Halal enzymatic cosmetic ingredients: the role of enzymes in ingredients selection

Maheswari Alfira Dwicesaria*, Mega Safithri, Dimas Andrianto, Ukhradiya Magharaniq Safira
Faculty of Mathematics and Natural Science, IPB University, Dramaga Campus, Bogor 16680, Indonesia

ABSTRACT
The increasing demand for halal products, particularly in the cosmetics industry, has led to a growing need to ensure that cosmetic products comply with Islamic laws. One of the challenges in achieving halal certification is determining the source of the active ingredients used in cosmetic products, such as enzymes. Enzymes derived from pigs or other animals that are not slaughtered according to Islamic laws are not considered halal. To ensure that the enzymes used in cosmetics are derived from halal sources, it is necessary to use enzymes generated from microorganisms through fermentation, provided that the raw materials and growth medium are halal-compliant. Compliance with regional and international standards, such as the Indonesian Ulema Council’s Fatwa and the Malaysian Cosmetic and Personal Care Standards, is essential for halal cosmetics. This article provides a comprehensive review of the role of enzymes in selecting halal-compliant cosmetic ingredients, focusing on the source of enzymes as a means of assessing the halalness of cosmetic products. It is essential to utilize halal enzymes such as those derived from plants to provide Muslim consumers with assurance when using cosmetic products.

Keywords: Cosmetic, Cosmetic ingredient, Enzyme, Enzymocosmetics, Halal

ARTICLE INFO

1. Introduction
Cosmetic products can be defined as any substances that applied on external surface of the human body such as the hair, skin, lips, etc for protecting, beautifying, cleansing, and preventing body odor (Fatima et al., 2020). Cosmetics also represent a symbol of beauty for women. Therefore Indonesia, with a female population of 133.54 million in 2020, is a promising market for cosmetics company (Aufi & Aji, 2021; Cabinet Secretariat of The Republic of Indonesia, 2021).

The global Muslim population is estimated to be 1.8 billion individuals, representing 24% of the global population. The Muslim population is estimated to rise at double the rate of the global population during the next few decades. Indonesia, Pakistan, and India were the three nations with the highest Muslim populations in 2010. With roughly 231 million members, or 93% of the adult population, Indonesia has the world’s biggest Muslim population. Over 87% of the Indonesian population is Muslim, making Islam the country’s dominant religion (Hackett et al., 2015).

According to The Business Research Company (2023), the worldwide halal cosmetics market size in 2022 is around $32.50 billion, and it is predicted to expand at a pace of 13.8% in 2027, with a market size of $62.65 billion by 2027. Globally, the halal market is predicted to grow every single year. As reported by Dinar Standard (2020), State of the Global Islamic Economy Report 2020, global Muslim expenditure on cosmetics increased by 3.4% from 2018 to 2019, hitting $66 billion. Following the emergence of COVID-19, it is forecasted that Muslim consumer spending on cosmetics will decline by 2.5% in 2020. Despite this temporary setback, a projected 5-year Compound Annual Growth Rate (CAGR) of 2.9% is expected, leading to a forecasted total of $76 billion in Muslim spending on cosmetics by the year 2024 (Fahmi, 2017).

The growing Muslim population is likely to drive the expansion of halal cosmetics businesses in the coming years. The phrase “increase in Muslim population” refers to a rise in the number of Muslims in a certain region, country, or planet. Several reasons, such as increased birth rates within Muslim households, Muslim immigration from other nations, and Islamic conversion, may be contributing for this expansion. The demand for halal cosmetics is rising as the Muslim population rises and more Muslims look for goods that conform to their religious principles. According to the Pew Research Center, the

* Corresponding author.
E-mail addresses: maheswarialfira@apps.ipb.ac.id

Halal Studies and Society
journal homepage: https://hass.ipb.ac.id/index.php/hass/index
https://doi.org/10.29244/hass.1.4.23-27
Received 10-11-2023; Received in revised form 31-11-2023; Accepted 08-12-2023
0000-0000 © 2023 The Authors. Published by IPB University. This is an open access article under the CC BY-NC license (http://creativecommons.org/licenses/by-nc/4.0/).
worldwide Muslim population is projected to reach 2.2 billion by 2030. As a result, the growing Muslim population will drive the future expansion of the halal cosmetics business (Hackett et al., 2015).

Prohibited ingredients in halal cosmetic products include those derived from pigs, carrion, blood, human body parts, predatory animals, reptiles, and insects. To attain halal certification, cosmetic materials sourced from permissible animals must be slaughtered in accordance with Islamic law (Sugibayashi et al., 2019). The complex process of selecting and processing ingredients, paying careful attention to locating, modifying, and certifying components in accordance with Islamic dietary regulations, is the foundation of Halal cosmetics. Enzymatic methods have emerged as a critical instrument in this task, allowing not only the extraction and alteration of components but also the certification of Halal compliance along the manufacturing process. By 2025, the global enzymes market is expected to expand by 14% per year to $15.25 billion (The Business Research Company, 2021).

Halal cosmetic products must exclude forbidden ingredients, including pigs, carrion, blood, human body parts, predatory animals, reptiles, and insects. Additionally, cosmetic ingredients derived from permissible animals must be slaughtered in accordance with Islamic law to be deemed halal (Sugibayashi et al., 2019). At the heart of Halal cosmetics lies the intricate process of ingredient selection and processing, with particular regard to sourcing, modifying, and certifying components in line with Islamic dietary laws. The used of enzymatic techniques have emerged as a pivotal tool in this endeavor, facilitating not only the extraction and modification of ingredients but also the assurance of Halal compliance throughout the production journey. The global enzymes market is expected to grow 14% a year to $15.25 billion by 2025 (The Business Research Company, 2021). This review journal aims to provide a comprehensive examination of the role of enzymes in the selection of Halal-compliant cosmetic ingredients.

2.Halal, Haram, and Najs Principle

In Islam, the Halal concept is based on Shariah Law, sourced from the Qur’an, sunnah, the consensus of Islamic jurists (imama’), analogy (qiyas), and the method of legal reasoning (ijtihad). Halal denotes actions or items that are permissible and unprohibited under Islamic law. This stands in contrast to haram, which signifies actions or items considered impermissible in Islam. A reward is given to those who follow halal law, but sin is for those who do not believe in it (Kashmash et al., 2023).

There are several verses in Qur’an that mentions about Halal and haram terms. Two of them are Surah al-Baqarah verse 168 and Surah al-Maidah verse 3 that describe below.

Prohibited to you are dead animals, blood, the flesh of swine, and that which has been dedicated to other than Allah, and [those animals] killed by strangling or by a violent blow or by a head-long fall or by the goring of horns, and those from which a wild animal has eaten, except what you [are able to] slaughter before its death, and those which are sacrificed on stones altars, and [prohibited is] that you seek decision through divining arrows. That is grave disobedience. This day those who disbelieve have despaired of [defeating] your religion; so fear them not, but fear Me. This Day I have prepared for you your religion and completed My favor upon you and have approved for you Islam as religion. But whoever is forced by severe hunger with no inclination to sin – then indeed, Allah is Forgiving and Merciful.” (QS. Al-Ma’ida’ [5]: 3).

Meanwhile, according to MS1500:2019, Shariah law and fatwa describe najs as impurities. As per Shariah law, Najs encompasses: a) dogs, pigs, and their progeny; b) Halal food tainted with non-halal substances; c) Halal food directly exposed to non-halal elements; d) any fluids and objects extracted from human or animal orifices, such as urine, blood, vomit, pus, feces, and placenta; e) carcasses or halal animals not slaughtered in accordance with Shariah law and fatwa, excluding aquatic animals and certain insects; and f) Khamr (intoxicating liquor) and edible or beverages containing or mixed with khamr, prohibited by Shariah law and fatwa (Malaysian Standard, 2019a).

According to Indonesian Ulema Council’s Fatwa (2013), he lawful use of cosmetics for decorative purposes: a. the materials used are halal and pure; b. intended for interests that are permissible according to sharia; and c. not dangerous. Cosmetic products containing ingredients produced through genetic engineering involving pig or human genes are considered harmful. Furthermore, cosmetic products utilizing ingredients like the raw materials, active ingredients, and/or additional ingredients from halal animal derivatives (such as fat) with an unknown method of slaughter are deemed makruh tahir and should be avoided. Likewise, cosmetic products utilizing ingredients from microbial products where the origin of the microbial growth medium is uncertain (particularly if it’s from pigs) should be avoided until there is clarity regarding the halalness and purity of the ingredients (Majelis Ulama Indonesia, 2013).

3. Enzyme

Enzymes are biological catalysts (also known as biocatalysts) that accelerate the metabolic processes in living organisms. Additionally, these catalysts can be isolated from cells and applied to catalyze a variety of commercially significant processes (Tipton & Mcdonald, 2015). Enzyme are classified according to the process they catalyse, and categorized based on the EC (Enzyme Commission) number. The term "enzyme" can refer to a single enzyme protein or a collection of proteins sharing a common catalytic characteristic. Completely distinct protein folds are known to catalyze the same reaction and consequently have the same EC value. These enzymes are called nonhomologous iso-functional enzymes (NISE) (Omelchenko et al., 2010). The oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases were characterized as six enzyme classes or EC levels. Translocases were categorized into a seventh enzyme category (EC 7) that was added to the EC in August 2018. The key factors in enzyme categorization are evolutionary and biophysical models, which allow structural similarity and sequence knowledge to be developed (Vandenberghe et al., 2020).

Similar to other catalysts, enzymes have two fundamental properties. First, they increase the rate of chemical reactions without being consumed or permanently altered. Second,
they increase reaction rates without altering the chemical equilibrium between reactants and products (Cooper, 2000). The lock and key model and the induced fit model are two alternative models for substrate binding to an enzyme active site. The first concept shows that the structure and chemistry of the substrate are complementary to the shape and chemistry of the enzyme active site. This implies that when the substrate approaches the active site, it fits exactly and bonds with the enzyme, producing an enzyme-substrate complex. The second proposes that the enzyme and substrate do not have the exact complementary shape/chemistry or alignment from the start. However, this alignment was generated at the active site by substrate-binding. Local molecular interactions with amino acid residues on the polypeptide chain often stabilize substrate binding to an enzyme (Lewis & Stone, 2023).

**4. Enzyme used in cosmetics ingredients.**

In the cosmetics sector, enzymes are often used. Enzymes are utilized in cosmetic compositions to help reduce acne, skin aging, and pigmentation. Other functions include exfoliation of the skin, preventing the formation of free radicals that harm the skin and body, maintaining of firm skin, and antibacterial effects (Sunar et al., 2016). Cosmetic enzymes can have an impact on the skin's microbiome, which is a collection of microorganisms that exist on the skin. The skin microbiome helps in skin barrier function and maintains skin homeostasis. Skin microbiomes have the ability to secrete protease enzymes, which play a critical role in the process of desquamation and the renewal of the stratum corneum. Additionally, the pH level is maintained through the synthesis of sebum and free fatty acids, while the disintegration of the lipidic film on the skin surface is aided by the release of lipase enzymes. It is important to note that these processes are essential for the overall health and function of the skin. Enzymes used in cosmetics can have the following effects on the skin's microbiome: First, enzymes used in cosmetics can change the pH of the skin, thus affecting the development and survival of microorganisms on the skin. Second, cosmetic enzymes can disturb the skin's natural barrier, making it more prone to infection and other skin disorders. Third, enzyme can increase the number of beneficial microorganisms: Some cosmetic enzymes, such as proteolytic enzymes, may stimulate the growth of healthy bacteria on the skin (Boxberger et al., 2021).

However, it is important to ensure that the enzymes used in cosmetics are taken from halal sources and that the product label clearly states this. There is no specific information available on halal microbial enzymes used in cosmetics. Enzymes generated from microorganisms during fermentation, on the other hand, are halal if the raw materials or other substances used in the growing medium are halal (Groccholl, 2023).

If a product's enzymes are derived from non-halal sources or made with non-halal or questionable ingredients, it cannot be authentically halal even though it has a halal label (Fischer, 2015). To achieve halal accreditation, it is crucial to analyze the origins and manufacturing methods of enzymes used in the cosmetic industry companies. Haram enzymes are either obtained from haram animals or manufactured with haram ingredients. If neither the development medium nor the completed product includes any haram components, the enzymes created by microorganisms during fermentation are halal. Enzyme-producing genetically modified microorganisms are not permitted to use recombinant DNA derived from haram or questionable sources (Ermis, 2017). The example of regional and international standard of halal cosmetics are Indonesian Ulema Council MUI Fatwa Number 26 of 2013 and The Malaysian Cosmetic and Personal Care Standard (MS2200:PART1:2008) (Majelis Ulama Indonesia, 2013; Malaysian Standard, 2019b).

Enzymocosmetics, a term utilized in the cosmetics industry to describe cosmetic products that employ proteolytic enzymes that specifically hydrolyze the peptide bonds of proteins within the stratum corneum, are widely recognized for their ability to enhance skin health and appearance (Gomes & Damazio, 2013; Kočevar Glavač et al., 2015). These products promote biological exfoliation, faster skin regeneration, provide deep cleansing, and enhance the penetration of cosmetically active substances (Monteiro & Silva, 2009). The stratum corneum becomes thinner, resulting in increased skin flexibility and texture. Papain from papaya, bromelain from pineapple, and ficain from fig trees are the primary plant enzymes that are used for skin exfoliation (Garcia & Gonçalves, 2021).

Papain (EC 3.4.22.2) is an endopeptidase-like proteolytic enzyme that is present in papaya fruits (Carica papaya) at a concentration of around 8%. This enzyme which contains a thiol group that is part of its catalytic site. Papain has a molecular weight of 23,406 Da, an isoelectric point of 8.75, and an enzymatic activity temperature of 65 °C. Glycine, valine, and tyrosine are the three major amino acids (Mitchel et al., 1970). The efficacy of the enzyme is contingent upon its origination in the plant, the environmental conditions of its cultivation, and the method of extraction applied. This enzyme is functional within a pH range of 5.0-9.0 and can withstand temperatures of 80°C or 90°C when substrates are present. However, it is rendered inactive and permanently damaged below a pH of 2.0, and it remains stable in urea-containing solutions at concentrations up to 8 M (de Castro Leite Júnior et al., 2022).

When it comes to dermal usage, its primary function is in medicine to devitalize tissues and accelerate the healing of burns and wounds (Merck, 2023). Papain reduces the pH in the wound bed, which inhibits the growth of harmful bacteria by stimulating the release of cytokines that promote cellular replication (Falanga, 2002). Papain contains anti-inflammatory, bacteriostatic, and bactericide properties in addition to debriding and speeding tissue healing (Osato et al., 1993; Owoyele et al., 2008). Whistaglousky et al., (2021) discovered that papain can increase collagen degradation by boosting MMP-1 levels and lowering TIMP-1 when the TIMP-1/MMP-1 ratio decreases. The lowered TIMP-1/MMP-1 ratio can classify collagenase or MMP-1 function as elevated because its inhibitor, TIMP-1, was repressed by papain. These findings indicate that the application of 3% papain gel can promote the healing of cutaneous wounds in mice by decrease of the local inflammatory response, stimulation of angiogenesis and improvement of collagen deposition organization (Figueiredo Azevedo et al., 2017). According to a patent (Baik et al., 2013), the papain component primarily acts to soften and exfoliate keratin on the epidermis.

Bromelain is a purified extract of the pineapple plant (Ananas comosus L.) which comprises a diverse array of proteolytic enzymes, as well as phosphatases, glucosidases, peroxidases, cellulases, glycoproteins, and carbohydrates (Feijoo-Siota & Villa, 2011). This enzyme is present in various parts of the pineapple, including the stem, fruit, leaves, and peel, but is most abundant in the stem (EC 3.4.22.32), and in the fruit (EC 3.4.22.33) (de Castro Leite Júnior et al., 2022). Protease bromelain is extracted from the fruit and stem of pineapples (Ananas comosus). Stem bromelain combines several thiol endopeptidases and other components extracted from the stem, bark, and leaves of Ananas comosus. Its molecular weight, isoelectric point, and optimal temperature for enzymatic activity are 35 kDa, 10°C, and 37°C, respectively (Chaurasiya & Umesh Hebban, 2013; Ferreira et al., 2011).
three major amino acids are alanine, glycine, and aspartic acid (Arshad et al., 2014).

Bromelain is used in the cosmetics industry to treat wrinkles, dry skin, and acne. Younger skin cells from the lower layers of the skin replace the dead cells in the top layer of the skin when the proteins from those cells are broken down. It also helps in the reduction of post-injection bruising and swelling (Abbas et al., 2021). Bromelain’s ability to debride skin burns may be advantageous for early skin grafting (Maurer, 2001). Because of its antibacterial properties, bromelain has been shown to be a possible protease that may be utilized therapeutically to treat acne (Abbas et al., 2021). According to Mori and Lee’s (2023) findings, bromelain exhibited beneficial effects against UV-dependent cell death and an increase in TFN-α mRNA expression. Furthermore, bromelain demonstrated a greater protective impact when utilized as a pre-treatment approach rather than a post-treatment strategy. Overall, this research demonstrates that bromelain may protect the skin from UV-induced cell death. The study conducted by Marco et al. (2018) revealed that bromelain exhibited proteolytic degradation of the receptor for advanced glycation end products (RAGE), reducing its cell-damaging effects. Additionally, Stopper et al. (2003) found that bromelain has anti-inflammatory properties by regulating inflammation.

Ficain, also known as ficin (EC 3.4.22.3) is a protease enzyme extracted from the latex stems of the fig tree (Ficus carica). The ficin enzyme belongs to the class of sulfhydryl proteases, which are enzymes with a sulfhydryl group (SH) on their active side, according to their chemical characteristics (Wahyuni et al., 2015). Ficin is a great exfoliator with enzymatic activity. It also has antioxidant properties (Michalun & Dinardo, 2014). According to Baeyens-Volant et al. (2015), the optimal temperature for enzymatic activity is 50 °C, and its molecular weight is 24,294 Da with an isoelectric point of 9.0. According to a recent study, ficin possesses antioxidant and whitening effects in skin cells and has the potential to be developed as a novel bio-cosmetic substance (Cho et al., 2019). According to a recent study conducted by Malewicz et al., (2022), it has been found that ficin may be effective in translating mechanistic studies on the brain processes of cysteine proteases’ pruritic and nociceptive actions. Furthermore, another study by Baidamshina et al., (2020) has demonstrated the stability and beneficial effects of chitosan-immobilized Ficin, which suggests that its addition to materials used in wound dressing may enhance the effectiveness of antimicrobial treatment and promote wound healing by preventing biofouling.

Photolyase is another promising enzyme. The photolyases/cryptochromes superfamily is a diverse group of photoactive enzymes found throughout life (Vierock & Hegemann, 2023). Photolyases are monomeric proteins that range in size from 50 to 61 kDa and contain 450-550 amino acids, as well as two cysteine dimers and cytosine-thymine dimers, which are generated by UV irradiation but considerably less often (Lucas-Dwicesaria et al., 2021). Photolyase is frequently utilized in topical creams or sunscreens for the purpose of safeguarding the skin from harmful UV exposure, as well as in therapeutic treatments aimed at addressing skin conditions such as premature photoaging, actinic keratosis, and squamous cell carcinoma (Ramirez-Gamboa et al., 2022).

The most frequent antioxidant enzyme with the fastest turnover rate is catalase (CAT, EC 1.11.1.6). This enzyme, which is found in living tissues and is critical in the conversion of hydrogen peroxide to water and molecular oxygen, is considered to be a crucial therapeutic element. Catalase is derived from both endogenous and external sources. It is present in erythrocytes, for example, and its exogenous sources include cotton, sunflower, and pumpkin (Mahomoodally et al., 2022). Several studies have documented the efficacy of catalase in treating inflammatory and dermatological conditions, including vitiligo (Kostović et al., 2007).

4. Conclusion

Recently, the use of enzymes as active components in cosmetics has gained popularity in the beauty industry. The source of the enzymes employed is one approach to assess the halalness of cosmetic products. The usage of halal enzymes is necessary to give Muslims assurance while using a cosmetic product. Enzymes that are considered halal are enzymes that sourced from plants.

References


Halal Studies and Society Vol 1 No. 1 (2024) : 23 -27
