for producing halal compositions: the mechanical method, the chemical method, and the enzymatic method. The mechanical method proposed in this chapter employs both dry-based and wet-based technologies. Tools used to carry out the dry-based method include expression and extraction, while wet-based method tools include spring cutting, bashing, and boiling. The principle used is the emulsification of the halal lipid from its source. The chemical method employs techniques such as maceration, percolation, chemical reaction, and hydrolysis. The principle in this method is the dissolution of the halal lipid from the emulsified source. The enzymatic method, on the other hand, allows the cleavage of halal lipids (Nurani *et al.*, 2022). The majority of the research in halal lipidology has exploited the mechanical method for the recovery of lipids from animals and plants, while other methods are scarcely addressed. The ability of these methods to protect the functional and nutritional properties of the original lipids against oxidation will determine their potential application in the cosmetic and personal care industry. The purpose of this chapter, therefore, is to explore different methods used in the extraction of halal lipids, along with their advantages and disadvantages (Abdallah *et al.*, 2021; L. M. Fonseca *et al.*, 2021).

6.1.1 Purification Techniques

The usual purification and separation methods employed in the triacylglycerol analysis of plant and animal lipid samples can be used in Halal lipids. These are usually gas chromatography, size-exclusion chromatography, and high-performance liquid chromatography, where the initial steps of preparation of aqueous inorganic solvents can render this method to be animal-source lipid-free (Ng *et al.*, 2022; Usman *et al.*, 2024). On the other hand, preparative and semi-preparative techniques employed in the purification of lipid samples, such as preparative gas chromatography or high-performance liquid chromatography, the use of chemicals resulting in the production of lipids, and supercritical fluid techniques are not suitable for application in Halal lipids. High-speed countercurrent chromatography can be applied to the fractionation of glycerolipids or other lipophilic substances to obtain fatty acid fractions rich in the desired fatty acid, without the need to use solvents or produce oxidized or degraded forms of the fatty acids (Zhang, 2022). In the purification of Halal lipid components for use in encapsulated ingredients, often involving multiple extractions from the lipid sources, the most important factors are the ability to purify a desired ingredient in a relatively pure form suitable for microencapsulation applications without the need to eliminate artifacts produced by the solvents or chemicals used in the purification, and the maintenance of the stability of the encapsulated ingredient produced (Hamed *et al.*, 2023).

7 Quality and Safety Considerations

To ensure that the lipids for cosmetic applications are safe and of high quality, a few issues need to be taken into consideration. Peroxidation takes place when lipids are subjected to oxidative stress, and oxidized lipids can produce undesirable sensory characteristics that deter the application of plant-derived lipids in cosmetics. Thus, the lipids obtained should be toxin-free and derived from non-toxic sources. Contaminants derived from conventional production, such as pesticides, heavy metals, uncontrolled microorganisms, and mycotoxins, should also be kept at a minimum level. The halal aspects, such as contamination with prohibited and najis substances, should also be considered for Muslim consumers (Nordin & Wan

Mohamed Radzi, 2021; Suparno, 2020). The quality of the lipid would be improved by taking into account a few preferred properties, including average molecular weight, hydrophobicity, polarity, and functional group characteristics. The application of plant-derived lipids with hypoallergenic characteristics and halal status would expand the current knowledge on the safety of applying lipids from new sources in cosmetics and personal care products (Nordin et al., 2021).

Extracted oils are susceptible to oxidation, resulting in lipid peroxidation. The process involves both chemical and biological reactions and can cause quality loss related to sensory and nutritional qualities. The quality of the oil could be evaluated by looking at parameters involving fatty acids, lipid purity, and those describing the gross quality of the oil. The overall quality of the oil should be acceptable prior to incorporation into final cosmetics (Figure 9.2)(Oyom et al., 2022; Yousuf et al., 2021). Contaminants, including heavy metals, dioxins, polycyclic aromatic hydrocarbons, organochlorides, and other organic chemicals, can be present in the lipids together with their trace components. They should meet the appropriate health and product safety guidelines since contamination with these materials can ultimately limit the use of the lipid for human application. Furthermore, the potential for contamination with pesticides used during cultivation should also be considered. The lipids need to be from non-genetically modified plants for halal status (Manning, 2022).

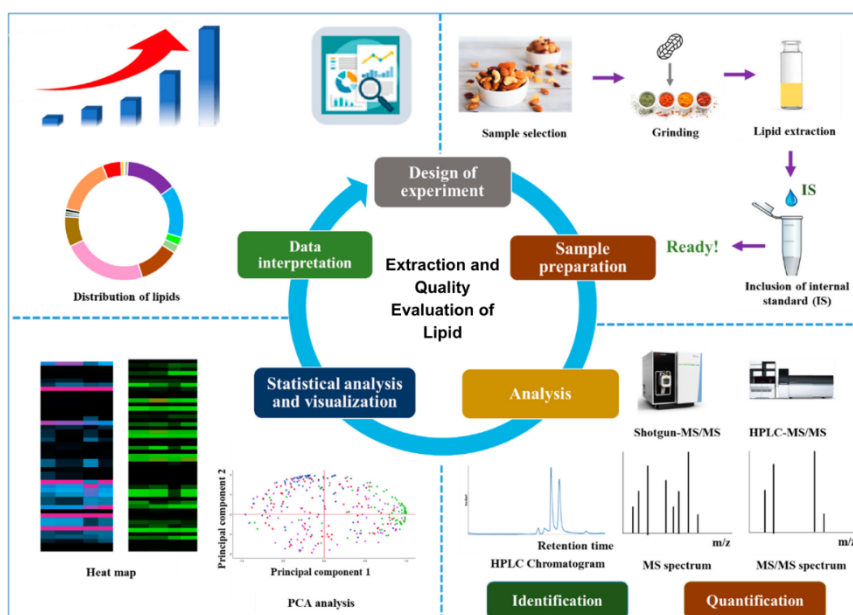


Figure 9.2: Comprehensive lipid extraction and quality control in Halal cosmetics production. The process of lipid extraction and advanced analytical methods for lipid identification and quantification ensures the distribution, integrity, and compliance of lipids with Halal standards, enabling the production of high-quality Halal-certified cosmetic products. Adapted from Yeo et al. 2023

7.1 Quality Control Measures

In each cosmetic preparation, it is important to strictly control the raw materials used for product manufacture, which include fat and oil composition and the verification of the presence of permissible species. Fat concentration in a cosmetic preparation usually corresponds to a percentage no higher than 30% by weight, which should be especially considered when ensuring the survival of the skin epithelium and the capacity to renew the tissue in these body regions. It is significantly important that the content of fat in product components fully corresponds to the percentage of free fatty acids in the skin, as the overproduction of these acids can cause the skin to appear dull and worse for wear (Mawazi et al., 2022). Vegetable oils and animal fats that contribute to the restoration of the structure and function of cell membranes, provide them with the necessary moisturizing and other functional properties and create a

comfortable environment for the amalgamation of the product with the skin are necessarily present in personal care products (A. Ahmad & Ahsan, 2020).

Quality Control Measures Considering the above, we can assume that halal cosmetics—lipophilic substances that ensure product stability, structure, and solution, and that, along with meeting the requirements for cosmetic products, do not contain byproducts of ritually unacceptable animals and correspond to halal food requirements—can be represented by individually selected concentrations of large quantities. However, there are regulatory restrictions imposed on halal products that have been created in Muslim countries. Oil control measures used by the global community for vegetable oil, animal oil, and their products do not always work at times when cosmetic enterprises, commercial organizations, and healthcare institutions need to learn about the origin of raw materials in the shortest possible time and guarantee to specialists and consumers the sources of these necessary oils (Uddin *et al.*, 2021). Products that correspond to the halal standards and meet all the necessary requirements and criteria presented above need to be verified and tested by analytical and safety control measures. These conversations regularly revolve around constant products. As a result, we have so far formed a regulatory framework that helps us to overcome analytical challenges for products or raw materials, modifying nutraceutical drugs that are used as pharmaceutical agents—these are the halal cosmetics that, at times, may contain medicinal and effervescent components. The implementation of high-quality control measures and regulations must be disseminated and clarified; an explanation of the main criteria and subscribed requirements is necessary for social producers and users. Control and verification measures should strictly comply with the principles and basis provided by Islamic religious dogmas (Aziz *et al.*, 2021; Lestari *et al.*, 2023).

8 Regulatory Compliance

Compliance with established regulations is required each time a cosmetic product is developed and marketed in a market or region. These regulations require the formulation to comply with safety aspects and innocuity, with rules and guidelines that instruct developers and manufacturers on aspects that are allowed in the quantities being used and the need to comply with specific requests. In many regions of the world, these regulations establish guidelines on the need to avoid animal or pork-derived ingredients and derivatives from being used in the development of cosmetic products. This necessity has led many cosmetics manufacturers to adopt regulatory compliance with Halal standards, designing specialized lines for certain markets that follow the rules for ingredients such as acids, glycerin, and derivatives, and formulations that avoid intoxication to the end user (Vlachou *et al.*, 2022; Yeh *et al.*, 2024). Compliance with established regulations will directly influence costs, arrival time at the market, distribution chain, development time, and formulation changes based on the raw materials. As Halal regulations are introduced in a market, compliance with these aspects acts as a barrier to entry for other suppliers in the cosmetics market in that region, creating highly competitive advantages. In this context, the research approach being communicated aims to identify Halal-compliant cosmetic formulations with defined regulations in place, the actual Halal-certified raw materials that can be used, and the need for production technologies that are environmentally concerned. The focus is then on presenting Halal lipids that can be used for these purposes, the regulatory aspects that explain why these ingredients can or cannot be used, and the impact of the use of the mentioned lipids in the cosmetic product once they have been incorporated into the cosmetic formulation that follows the defined conditions for certification compliance (Adham *et al.*, 2024).

9 Formulation Techniques with Halal Lipids

Creating a starch-based film is a novel method to formulate and encapsulate halal materials into a film. Forming a polysaccharide matrix with lipid inclusion modifies the plasticizing behaviour of relatively small lipid inclusions, reducing the free volume percentage of the host glycerol matrix. Starch is a low-cost natural biopolymer that is similar to thermoplastic. PLA-based halal films have been successfully created for cosmetic applications to deposit the necessary ingredients on the skin, where they dissolve upon contact. The starch or PLA-based film can be formed into precise shapes with the formation of containers or other

components. However, processing logistics are expensive and require precision to maintain shape integrity to prevent property loss (Mohd Hatta et al., 2023; Ezati et al., 2023).

Solid lipid nanoparticles are interesting candidates as carriers for the supply of cosmetic ingredients to the skin. They are small, and the fact that they are solid at room temperature prevents the lipid ingredients they contain from weeding out over time. Cookie milling uses low-cost materials to convert the original source into a free-flowing powder. This concept is attractive for consumers, who will only need to add a suitable amount and volume of water to produce products of the desired texture (J. Ahmad, 2021). The term 'cookie' comprises processes such as non-aqueous solvent extraction, supercritical fluid extraction, aqueous extraction, and pulsed electric field treatment, as well as methods using high-pressure homogenizers. The term 'milling' uses planetary force ball milling and ultra-high-speed milling, leading to a fine powder that does not lead to agglutination. The powder can be processed into different shapes, filled with other materials, or can be used as an intermediary to fabricate other lipid-based materials. The lipid particle surface is locked, giving the compound increased oxidation resistance, especially when lipid particles are dispersed (Oliveira et al., 2022; Safta et al., 2024).

9.1 Emulsification and Stability

Improving the emulsification and stability of halal emulsifiers is important to enhance the properties of the final emulsion system. These desired emulsifying properties can modify the structural and interfacial properties of an emulsifier to achieve better dispersion and antimicrobial activities. Performing modification techniques like esterification, hydrogenation, interesterification, fractionation, and partial glycerolysis on these potential halal lipids enabled the production of structured lipids with altered physicochemical behaviour. In the case of glyceride synthesis, it can also enable the creation of double-tail SN-glyceride derivatives to be used as novel non-ionic surfactants for personal and home care applications (Zaman et al., 2023). Distinct possibilities for the use of halal structured lipids include them being used as a single raw material that is conveniently equipped with both oil-based antimicrobial activities, offering protection against microbial spoilage, off-smelling notes to their oil and fragrance compounds, and a consistent release of actives for long-lasting protection (Figure 9.3) (Zaman et al., 2023; Angelopoulou et al., 2022).

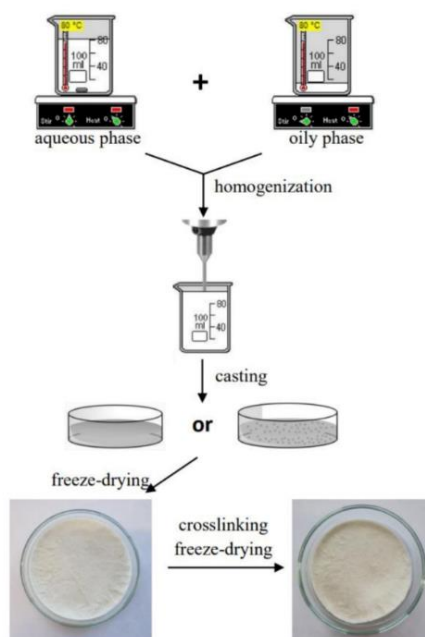


Figure 9.3: Schematic representation of the emulsification process for Halal lipid-based cosmetic formulations. The emulsion is subsequently processed via casting followed by freeze-drying or crosslinking freeze-drying, resulting in a powdered cosmetic formulation suitable for Halal-certified applications. Adapted from Prus-Walendziak and Kozłowska, 2021

In emulsion systems, the use of halal glycerides in deploying preservative-like activity can effectively reduce synthetic preservative exposure among end users, given their potential application as naturally derived antimicrobials to limit mould proliferation in water-sensitive products (Lakshmayya *et al.*, 2023). In emulsion systems, the use of halal glycerides in deploying preservative-like activity can effectively reduce synthetic preservative exposure among end users, given their potential application as naturally derived antimicrobials to limit mould proliferation in water-sensitive products (Lakshmayya *et al.*, 2023). Consequently, glyceride-based preservatives have significant market potential, especially in the halal, organic, and natural personal and home care product categories, where there are stringent prohibitions against conventional actives. Halal glycerides are considered cost-effective and especially advantageous for reducing preservative fears among parents who prefer gentle ingredients for their children. Given this unique attribute, in addition to the ability to tailor emulsification performance based on the utilization of raw materials, this strategy is able to provide halal chemistries in favour of better product quality and safety attributes in our personal and home care sector.

10 Market Trends and Consumer Perception

The increasing number of halal consumers has brought about a change in the cosmetics and personal care products market. Halal and safe purchases have now become important considerations for Muslim consumers. A more aware young generation and concerns over health as well as environmental issues can influence higher spending on halal cosmetics and personal care products (Khan *et al.*, 2021). Although Sharia-raised children are proportionally fewer than consumers in other age groups in the commercial market, the majority of Muslim parents actively seek healthy food products and cosmetics that are safe for their children. In the context of cosmetic ingredients, consumer perception, satisfaction, and knowledge have distinct relevance, as the continued success of cosmetic products in the marketplace depends on meeting consumer needs for a more attractive appearance (Shenker *et al.*, 2024).

Market trends in the halal cosmetics and personal care products sector fall under three categories: the rapidly growing trend of the halal cosmetics and personal care products industry, the growing trend of organic cosmetic products, and the focus of multinational corporations on safety and environmentally friendly products. The global halal cosmetic market will reach 54.16 billion USD by 2022, 12.58% more than in 2017 (Sulaiman *et al.*, 2020). This significant growth makes guarantees regarding the quality and halal content of cosmetic products a necessity. In an ever-competitive environment, pure and organic cosmetic and personal care product manufacturers can focus on the promotion of organic compounds that are free from unwanted chemicals, which have been safely tested on animals, excluding pork, alcohol, animal-derived toxins, lead, mercury, and formaldehyde. These products are either "animal cruelty-free" or "not tested on animals." (Pramugari *et al.*, 2021). Several international MNCs are increasingly launching new products that promote sustainability and serve the needs of their consumers, thus establishing their focus on the health and safety of their users of cosmetics and personal care products. Some of the primary halal and organic cosmetic products encompass skin care products for the face and body, products for hair care, decorative or color cosmetics, and products for fragrances (Azam & Abdullah, 2020; Bednarz & Klimczak, 2024).

11 Demand for Halal Cosmetics

Halal cosmetics provide consumers with a sense of assurance in terms of purity and hygiene. With the growing interest in natural ingredients, halal ingredients fit seamlessly into this trend and are consistent with it. The current variant of halal cosmetics features a change in requirements for raw materials but does not command any changes in procedures, technologies, or processes, especially formulation and packaging. Modern consumers want a product to be halal at affordable prices; halal is no longer a niche market (Sari *et al.*, 2024; Shahid *et al.*, 2023). Demand for halal cosmetics continues to grow as consumers recognize the need for a healthy and ethical style of living. Awareness, location, and perceived halal products have become important factors in purchasing, and the demand for halal beauty products is also fueled by the increasing

concern over ethical or cruelty-free products; there is a strong preference to buy products that have not been tested on animals. Personal values as well as environmental issues both become the foundation of decision-making in purchasing cosmetics or beauty care. The industry cannot ignore these trends; it is worth noting that young Muslim women, as consumers of halal cosmetics, are forsaking cosmetics for the purpose of religious or health reasons and also for ethical reasons (Gumus & Onurlubas, 2023; Jamaludin et al., 2024).

As a result, the cosmetics industry is seeking information to design halal products that can shape new beauty trends. Concerns about raw materials should not be seen as a phase but as the development of market trends. Although the ingredients are not particularly unique, sales are increasing with halal additives becoming more relevant. Demand for halal cosmetics is significantly increasing; Muslim and non-Muslim consumers alike want beauty products to meet halal requirements. Muslims who require halal cosmetics comprise a significant portion of the global population, a market that is likely to grow annually (Khan et al., 2021). In addition to meeting the basic properties of the material, which currently uses the label halal at reasonable prices and in accordance with innovation, preferences related to natural, organic, ethical, and cruelty-free labels can be important to the acceptance of consumers. The demand for raw materials to develop a halal product has grown dramatically and has not been set aside simply because the demand for halal products is uncertain. In other words, the status of a product to meet halal is, in fact, relatively easy and constructive and will not result in a decrease in their level of interest. Therefore, obtaining halal results for raw materials used in cosmetic formulation is crucial to maintaining the trust of the consumer marketplace (Krisna & Yusuf, 2023).

12 Consumer Attitudes and Preferences for Halal Cosmetics

The growth of the global Halal market is on the rise, as evident with abundant numbers of Halal schemes and labels adopted throughout the world. Apart from the over one billion Muslim consumers, there are claims that a significant percentage of world Muslims are not well informed about their preferred choice, which other religious groups like Jews, Sikhs, and religious vegetarians are associated with in the Halal brand. Because of commonalities in religious dietary laws with Halal, some of the world's food that carry similar labels for Halal and Kosher include Majorcan almonds, Parma ham, Mahon cheese, and champagne (Akram, 2020). However, the use of animal fat and pork derivatives in food labels is considered non-permissible ingredients for Halal. Animal derivatives such as lard, gelatin, and glycerin can be replaced with a wide selection of Halal alternatives such as beef tallow, vegetable sources, marine sources, and synthetic alternatives authorized by the regulators (Mohamad et al., 2022).

Because of limited exposure to Halal issues, more research on how consumers express themselves on the matter is expected. From the marketing and branding perspectives, a generic voice of Muslim consumers, Islamic scholars, and Halal promoters was referred to, but often, these references could be misrepresented. Many consumers are ambiguous in their understanding and practice of their religion (Yener, 2022). Assertions on the label aspects could support incorrect signals. Getting value is always a concern, and previously compiled references from both Muslim-majority and minority countries were indicated as illustrations of what Muslim consumers prefer, highlighting the similarities: all want clean ingredients and natural components in the products they use. They appreciate sophisticated components in their cosmetics. Vegetation, in particular, is wanted in cosmetics because it offers concentrated properties in certain products (Noguerol et al., 2021; Singh et al., 2021).

12.1 Sustainable Practices in Halal Lipid Sourcing

Lipids make up a large part of our skin's composition and play a huge role in maintaining healthy skin. The use of plant-derived lipids is the alternative focus discovered by a formulation scientist. This is in line with the trend in the cosmetic area towards the use of natural and organic ingredients. Exclusive plant-derived lipids are halal, making it the best sustainable option for what would replace the lipids in halal personal care products in the future. In fact, the demand for natural organic personal care products is expected to

continue growing. Personal care manufacturers are looking for various natural materials and concepts (Sasounian *et al.*, 2024).

For example, one of the examples of plant-derived lipids that are halal and sustainable is from grape seed and sunflower oils. These oils can be sourced sustainably and have been identified in the lipids range of halal cosmetic range. They are rich in essential fatty acids, antioxidants, and nutrients that are beneficial for the skin. Another example that has been identified is the oil from kernels. The kernels of these fruits are large, which means that they could produce oils in large quantities. The oils derived are stable and have beneficial properties as hair conditioning agents, especially with their long-chain fatty acids. Some studies have also been performed to verify their benefits to the skin (Viscusi *et al.*, 2021).

13 Environmental Impact

In terms of environmental impact, the search for new materials often results in increased pressure on non-renewable resources, displacement of traditional agricultural activities, increased deforestation and industry supersaturation, and the growth of various environmental hazards that affect both the natural world and public health. In addition, oil-based raw materials, in particular partially hydrogenated, have a negative impact on both the environment and health, with a significant amount of hazardous substances emitted to the atmosphere during the production process. The extraction of hydrocarbons, their transport, and processing leads to major accidents, and emissions of oil and oil products pollute the soil and cause extensive fires that pollute the atmosphere (Bai *et al.*, 2021). The use of oil hydrocarbons as raw materials in the production of cosmetics and personal care products is often associated with a positive environmental effect arising from a decrease in the emission of solid suspended particles, since, in general, cosmetic products, due to their working composition, do not create conditions for the production of visible solid particles. Increases in taxes on petroleum products will lead to a significant increase in the cost of production of these products. The use of alternative resources creates conditions for a competitive production of goods, the formulation of which does not depend on oil market conjuncture, which is especially important in the increasing level of oil dependence of cosmetics and personal care products (Potrč *et al.*, 2021). The development of the production of cosmetics and personal care products based on alternative raw materials stimulates the production and growth of alternative raw materials that are carriers of information, since with the growth of information flows, the refining of natural compounds and semi-processed products of their processing also grows, which is reflected in the constant improvement of existing and the emergence of new environmentally friendly processes. Owing to naturalness, the advantages of products based on alternative raw materials are due to their highly competitive properties. In the production of cosmetic products with extendable shelf life, which are subject to mandatory recycling, preference will be given to biodegradable ingredients. Cosmetic products based on natural and organic ingredients, enriched with plant extracts, often have increased anti-stress properties, which allows their use in environmentally friendly biocosmetology (He *et al.*, 2023; Potrč *et al.*, 2021)

14 Future Directions and Innovations

This study has given an insight into the need for more detailed information on the fats and oils in cosmetics and personal care products, particularly those from a halal and safety point of view. It has provided details of both the plant and animal fats and oil categories that gel to form the lipids, both structured and others which are included in the final formulation. Both primary and secondary structured lipids and their unique properties and benefits have been detailed, while ways to make structured lipids from oils lower in saturated fatty acids have been examined.

It has been observed, from information that is available, that with very few plant oil exceptions the LB/UB is around 0.48. It has been suggested here that structured lipids based on oils with LB/UB values that are close to 1 might be more suited to skin applications, particularly those that use the slab-type skin path model, in that the more major lipid bilayer will be better emulated. The design principles relevant to the prevailing thinking regarding the design of more physiological SLs which are addressed here have also

been pursued, as ways likely to increase conversions. If conclusive, these can also be seen as promising means to lower doses to more reasonable levels. Unfortunately, while many well-paid customers could probably afford cosmetics in which higher sliceable SLs were utilized, the low-end affordable list comprises sunflower, olive, soybean, groundnut, corn, and palm oils. Facilitating low conversion wiggle room would also encourage greater interest by extraction and refining chemists in alternative enzyme sources to lipase.

15 Research and Development Efforts

Consumer awareness and acceptance of halal cosmetics and personal care products are on the rise, leading to the rapid emergence of this niche market, specifically within the Muslim community. The global demand for halal-labelled cosmetics and personal care products has been growing at an estimated market rate of around 12-17% per annum, and it is expected to continue to grow in the years to come. However, the majority of halal-labelled cosmetics and personal care products in the market only involve certification of finished products from the Islamic religious perspective. This practice only scratches the surface, and deeper research should be conducted into the ingredients used in these products, especially for those contained in non-soluble forms, such as waxes, emollients, and lipids.

To date, halal lipids for use in cosmetics and personal care products are a niche market that is largely dominated by natural waxes, oils, and butter that are plant-based. These types of cosmetic ingredients have various types of colouring and pigmentation, levels of stability, penetration levels, moisture binding, and levels of usage. This has prompted more research and development in the production of halal lipids from animals and microorganisms as alternative sources. Currently, there is no report on the halal lipid equivalent from microbes for comparability with plant-based and animal-sourced natural lipids. This chapter is specifically created to explore the use of halal lipids in cosmetics and personal care products from the Islamic religious perspective using analytical and in-silico methods.

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