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Review

# Innovative Emulsifiers in Cosmetic Products: A Patent Review (2013–2023)

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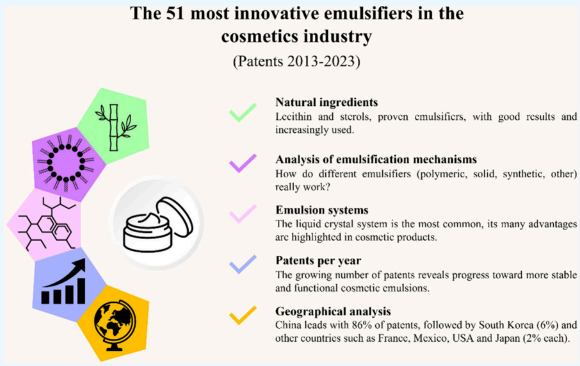
**ABSTRACT:** The cosmetics industry, characterized by innovation and dynamism, is constantly undergoing research, often guided by market trends. Although it covers various sectors, emulsifiers have had a notable impact on its development. Numerous products depend on these components, and continuous research has led to the creation of ever-better products. This Review analyzes emulsifiers for cosmetic use patented between 2013 and 2023, using Espacenet as the main database. Fifty-one patents were examined, considering the annual growth in publications, their geographic distribution, types of emulsifiers, their chemical and physical properties, chemical structures, emulsification mechanisms, and systems formed. An increase in the publication of patents was observed, with some decreases in certain years, highlighting that 86% of the patents come from China. The classification of emulsifiers revealed a predominance of those of natural origin, followed by polymeric, synthetic, and defined molecule compounds. The emulsification mechanisms of each group and the systems they formed according to the patents were also reviewed. In addition, trends in the physical and chemical properties of the emulsifiers were identified. This characterization demonstrates the growth in emulsifier research, which allows for the improvement of emulsions on the market, offering greater stability and functionality to develop superior cosmetic products.




## ■ INTRODUCTION

In the dynamic world of science and cosmetics, emulsions play an important role and, with them, emulsifiers. An emulsion, by definition, is a thermodynamically unstable system in which two immiscible liquid phases are mixed. This mixing does not occur spontaneously, so an emulsifier is generally required, a compound whose properties allow the phases to remain mixed.

In the cosmetics industry, emulsions account for a high percentage of the products; therefore, the development of better emulsifiers is remarkable. In addition, the consumption of cosmetic products also marks a development trend, with numerous studies showing that users are becoming more informed about the products they use and consider certain characteristics that they should have. For example, according to Mintel's 2024 global consumer trends report,[1] users are willing to pay for a cosmetics market that has natural ingredients in its formulations. In addition, they say that the beauty industry should be committed to being sustainable. The evolution of cosmetics and the tendency to create products that are less toxic for the environment and for humans is evident. Those cosmetics that have natural ingredients in their formulation or have a low impact on the environment are popular among users, and this is further reflected in patent applications for cosmetic products.[2]

These market trends have had a great impact on the development of new emulsifiers, generating a great variety of them and having their origin in common. In this way, it is possible to group emulsifiers if they are of natural origin, synthetic, from microorganisms, from fatty acids, or of polymeric character. The nature of each emulsifier makes it possible to recognize the type of system that it can form, considering its chemical properties. Thus, it is possible to have more effective emulsifiers or those that work better in combination with others so that the stability of the system can be maintained without alterations.

Although the objective of an emulsifier is to create a stable emulsion, not all of them act in the same way; this is known as the emulsification mechanism. Depending on the chemical and physical properties, the possible interactions, the environment in which it is, and the process to which it is subjected, the emulsifier will act in a certain way and may form systems with

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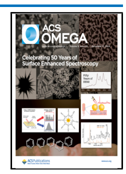

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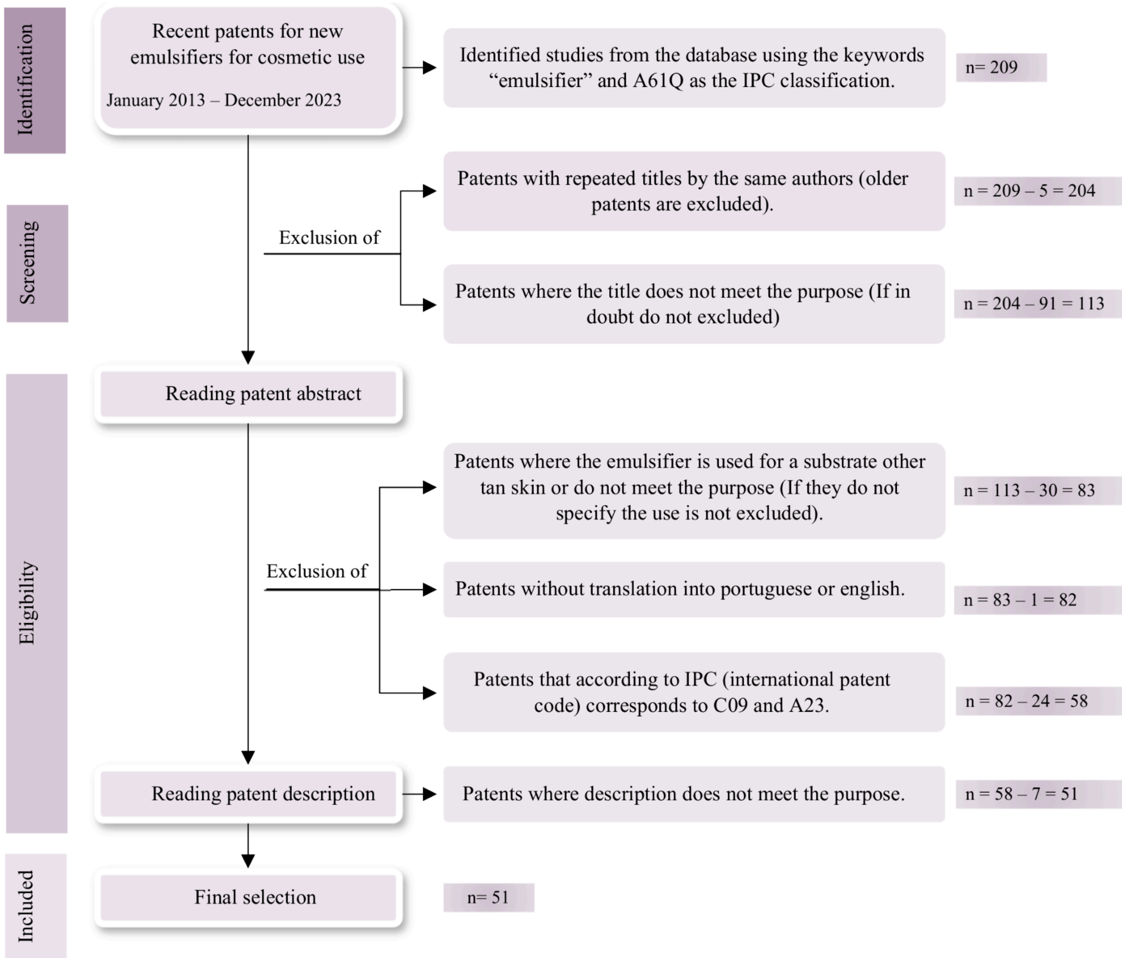


**Figure 1.** A systematic approach to patent review with inclusion and exclusion criteria.

specific characteristics. For example, polymeric emulsifiers act by influencing the viscosity of the system,[3] or solid emulsifiers will form Pickering-type emulsions, where they will depend on the wettability of the particles to determine the type of emulsion that can be formed.[4] With this information, it can be more profitable to use them, obtaining emulsifiers that meet the requirements of the users and are more innovative and effective.

When the emulsion starts to form and the emulsification mechanism is understood, it is important to consider the type of system that is finally formed, which depends on the droplet size or internal structure of the emulsion. This will depend on the emulsifiers used, the production process, the ingredients that make up the emulsion, and the percentage use of the emulsifier. From these systems, information can be obtained regarding the possible stability of the emulsion and its functionality. For example, in the case of a droplet size, a smaller droplet will make phase separation less likely. The liquid crystal structure influences the release of active ingredients or the protection of certain compounds belonging to the emulsion.[5]

In this Review, we sought to characterize the emulsifiers for cosmetic use patented between 2013 and 2023. The review focused on analyzing them in terms of their composition, the type of systems they form, and their physical and chemical properties. In addition, the emulsification mechanisms and chemical structures involved were investigated. Along with this, a geographical analysis of patents was carried out, considering possible influences and trends in patent publications over this period.

## ■ MATERIALS AND METHODS

Espacenet, developed by the European Patent Office (EPO), was chosen as the database repository. The keyword "emulsifier" and the code A61Q were chosen as inclusion criteria. According to the International Patent Classification (IPC), code A61Q is associated with "specific use of cosmetics or similar toiletry preparations". According to Espacenet, 209 patents met the first criteria. Subsequently, 5 duplicate cases were identified and rejected. As a second criterion, the title was considered, which had to comply with the purpose of the review, and 91 patents were discarded. Then, with the abstract, those that did not meet the purpose and those that did not involve skin emulsifiers were discarded, rejecting 30 patents. Patents that did not allow translation into English or Portuguese (1 patent) and those that according to IPC corresponded to codes C09 and A23 (24 patents) were eliminated. Finally, the patents that did not meet the objective were rejected (7 patents), leaving 51 patents in total. This allows the identification of innovative emulsifiers and their chemical characteristics in the cosmetic industry. The screening scheme is depicted in Figure 1.


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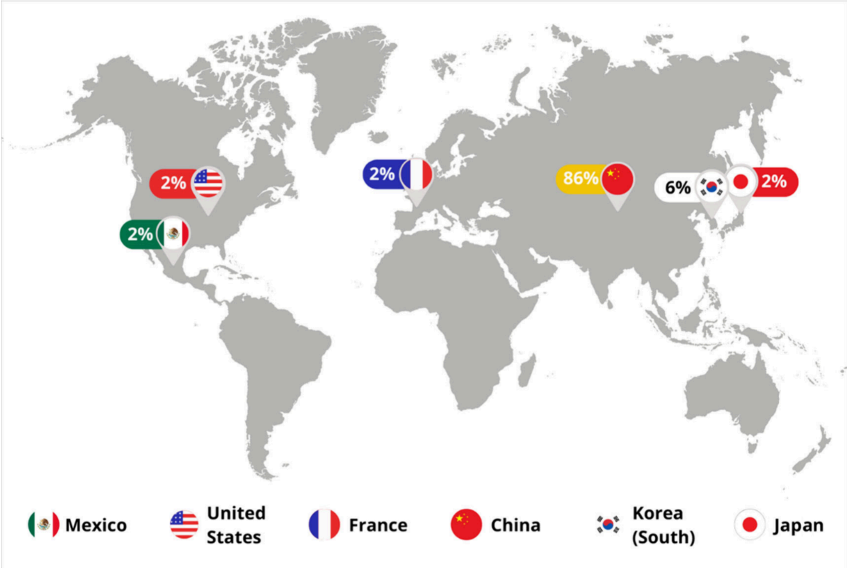


**Figure 2.** Percentage of published patents by country (elaborated by the authors, free domain).

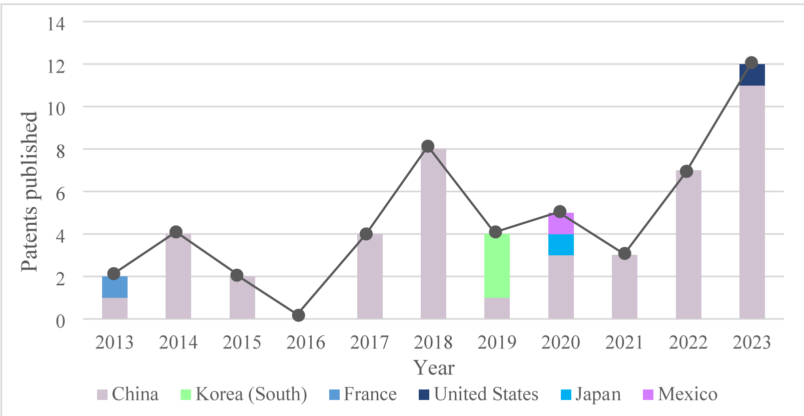


**Figure 3.** Patents published per year from 2013 to 2023 for the Espacenet database.

## RESULTS AND DISCUSSION

**Countries Patenting Emulsifiers for Cosmetic Use on the Skin and Number of Patents Published Per Year between 2013 and 2023.** Throughout the years, there has been a growth in the innovation and development of products for cosmetic use, including patents that have been developed. Of the 51 patents selected in this Review, one point of review was the country of origin. It is known that China has become a country with a high potential in the development of cosmetic products, evidenced in Figure 2, where it predominates with a percentage of 86% (44 patents), followed by the Republic of Korea with 6% (3 patents). In addition, countries such as Mexico and the United States in America, France in Europe, and Japan in Asia have a percentage of 2% (1 patent) of patents published between 2013 and 2023.

These results show a potential growth of the cosmetic industry in China, which is a leading country in patent registrations.[6] These patented developments cause growth in the cosmetic industry, which may be related to the growth of the cosmetic market in China. This market has been growing, and it is expected to become the largest market for cosmetic and personal care products.[7] This growth could be related to two key factors in China. The first is the plan proposed by the government in 2006, whose objective was to position the country as a leading global innovation nation. This approach has driven a significant increase in patent production.[8] The second factor is linked to the high prevalence of dermatological problems in the Chinese population, affecting approximately 70% of people.[9] It has been shown that these problems can be related to environmental conditions, allergies, and personal care habits.[10] Thus, the increasing production of cosmetic emulsifier patents aligns with government objectives and the needs of its population. On the other hand, the development of sustainable technologies for the manufacture of these emulsifiers has great relevance; although this was not considered for the review, most patents mentioned the process of obtaining them, giving it great importance.

In the period from 2013 to 2023 the number of patents published per year has had some significant variations. For example, according to Figure 3, from 2014 to 2016 there was a decrease in the number of patents, reaching zero in 2016, then in the next years it went up even more than the previous years. After that, a decrease is marked from 2019 to 2021. Finally, for 2022 and 2023, the number of published patents exceeded the previous maximum. To analyze these changes, it is important to consider the global situation and the situation in China, as



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### Table 1. Patents for New Emulsifiers for Cosmetic Use on Skin Published from 2013 to 2023 in Espacenet

| | publication number | year | emulsifier | stability | emulsifier usage percentage | emulsion orientation | type of system | particle size | ionic character |
|---|---|---|---|---|---|---|---|---|---|
| 1 | CN109498486 (A); CN109498486 (B)[13] | 2019 | titanium dioxide | 1 month | 0.5–3% | O/W, W/O | pickering | 1–20 μm 3–30 μm | NA |
| 2 | CN111616978 (A)[14] | 2020 | rapeseed oil amidopropyldimethylamine | no reported | 1–2% | O/W | liquid crystal | NA | cationic |
| 3 | CN114028260 (A); CN114028260 (B)[15] | 2022 | ceramide E, hydrogenated lecithin, moisturizer (e.g., glycerol), emulsifier (Tween 80), auxiliary agent, and the balance is water. | 28 days | NA | O/W | NA | NA | amphoteric |
| 4 | CN108338937 (A)[16] | 2018 | hydroxypropyl-β-cyclodextrin, chitin and surfactant (monolauryl phosphate (MAP)) | no reported | NA | NA | nanoemulsion | NA | anionic |
| 5 | CN103070781 (A)[17] | 2013 | inulin lauryl carbamate, glyceryl monostearate, stearyl alcohol, cetyl alcohol. | no reported | NA | O/W | NA | NA | nonionic |
| 6 | CN104367485 (A)[18] | 2015 | saturated fatty alcohol (C10–22), carbon chain alkylglycoside (C16–18), glycerol monosaturated carbon chain fatty acid ester (C12–18), saturated carbon chain fatty alcohol phosphate potassium salt (C16–18), sodium cocoylhydroxysulfonate | 24 h | NA | NA | NA | NA | anionic |
| 7 | CN113952239 (A); CN113952239 (B)[19] | 2022 | TWEEN-20, TWEEN-60, cetearyl alcohol, retinyl propionate, polar oil, preservative and water | 32 days | NA | O/W | liquid crystal | NA | nonionic |
| 8 | JP2020109074 (A); JP7219697 (B2)[20] | 2020 | amphipathic lipid (e.g., hydrogenated lecithin). sterol: (e.g., β-sitosterol). saturated linear fatty acid (e.g., palmitic acid). solvent (polyhydric alcohol or water) | 1 month | NA | O/W | microemulsion | 10–30 μm | amphoteric |
| 9 | CN107028811 (A); CN107028811 (B)[21] | 2017 | PEG40 stearate and PEG60 hydrogenated castor oil | no reported | 1–4% | O/W | NA | NA | nonionic |
| 10 | CN113855585 (A)[22] | 2021 | inulin lauryl carbamate, behenyltrimethylammonium chloride, and TWEEN 20, sometimes (sucrose laurate) | 23 days | NA | O/W | nanoemulsion | 130 - 150 nm | cationic |
| 11 | CN108743453 (A)[23] | 2018 | higher fatty alcohol emulsifier (e.g., cetyl alcohol). phytosterol emulsifier (e.g., PEG-20 phytosterols) and hydrogenated lecithin | no reported | 3–15% | O/W | liquid crystal | NA | amphoteric |
| 12 | CN116035937 (A)[24] | 2023 | liquid crystal emulsifiers (e.g., **lecithins:** hydrogenated lecithin and lecithin). ceramide-like emulsifiers (e.g., **fatty alcohol acylamino acid ester:** dioctyldodecanol lauroyl glutamate) | no reported | 0,1–20% | O/W | liquid crystal | NA | amphoteric |
| 13 | CN108261350 (A)[25] | 2018 | silicone emulsifier with long-chain fatty acid esters and polyether segments in the side chain | no reported | 0,2–10% | W/O | NA | NA | nonionic |
| 14 | CN104083293 (A); CN104083293 (B)[26] | 2014 | preferably: $C_{12}H_{25}Me_2SiO[Me(C_3H_6O(C_2H_4O)_9(C_3H_6O)C_4H_9)SiO]_4\ (Me_2SiO)_{62}SiMe_2C_{12}H_{25}$ | no reported | NA | W/O | NA | NA | nonionic |
| 15 | CN114073651 (A)[27] | 2022 | Lecithin (e.g., soybean lecithin) and acrylic polymers (e.g., carbomers) | no reported | NA | NA | NA | NA | amphoteric |
| 16 | CN103494714 (A); CN103494714 (B)[28] | 2014 | Hydrogenated lecithin. Alkyl glycosides (e.g., tetradecyl glycoside). Sucrose ester (e.g., sucrose monostearate) | no reported | 0,5–20% | O/W | liquid crystal | NA | amphoteric |
| 17 | CN116549309 (A)[29] | 2023 | polyglycerol (polymerization degree is 3–10) | no reported | 0,1–20% | O/W | liquid crystal | NA | nonionic |
| 18 | CN116407457 (A)[30] | 2023 | polyglycerol ester (1) (e.g., hexapolyglycerol behenate). polyglycerol ester (2) (e.g., hexapolyglycerol dibehenate). sucrose distearate (e.g., sucrose palmitate) | no reported | NA | O/W | NA | NA | nonionic |



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**Table 1. continued**

| | publication number | year | emulsifier | stability | emulsifier usage percentage | emulsion orientation | type of system | particle size | ionic character |
|---|---|---|---|---|---|---|---|---|---|
| 19 | KR20190070644 (A)[31] | 2019 | hydrogenated lecithin, glyceryl stearate, cetearyl alcohol, stearic acid and polyglyceride (3-methylglucose distearate, polyglyceryl-10 diisostearate) | no reported | 2−5% | O/W | liquid crystal | NA | amphoteric |
| 20 | CN115887267 (A)[32] | 2023 | PEG-4 polyglyceryl-2 stearate, potassium cetyl phosphate, and cetearyl alcohol. | no reported | NA | O/W | microemulsion | 0,5−1,5 μm | anionic |
| 21 | CN115778848 (A)[33] | 2023 | mix class A + class B or C. **class A (1):** e.g., PEG-100 stearate. **class B (1 or 2):** e.g., glyceryl stearate **class C (1):** e.g., PEG-6 glyceryl isostearate | 1 week | 3−10% | O/W | nanoemulsion | 80−240 nm | nonionic |
| 22 | CN115969736 (A)[34] | 2023 | span emulsifier (e.g., sorbitan laurate, sorbitan palmitate) | 12 weeks | 2−10% | W/O | NA | NA | nonionic |
| 23 | CN116421486 (A)[35] | 2023 | polyglycerol emulsifier (e.g., polyglycerol-10 stearate). long-chain fatty alcohol (e.g., stearyl alcohol) and a mixture of hydrogenated lecithin and phytosterols | 1 month | 2−5% | O/W | NA | NA | amphoteric |
| 24 | CN114767589 (A); CN114767589 (B)[36] | 2022 | two or more types of hydrolyzed jojoba esters, sodium palmitate, sodium stearate, and cocoate | no reported | 2−30% | O/W | NA | NA | anionic |
| 25 | CN115887304 (A); CN115887304 (B)[37] | 2023 | polyglycerol-3 stearate, olive oil, cetyl alcohol and sodium stearoyl lactylate | no reported | 5−10% | O/W | liquid crystal | NA | anionic |
| 26 | CN116831935 (A)[38] | 2023 | fatty alcohol (e.g., lauryl alcohol). fatty acid (e.g., lauric acid). lecithin (e.g., soybean lecithin). glycolipid (e.g., sophorolipid) | no reported | 1.5−2.5% | O/W | liquid crystal | NA | amphoteric |
| 27 | CN108379105 (A)[39] | 2018 | long-chain alkyl glycosides, long-chain fatty alcohols and glycerol single long chain fatty acid ester | no reported | NA | NA | NA | NA | na |
| 28 | MX2020001623 (A)[40] | 2020 | **component of formula (A):** $R1(OC_2H_4)_n(OC_3H_6)_m$. R1 alkyl or alkenyl group C16−26. *n*: 15−60. *m*: 0−10. ($n + m > 15$). **component of formula (B):** $R2(OC_2H_4)_r(OC_3H_6)_s$. R2 alkyl or alkenyl group. *r*: 0.01−14.99. *s*: 0.01−14.99. ($r + s \leq 15$). **component of formula (C):** $R3(OC_2H_4)_x(OC_3H_6)_y$. R2 alkyl or alkenyl group C16−26. *x*: 0.01−14.99. *y*: 0.01−14.99 ($x + y \leq 15 \neq r + s$) | 3 months | 0.1−10% | O/W, W/O, O/Polyol, W/O/W | microemulsions or nanoemulsions | 10−10 000 nm | nonionic |
| 29 | CN108743438 (A)[41] | 2018 | polyglyceryl-3 distearat, polyglyceryl-10 myristate, C13−C16 isoparaffin (e.g., isotridecane) | no reported | NA | O/W | NA | NA | nonionic |
| 30 | CN104188815 (A)[42] | 2014 | domestic sucrose ester, polysoybean sucrose ester, glycerol, emulsifier (e.g., stearyl alcohol), KOH, Nepal gold ester (preservative), appropriate amount of flavor, and deionized water | no reported | NA | O/W | NA | NA | NA |
| 31 | KR102053280 (B1)[43] | 2019 | *Candida bombicola* UA-06. medium: yeast extract, glycerin, $K_2HPO_4$, $KH_2PO_4$, $NH_4NO_3$, $MgSO_4$, glucuronolactone, and vegetable oil and purified water is preferred | 3 months | 0,0001−30% | W/O | NA | NA | NA |
| 32 | KR102283331 (B1); KR20190033962 (A)[44] | 2019 | *Candida bombicola* UA-06. containing mostly glycero glycolipids, glycerolipids, glycolipids, etc. | 6 months | NA | O/W | NA | NA | NA |
| 33 | CN108670880 (A)[45] | 2018 | refined soybean lecithin, methylene chloride-ethanol mixture, palladium catalyst, cholesterol, tannic acid, polyoxyethylene castor oil, glycerol, deionized water, glyceryl sucrose monostearate | no reported | NA | NA | NA | NA | amphoteric |
| 34 | CN108992365 (A)[46] | 2018 | cyclomethicone, cyclohexasiloxane, isononyl isononanoate, caprylic acid, butanediol, glycerol, hexamethylcyclotrisiloxane, modified bentonite, aminomethyl propanol | no reported | NA | NA | NA | NA | NA |
| 35 | FR2987362 (A1); FR2987362 (B1)[47] | 2013 | **SILMERTM ACR Di-10: R-$(CH_2)_3$-Si$(CH_3)_2$[O-Si$(CH_3)_2$-]nO-Si$(CH_3)_2$-$(CH_2)_3$-R.** R: $-(O-CH_2-CH_2-)_x[O-CH_2-CH(CH_3)-]_yO-C(=O)-CH=CH_2$. *x* and *y*: 0−40, $50 < x + y > 0$. *n*: 0−45. **SILMERTM ACR D208: Si$(CH_3)_3$[O-Si$(CH_3)_2$-m[O-Si$(CH_3)$[$(CH_2)_3$-R]-]pO-Si$(CH_2)_3$** R: $-(O-CH_2-CH_2-)_x[O-CH_2-CH(CH_3)-]_yO-C(=O)-CH= CH_2$. *x* and *y*: 0−40, $50 < x + y > 0$. $1 \leq m \leq 7$. $1 \leq p < 20$. optionally **R2—C(=O)—O—RCH$_2$—CH(R4)—O]$_m$—R3.** R2 represents an unsaturated monovalent aliphatic radical comprising from 2 to 4 carbon atoms. R4: hydrogen atom, a methyl radical, or an ethyl radical. R3 represents an aliphatic hydrocarbon radical, linear or branched, saturated or unsaturated, comprising from 8 to 30 carbon atoms. $0 \leq m \leq 50$ | no reported | 1−5% | O/W W/O W/O/W O/W/O | NA | NA | anionic |
| 36 | CN115708783 (A)[48] | 2023 | alkyl derivatives of glutamic acid esters (e.g., dioctyldodecyl lauroyl glutamate), C12−22 linear saturated fatty alcohols (e.g., cetyl alcohol). sterols (e.g., phytosterols) | no reported | NA | NA | liquid crystal | NA | nonionic |



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**Table 1. continued**

| | publication number | year | emulsifier | stability | emulsifier usage percentage | emulsion orientation | type of system | particle size | ionic character |
|---|---|---|---|---|---|---|---|---|---|
| 37 | CN116035942 (A)[49] | 2023 | **compound (a)** $m = 1$ and $n = 2$. R: a saturated branched chain alkane having 20 carbon atoms. R1: a linear alkane with 11 carbon atoms. R2 = R. **compound (b)** $m = 1$ and $n = 2$. R and R1 are the same as R and R1 in compound (a). R2: polyol ester-forming residues, including but not limited to $-CH_2CH(OH)CH_2(OH)$ | no reported | 0.1–10% | NA | NA | NA | nonionic |
| 38 | CN113509395 (A)[50] | 2021 | emulsifier (e.g., sodium stearoyl lactyllylate). higher alcohol (e.g., behenyl alcohol). liquid oil (e.g., glyceryl stearate) | no reported | 2–6% | NA | NA | NA | anionic |
| 39 | CN113797105 (A); CN113797105 (B)[51] | 2021 | polyglyceryl-3 methylglucose distearate and polyglyceryl-10 distearate | no reported | 2–5% | O/W | NA | NA | nonionic |
| 40 | CN108888570 (A); CN108888570 (B)[52] | 2018 | diisopropyl sebacate, wetting agent (e.g., butylene glycol behenate). hydroxypropyl methylcellulose stearoxy ether and rice bran extract | no reported | NA | NA | NA | NA | nonionic |
| 41 | CN114224767 (A); CN114224767 (B)[53] | 2022 | enzymolyzed lecithin and glycerol | no reported | NA | O/W | NA | NA | amphoteric |
| 42 | CN114376934 (A)[54] | 2022 | egg yolk oil, wild soybean seed extract, phytosterols, and hydrogenated lecithin | 1 month | 0.5–8% | O/W | NA | NA | amphoteric |
| 43 | CN103976893 (A); CN103976893 (B)[55] | 2014 | **component 1:** vinyl long-chain alkyl ether, acrylic acid long-chain alkyl ester or methacrylic acid long-chain alkyl ester with a total number of carbon atoms of 12–34. **component 2:** acryloyldimethyl taurine. **inorganic base** (e.g., sodium hydroxide). **cross-linking agent** (e.g., 1,2-propanediol). **initiator** (e.g., sodium persulfate). **water-in-oil emulsifier** (e.g., glyceryl monostearate). **oil-in-water emulsifier** (e.g., PEG-40 stearyl alcohol ether). **deionized water** | no reported | NA | O/W | NA | NA | anionic |
| 44 | CN111065369 (A)[56] | 2020 | **diluent** (e.g., 1,3-propanediol). **alcohol of formula:** $C_mH_{2m} + 1$ OH ($8 \leq m \leq 18$, m is even number). **R21-O-(G21)$_r$-H:** R21: *n*-dodecyl, $1.05 \leq r \leq 5$, $r$ is decimal number. **R22-O-(G22)$_s$-H:** R22: *n*-tetradecyl group, $1.05 \leq s \leq 5$, $s$ is decimal number. **R23-O-(G23)$_t$-H:** R23: *n*-octyl group, $1.05 \leq r \leq 5$, $r$ is decimal number. **R24-O-(G24)$_u$-H:** R24: *n*-decyl group, $1.05 \leq u \leq 5$, u is decimal number. **R31-O-(G31)$_x$-H:** R31: *n*-hexadecyl group, $1.05 \leq x \leq 5$, $x$ is decimal number. **R32-O-(G32)$_y$-H:** *R*32: *n*-octadecyl group, $1.05 \leq y \leq 5$, $y$ is decimal number. G21, G22, G23, G24, G31 and G32: reducing sugar residue | 3 months | NA | O/W | NA | NA | nonionic |
| 45 | CN107028817 (A)[57] | 2017 | **ozone vegetable oil** (e.g., ozonated olive oil). **emulsifier** (e.g., sorbitan trioleate). **moisturizer** (e.g., glycerin). water | 3 months | NA | NA | NA | NA | anionic |
| 46 | CN105199012 (A)[58] | 2015 | hydrophobically modified hyaluronic acid in colloidal particles | no reported | NA | O/W | microemulsion | NA | nonionic |
| 47 | CN110897918 (A)[59] | 2020 | polyglycerol-10 stearate, cetyl alcohol, polyglycerol-10 laurate, glyceryl stearate | 1 month | NA | O/W | NA | NA | nonionic |
| 48 | CN114617783 (A)[60] | 2022 | **glycoside emulsifier**, (e.g., lauryl glucoside). **polyglycerol fatty acid ester** (e.g., polyglyceryl-4 caprate). **water** | 12 h | NA | W/O | NA | NA | nonionic |
| 49 | CN106880509 (A)[61] | 2017 | dihydroxystearic acid soap, dihydroxybehenic acid, trihydroxystearic acid, tetrahydroxystearic acid soap, hexahydroxystearic acid soap (where M is K, Na, or a mixture thereof) | no reported | >2% | O/W W/O or multiple | NA | NA | anionic |
| 50 | CN107157786 (A)[62] | 2017 | mono- and diglycerides of fatty acids, propylene glycol fatty acid esters, sorbitan fatty acid ester, glycerin, citric acid, anhydrous ethanol, sodium lauryl polyether sulfate, cocamidopropyl dimethylamine ethyl lactone, and methylisothiazolinone | no reported | NA | NA | NA | NA | anphoteric |
| 51 | US2023381087 (A1)[63] | 2023 | polyglycerol-*n* (*n*: 2–1). ricinoleic acid or polyhydroxystearic acid. Olive oil fatty acids and/or olive oil | 1 month | 0.1–20% | W/O | NA | NA | nonionic |



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this was the leading country in the publication of emulsifier patents for cosmetic use 2013–2023. (Figure 2)

Examining Figure 3, in the first decline (2014–2016) it is important to consider the economic situation that China went through. According to BBC News, China reported lower economic growth than previously reported,[11] which probably could also be the cause of a decrease in resources for cosmetic research, resulting in a decrease of published patents. As for the second decline (2019–2021), this revolves around the global phenomenon experienced, which was the pandemic; although many projects were delayed, patents were not reduced to zero as happened in 2016. This allows us to compare the impacts that can be generated around research and development when an economic system is affected or when there is a global phenomenon that can impact various industrial sectors.

The growth in patent production is also evident in recent years, as there has been an increase since 2021 (Figure 3). This increase even exceeds previous highs, indicating a steady growth of the cosmetics industry. This may have several reasons. Since the pandemic, there has been a growth in the consumption of skin or hair care products.[12] On the other hand, technology allows people to stay informed about the implications of products for their skin. This high consumption and increased use of cosmetic products also make the industry move and drive research for their products, generating more patents. Finally, the regulations of each country have become stricter in terms of cosmetic products, which has made manufacturers of cosmetic products think more about the health of consumers.

**New Emulsifiers for Cosmetic Use on Skin Published from 2013 to 2023 in Espacenet.** After reviewing the 51 selected patents, a compilation of information was made with the most relevant chemical characteristics; these were selected according to observations of what is considered fundamental in an emulsifier for cosmetic use. Table 1 shows this compilation of information. It should be noted that not all patents provide the same information; there are even patents that do not mention the characterization of the emulsifier, so the information in the table is reduced.

Taking the information in Table 1 and to achieve a better understanding of the composition of the new emulsifiers, a classification was made according to their composition. Initially, a classification was made of emulsifiers that are composed of a single compound and those that had a mixture of compounds (Figure 4). In the first group, it was decided to include emulsifiers produced by microorganisms, which were not characterized and came from one type of microorganism. Then, each chemical compound was classified according to its origin, resulting in four major groups: natural origin, synthetic origin, polymeric compounds, and defined molecule. At the moment of grouping the emulsifiers, "natural origin" was predominant; due to the global importance that is being given to this subject, it was decided to emphasize this group. In second place are the polymeric compounds, and finally the synthetic compounds.

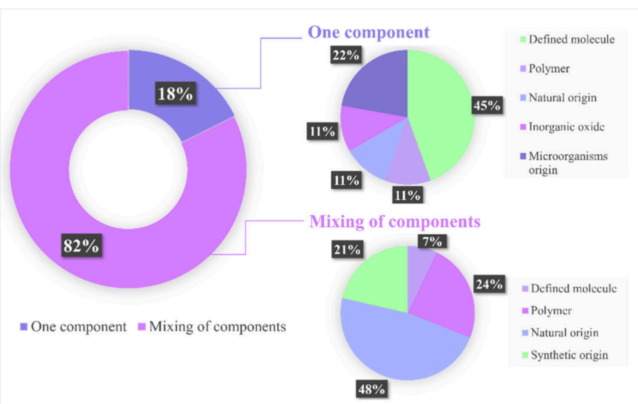


**Figure 4.** Classification of emulsifiers according to the number of compounds and the type of compound that it has.

As can be seen in Figure 4, most patented emulsifiers consist of a combination of several compounds; this mixture generates a synergy and results in stable systems with some characteristics. In the minority, there are emulsifiers consisting of a single molecule, which alone have a great emulsifying power with good results.

For single compound emulsifiers, titanium oxide is used (Table 1, patent 1), which is the only compound in the entire Review that generates a Pickering emulsion.[13] This patent shows how the modification of the titanium oxide generates greater amphiphilicity and dispersibility in the emulsion, increasing stability by reaching a contact angle of 83.3 ± 3° compared to the original 50°.[64] These emulsions are of great interest for study in cosmetics, and although they are stable to coalescence, instabilities such as sedimentation (W/O) or creaming (O/W) can occur. These emulsifiers also influence sensory perception, and in the case of titanium dioxide its perception depends on the concentration used.[65] Their emulsification mechanism depends on three aspects: (1) The particle size should be smaller than the droplet size of the target emulsion. (2) The particles should be akin to both phases but should not solubilize in them. (3) Particles should retain wettability with the phases. The characteristic that most influences the mechanism is the wettability of the particles, where their contact angle (between the particles, the oil phase, and the aqueous phase) will determine the orientation of the emulsion, which means the higher the wettability of a phase, the more it will be the continuous phase.[4]

Other interesting emulsifiers are those obtained by means of microorganisms (Table 1, patents 31 and 32). Both patents used the same type of microorganism: *Candida bombicola*. However, the study of emulsifiers produced by microorganisms has been done with a great variety of species.[66] In addition to this, the genus *Candida* has been explored for this purpose, including for use as a food emulsifier.[67] This means that such research has been scaled up to the cosmetic industry, with beneficial results. Biosurfactants, as they are known, have general advantages compared to those produced by chemical synthesis, such as higher biodegradability, lower toxicity, and applications in different industries. Another important aspect that biosurfactants show is their antimicrobial activity, since these molecules manage to interact with the lipid components of microorganisms, affecting their hydrophobic properties and their ability to alter the adhesion of microorganisms and the subsequent formation of biofilms.[68] For these reasons, biosurfactants have become a viable alternative in the cosmetic industry, and some have even been considered multifunctional due to their multiple cosmetic properties.[69]

Another category that is found in both groups is "molecule defined" (Figure 4). In these patents, the emulsifiers were fully characterized with good results. As can be seen, this category has a high percentage when it is a single component (Table 1, patents 13, 14, 35, and 37) and a very low percentage when it


https://doi.org/10.1021/acsomega.4c07305
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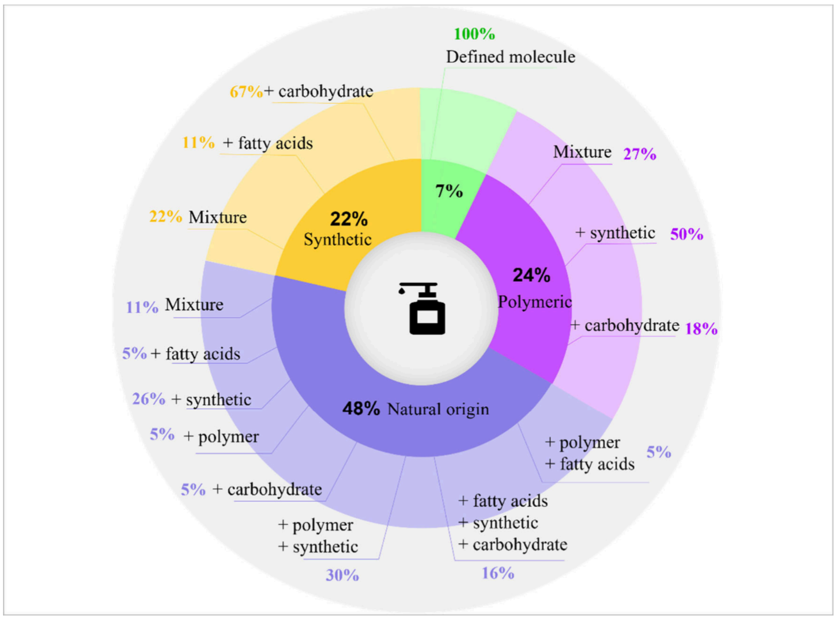


**Figure 5.** Classification of patent emulsifiers according to the characterization of their components.

is a mixture of components (Table 1, patents 28, 44, and 49). It is worth mentioning that these patents include those filed by Mexico and France.

It is known that emulsifiers must have affinity with both water and oil in their structure; for example, Table 3 shows the emulsifier of patent 49, which mentions that they are fatty acid soaps. In the structures presented, two water-affinity sections can be observed, one in the form of salt and the other polyhydroxylated, and on the other hand there is a saturated chain that has affinity with the fatty components. Their emulsification mechanism turns out to be simple, as they will form micelles that, depending on their conditions, will generate oil-in-water, water-in-oil, or multiple emulsions. It should be noted that this emulsifier was developed with an antimicrobial effect in mind, since, as mentioned above, many compounds used in cosmetics generate irritation or cosmetics are contaminated by microorganisms, events that could be reduced with this emulsifier.

Emulsifiers that are a mixture of compounds represent a high percentage, as mentioned above, and these compositions provide greater stability to the emulsion, since their different emulsification mechanisms complement each other, keeping the emulsion in the best conditions. As can be seen in Figure 5, priority was given to emulsifiers of natural origin, which constituted 48% of the total. Within this category, emulsifiers were further classified as mixtures of natural compounds combined with fatty acids or polymers. The second category included emulsifiers containing polymers (24%) without natural compounds, which were grouped into categories of those mixed with synthetic compounds or carbohydrates. The third category encompassed emulsifiers of synthetic origin (22%), which included mixtures combined with fatty acids and carbohydrates; notably, this group lacked natural compounds or polymers. Finally, emulsifiers with defined molecules represented the smallest percentage (7%).

Thanks to the high percentage of emulsifiers that consist of a mixture of compounds, it was decided to organize them as shown in Figure 5. First, we started with a classification giving priority to emulsifiers that had natural origin in their composition (48%), and then, among them, we classified those that were a mixture of compounds of natural origin with fatty acids or polymers, for example. In second place, emulsifiers that had polymers in their composition (24%), without compounds of natural origin, were grouped together with those that were mixtures or were mixed with synthetic compounds or carbohydrates. In third place were the emulsifiers with compounds of synthetic origin (22%), and among them were grouped the mixtures and combinations with fatty acids and carbohydrates; it should be noted that in this group there are no emulsifiers with compounds of natural origin or polymers. Lastly, the group of patents with defined molecules represented the lowest percentage (7%).

Emulsifiers of natural origin play a relevant role in this Review; a total of 41% of all patents have at least one compound of natural origin in their composition. One of the most mentioned compounds has been lecithin, a compound that is present in different organisms and can have several origins. Lecithin has been extensively studied and is characterized by its ability to form liposome-like structures.[70] For example, patent 26 (Table 1) mentions the presence of liposomes, which can facilitate the transport of active ingredients and their absorption in cosmetic products. In addition to this, it is confirmed that emulsions are more stable when lecithin is used in combination with monoglycerides or water-soluble polymers,[71] as in patent 15 (Tables 1 and 2) where they are combined with water-soluble polymers. Similarly, sterols are used as emulsifiers (Table 1, patents 8, 11, 23, 33, 36, and 42). Thanks to their −OH group (hydrophilic) and their cyclic structure (lipophilic), these compounds become emulsifiers or stabilizers of emulsions.[72]

The second largest category for the mixture of components is polymers, with 24% (Figure 5) and 11% for the single compound group (Figure 4). Emulsions that are stabilized by polymers tend to behave like gels, with a higher viscosity. This viscosity causes the dispersed phase to have limited movement, decreasing the probability that its droplets will coalesce.[3] The polymers used as emulsifiers have a hydrophobic portion that must adhere strongly to the oily phase, leaving the hydrophilic


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**Table 2. Evaluation under Stress Conditions of the Emulsions Formed by the Patented Emulsifiers**

| | publication no. | stress conditions | | | |
|---|---|---|---|---|---|
| | | pH | temperature | UV light | ionic strength |
| 1 | CN109498486 (A); CN109498486 (B)[13] | 1−12 | 50, 70, and 90 °C | NA | 0−3% |
| 2 | CN111616978 (A)[14] | 4−6 | NA | NA | NA |
| 3 | CN114028260 (A); CN114028260 (B)[15] | NA | room temperature | NA | NA |
| 4 | CN108338937 (A)[16] | NA | NA | NA | NA |
| 5 | CN103070781 (A)[17] | 4.0−8.5 | NA | NA | NA |
| 6 | CN104367485 (A)[18] | NA | −5 to 40 °C | NA | NA |
| 7 | CN113952239 (A); CN113952239 (B)[19] | NA | 40 °C | NA | NA |
| 8 | JP2020109074 (A); JP7219697 (B2)[20] | 6 to 8 | −10 to 50 °C | NA | NA |
| 9 | CN107028811 (A); CN107028811 (B)[21] | NA | NA | NA | NA |
| 10 | CN113855585 (A)[22] | NA | 50 °C | NA | NA |
| 11 | CN108743453 (A)[23] | NA | −18 to 43 °C | NA | NA |
| 12 | CN116035937 (A)[24] | NA | NA | NA | NA |
| 13 | CN108261350 (A)[25] | NA | NA | NA | NA |
| 14 | CN104083293 (A); CN104083293 (B)[26] | 5−9 | −10 to 40 °C | NA | NA |
| 15 | CN114073651 (A)[27] | NA | NA | NA | NA |
| 16 | CN103494714 (A); CN103494714 (B)[28] | NA | 30, 35, and 37 °C | NA | NA |
| 17 | CN116549309 (A)[29] | NA | NA | NA | NA |
| 18 | CN116407457 (A)[30] | NA | −15 and 48 °C | NA | NA |
| 19 | KR20190070644 (A)[31] | NA | −20 to 45 °C | NA | NA |
| 20 | CN115887267 (A)[32] | NA | NA | NA | NA |
| 21 | CN115778848 (A)[33] | NA | −18, 4, and 48 °C | NA | NA |
| 22 | CN115969736 (A)[34] | NA | −18, 4, 25, 40, and 48 °C | NA | NA |
| 23 | CN116421486 (A)[35] | NA | −18 °C | NA | NA |
| 24 | CN114767589 (A); CN114767589 (B)[36] | 9.5 | −18, 4, 40, and 48 °C and room temperature | NA | NA |
| 25 | CN115887304 (A); CN115887304 (B)[37] | NA | NA | NA | NA |
| 26 | CN116831935 (A)[38] | NA | NA | NA | NA |
| 27 | CN108379105 (A)[39] | NA | NA | NA | NA |
| 28 | MX2020001623 (A)[40] | 2−14 | 5, 23, 40, 45, and 50 °C | NA | 1−40% |
| 29 | CN108743438 (A)[41] | NA | NA | NA | NA |
| 30 | CN104188815 (A)[42] | NA | NA | NA | NA |
| 31 | KR102053280 (B1)[43] | NA | −5, 25, and 50 °C and room temperature | NA | NA |
| 32 | KR102283331 (B1); KR20190033962 (A)[44] | NA | 15 to 25 °C | NA | NA |
| 33 | CN108670880 (A)[45] | NA | NA | NA | NA |
| 34 | CN108992365 (A)[46] | NA | NA | NA | NA |
| 35 | FR2987362 (A1); FR2987362 (B1)[47] | NA | NA | NA | NA |
| 36 | CN115708783 (A)[48] | NA | NA | NA | NA |
| 37 | CN116035942 (A)[49] | NA | NA | NA | NA |
| 38 | CN113509395 (A)[50] | 4 to 12 | NA | NA | NA |
| 39 | CN113797105 (A); CN113797105 (B)[51] | NA | −10 and 42 °C | NA | NA |
| 40 | CN108888570 (A); CN108888570 (B)[52] | NA | 38 °C | NA | 3.0% |
| 41 | CN114224767 (A); CN114224767 (B)[53] | NA | −5 to −10 and 45 °C | NA | NA |
| 42 | CN114376934 (A)[54] | NA | −17 and 45 °C | NA | NA |
| 43 | CN103976893 (A); CN103976893 (B)[55] | NA | NA | NA | NA |
| 44 | CN111065369 (A)[56] | NA | 20 and 45 °C | NA | 1% |
| 45 | CN107028817 (A)[57] | NA | 37 °C | NA | NA |
| 46 | CN105199012 (A)[58] | NA | NA | NA | NA |
| 47 | CN110897918 (A)[59] | 5.5 to 7.5 | −8 and 48 °C | resistant | NA |
| 48 | CN114617783 (A)[60] | NA | −8 and 48 °C | NA | NA |
| 49 | CN106880509 (A)[61] | NA | −24 and 40 °C | NA | NA |
| 50 | CN107157786 (A)[62] | NA | NA | NA | NA |
| 51 | US2023381087 (A1)[63] | NA | 45 °C | resistant | NA |

portion to be solvated by the water molecules.[73] In patent 46 (Tables 1 and 2), hyaluronic acid (polymer) is modified with a hydrophobic molecule. These types of emulsifiers can form intramolecular domains improving viscosity over concentration, which is due to the association nature of the hydrophobic groups.[74]

The third group includes synthetic emulsifiers with 22% (Figure 5), and these start their emulsification process from the critical micellar concentration (CMC). This micelle formation process is governed by the entropy of the system. In the case of an O/W emulsion, the hydrophobic group of the molecule moves to the interior of the micelle, avoiding the hydrophilic environment of the dispersing phase. In addition, water does


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## Table 3. Chemical Structures of Some Patents Based on Their Classification

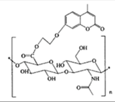
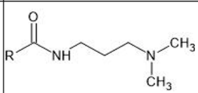
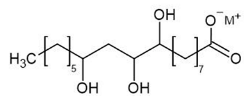
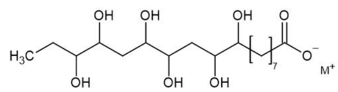
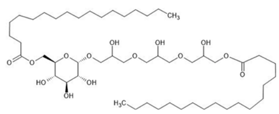
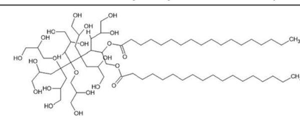
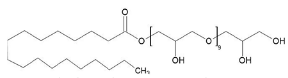
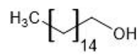
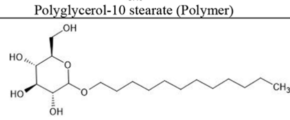
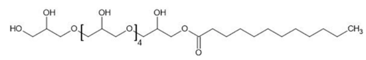
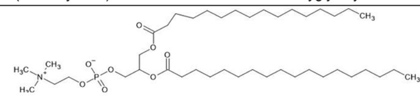
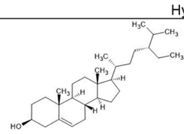
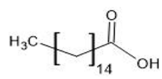
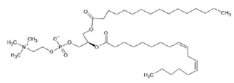
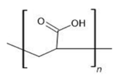
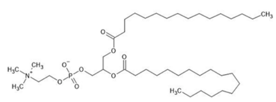
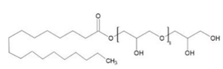
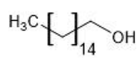
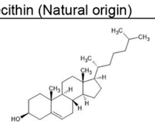
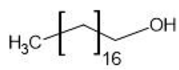
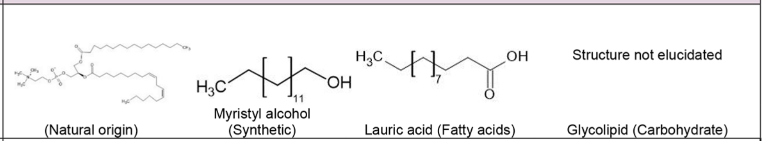
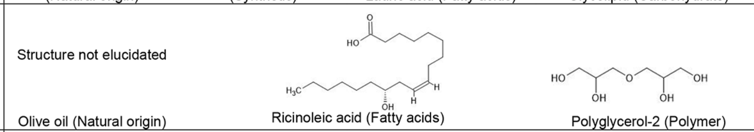
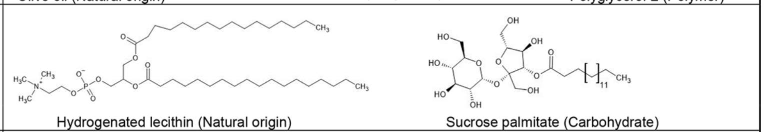
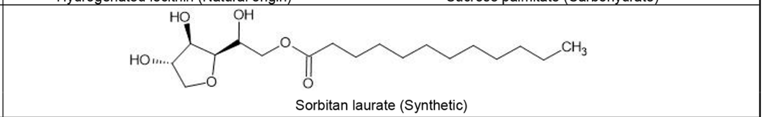
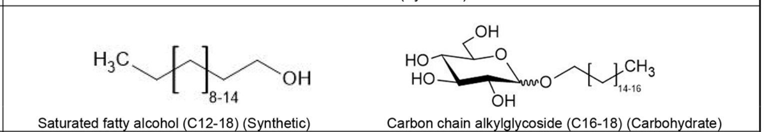
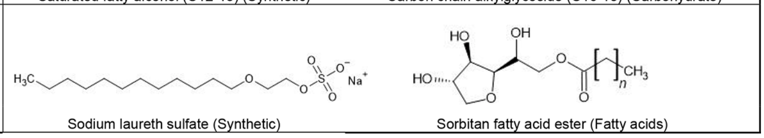
| Publication number | Category | Emulsifier | Structure |
|---|---|---|---|
| **One component** | | | |
| CN104083293 (A); CN104083293 (B)[26] | **Defined molecule** | $C_{12}H_{25}Me_2SiO[Me(C_3H_6O(C_2H_4O)_9(C_3H_6O)C_4H_9)SiO]_4(Me_2SiO)_{62}SiMe_2C_{12}H_{25}$ | NA |
| CN105199012 (A)[58] | **Polymer** | Hydrophobically modified hyaluronic acid self-assembled colloid |  |
| CN111616978 (A)[14] | **Natural origin** | Rapeseed oil amidopropyldimethylamine |  |
| CN109498486 (A); CN109498486 (B)[13] | **Inorganic oxide** | Titanium dioxide | O=Ti=O |
| KR102053280 (B1)[43] | **Microorganisms origin** | Fermentation emulsifier by *Candida bombicolaUA-06*. Medium: yeast extract, glycerin, K2HPO4, KH2PO4, NH4NO3, MgSO4, glucuronolactone, and vegetable oil and purified water is preferred. | NA |
| **Mixing of components** | | | |
| CN106880509 (A)[61] | **Defined molecule** | Dihydroxystearic acid soap, Dihydroxybehenic acid, Trihydroxystearic acid, Tetrahydroxystearic acid soap, Hexahydroxystearic acid soap (where M is K, Na, or a mixture thereof) |  Trihydroxystearic acid  Hexahydroxystearic acid soap |
| CN113797105 (A); CN113797105 (B)[51] | **Polymer mixture** | Polyglyceryl-3 methylglucose distearate and polyglyceryl-10 distearate |  Polyglyceryl-3 methylglucose distearate  Polyglyceryl-10 distearate |
| **Publication number** | **Category** | **Emulsifier** | **Structure** |
| CN110897918 (A)[59] | **Polymer + synthetic** | Polyglycerol-10 stearate, cetyl alcohol, polyglycerol-10 laurate, glyceryl stearate. |  Polyglycerol-10 stearate (Polymer)  Cetyl alcohol (Synthetic) |
| CN114617783 (A)[60] | **Polymer + carbohydrate** | **Glycoside emulsifier:** better results with combination of lauryl glucoside and cocoyl glucoside. **Polyglycerol fatty acid ester:** better results with polyglycerol-6 laurate. Water supplemented |  Lauryl glucoside (Carbohydrate)  Polyglyceryl-6 laurate (Polymer) |
| CN114376934 (A)[54] | **Natural origin mixture** | Egg yolk oil, wild soybean seed extract, phytosterols, hydrogenated lecithin |  Hydrogenated lecithin (Natural origin) |
| JP2020109074 (A); JP7219697 (B2)[20] | **Natural origin + fatty acids** | **Amphipathic lipid:** lecithin, hydrogenated lecithin, ceramide, and phosphatidylcholine. **A sterol:** phytosterols are more preferred. **Saturated linear fatty acid:** straight-chain saturated fatty acids having 6 to 22 carbon atoms are preferred.**Solvent:** polyhydric alcohol or water is preferred. |  β-sitosterol (Natural origin)  Palmitic acid (Fatty acids) |
| CN114073651 (A)[27] | **Natural origin + polymer** | **Lecithin:** soybean lecithin, egg yolk lecithin or equivalent compositions thereof. **Acrylic polymers:** carbomers, ionic copolymers or combinations thereof |  Soybean lecithin (Natural origin)  Carbomer (Polymer) |
| CN116421486 (A)[35] | **Natural origin + polymer + synthetic** | **Polyglycerol emulsifier**: polyglycerol-10 stearate, polyglycerol-10 myristate and polyglycerol-6 distearate. **Long-chain fatty alcohol:** one or more of stearyl alcohol, cetearyl alcohol, and cetyl alcohol. **A mixture** of hydrogenated lecithin and plant sterols make up 100% |  Hydrogenated lecithin (Natural origin)  Polyglycerol-10 stearate (Polymer)  Cetyl alcohol (Synthetic) |
| CN115708783 (A)[48] | **Natural origin + synthetic** | Alkyl derivatives of **glutamic acid esters:** dioctyldodecyl lauroyl glutamate. **C12-22 linear saturated fatty alcohols:** cetyl alcohol and stearyl alcohol or a mixture of cetyl alcohol, stearyl alcohol and behenyl alcohol. **Plant sterols:** phytosterols and cholesterol. Other ingredients |  Cholesterol (Natural origin)  Stearyl alcohol (Synthetic) |

**Table 3. continued**

| Publication number | Category | Emulsifier | Structure |
|---|---|---|---|
| CN116831935 (A) [38] | Natural origin + synthetic + fatty acids + carbohydrate | **Fatty alcohol:** a mixture of cetearyl alcohol and lauryl alcohol, or a mixture of cetearyl alcohol and myristyl alcohol. **Fatty acid:** a mixture of palmitic acid and lauric acid, or a mixture of palmitic acid and oleic acid. **lecithin:** soybean lecithin and **glycolipid**: mixture of sophorolipid and rhamnolipid |   |
| US2023381087 (A1) [63] | Natural origin + fatty acids + polymer | Polyglycerol-n (n being 2-1). Ricinoleic acid (also known as 12-hydroxy-9-cis-octadecenoic acid) or polyhydroxystearic acid. Olive oil fatty acids and/or olive oil |   |
| CN103494714 (A); CN103494714 (B) [28] | Natural origin + carbohydrate | Hydrogenated lecithin. **Alkyl glycosides:** tetradecyl glycoside, hexadecyl glycoside, octadecyl glycoside and eicosyl glycoside. **Sucrose ester:** sucrose monostearate, sucrose distearate, sucrose tristearate, sucrose palmitate, and sucrose oleate. |   |
| CN115969736 (A) [34] | Synthetic mixture | One or more: sorbitan laurate, sorbitan palmitate, sorbitan oleate, sorbitan sesquioleate, sorbitan isostearate and sorbitan oleate |   |
| CN104367485 (A) [18] | Synthetic + carbohydrate | Saturated fatty alcohol (C12-18), carbon chain alkylglycoside (C16-18), glycerol monosaturated carbon chain fatty acid ester (C12-18), saturated carbon chain fatty alcohol phosphate potassium salt (C16-18), sodium cocoylhydroxysulfonate |   |
| CN107157786 (A) [62] | Synthetic + fatty acids | Mono and double fatty acid glycerides, propylene glycol fatty acid esters, sorbitan fatty acid ester, glycerin, citric acid, absolute ethanol, sodium laureth sulfate, cocamidopropyl, dimethylaminobutyrolactone and of methylisothiazolinone. |   |

not create hydrogen interactions with the emulsifier chains, since cavities are generated in the solvent, which means that when the micelles are formed the water can interact with each other again and entropy decreases.[75]

Continuing with the information in Table 1, a crucial aspect in the formulation of emulsions is the stability that the emulsifier contributes to the system since, as is well-known, emulsions are thermodynamically unstable systems. Despite the relevance of this topic, only 39% of the patents reviewed report the time during which emulsion stability was evaluated, 29% refer to stability qualitatively, and 31% do not address the topic at all. In addition, some patents describe stability tests under specific stress conditions, as detailed in Table 2. These conditions, which include variations in pH, temperature, UV light exposure, and ionic strength, simulate scenarios to which the products may be exposed in the marketplace. According to the data in Table 2, only 6% of the patents evaluated three of the four conditions, 12% evaluated two conditions, 43% evaluated one, and 39% did not evaluate any. Although some patents do not go into detail, these results are significant because, from a chemical point of view, it is essential to evaluate the sensitivity of emulsions to optimize the product stability and performance.

The percentage of emulsifier used becomes important at the time of characterizing the emulsion to be developed. Only 47% of the patents published this information. The patents that mention it present ranges, some that are quite wide, as in patents 12, 24, and 31 (Table 1), and others with not so wide ranges, as in patents 2, 9, and 19 (Table 1). These percentages are specific for each emulsifier and each emulsion, generally depending on the amount and type of dispersed phase to be emulsified.

As for the emulsion orientation, 85% of the patents that mention it are of the O/W type, which consists of an oil phase dispersed in a continuous aqueous medium, one of the most used vehicles in skin care formulations. Since these emulsifiers are for use on the skin, it is important to highlight this trend. The skin in its outermost layer (stratum corneum) has the well-known natural moisturizing factor (NMF), which is formed by hygroscopic compounds that keep the corneocytes hydrated.[76] This makes the skin have a greater affinity with products where the dispersing phase is water, since there will be a greater adherence so that after their adherence the active ingredients that are in the oily phase will be able to act on the skin. In addition, since water is the external phase, O/W emulsions tend to leave a less greasy feel on the skin. These emulsions are ideal for oily skin and recommended for daily care, especially in most moisturizing products.[77,78]

Another characteristic of emulsions is that they can form different systems depending on the particle size or structure formed internally. Of the 51 patents, the type of system was reported by 18 (35%). As can be seen in Figure 6, four systems were reported: pickering emulsions, microemulsions, nanoemulsions, and liquid crystals. The pickering emulsion system, as mentioned before, is the emulsion formed when its emulsifier is a solid particle adsorbed in the interface (Table 1, patent 1).

Microemulsions and nanoemulsions are emulsions with small droplets in their dispersed phases, but they have important differences and similarities. Microemulsions are thermodynamically stable systems with droplets ranging from 100 to 400 nm, while nanoemulsions, although smaller (1 to 100 nm), are thermodynamically unstable and usually require a cosurfactant to maintain their stability. Related to this, the particle size in both systems is influenced by the composition

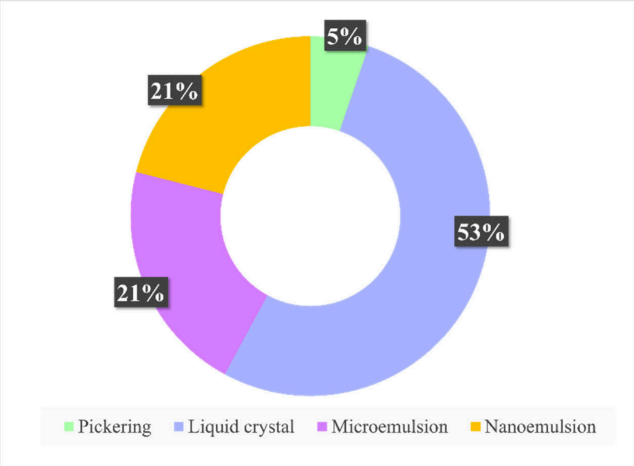



**Figure 6.** Type of emulsified systems reported in patents.

of the emulsion. In the case of emulsifiers and coemulsifiers, these reduce the energy between phases, allowing the droplet size to be maintained or increased, which can turn a nanoemulsion into a microemulsion.[79]

Another difference is that microemulsions are affected by exposure to water or temperature changes, while nanoemulsions tend to maintain their stability.[80] One aspect that can cause confusion is the relationship between the droplet size and light scattering. As the droplet size decreases, the emulsion becomes more translucent. However, this is not a decisive factor in distinguishing between them, as both nanoemulsions and microemulsions can be translucent.[79] Both technologies offer significant advantages in cosmetic products, improving the efficacy and performance of formulations.[80,81]

Finally, the system with the highest percentage (53%) is a liquid crystal type system. This system consists of the formation of an interface with both liquid and crystalline characteristics where emulsifier molecules are adsorbed, generating a multilayer around the dispersed phase and preventing its coalescence.[5] Its stability can be attributed to the mechanical strength of the interface and to the dispersed phase fixed in the liquid crystalline system.[82]

The ionic character of the emulsifiers was part of the review (Figure 7). The importance of this characteristic of the emulsifiers starts many times in the stability of the emulsion, because in the case of an O/W emulsion the micelles acquire a surface charge (the polar head of the emulsifier) to increase the zeta potential of the droplets, resulting in a repulsion between them and avoiding the coalescence phenomenon; although this aspect is not decisive in the stability of the emulsion, it can have an influence.[83] Thus, ionic emulsifiers can generate greater benefits in the emulsion; however, in the case of anionic emulsifiers, they have been controversial because they have a high detergent power, reducing the barrier function of the skin.[84] On the other hand, as for the amphoteric emulsifiers, lecithin is presented. This emulsifier is of great importance, since it is part of the compounds of natural origin,[82] so it is more friendly to the skin and has a high emulsifying power.

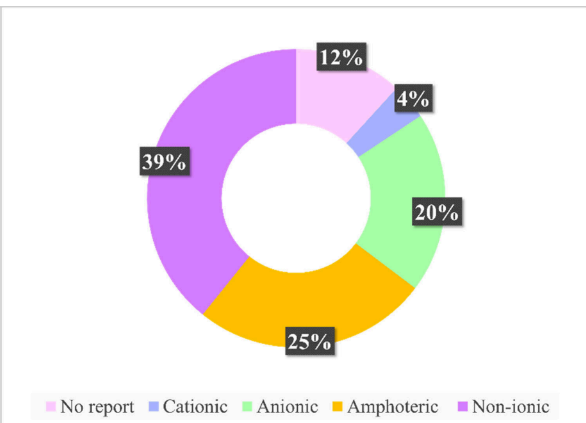



**Figure 7.** Ionic character of emulsifiers reported in patents.

Finally, the nonionic emulsifiers stand out with 39% (Figure 7) because, considering the above-mentioned information, they are more skin-friendly since they do not have charges that can cause any imbalance. The stabilization of emulsions by nonionic surfactants is largely governed by steric hindrance, which is a key mechanism preventing the coalescence of droplets.[85] Nonionic surfactants stabilize emulsions by creating a physical barrier around the dispersed droplets, primarily through the hydrophobic chains of the surfactant molecules. These hydrophobic chains protrude into the surrounding medium and provide a repulsive force when droplets approach each other, thereby reducing the likelihood of droplet aggregation. The length of the hydrophobic chains plays a critical role in this stabilization mechanism; longer chains provide more effective steric hindrance by increasing the physical distance between droplets.[86] This increased separation helps maintain the emulsion's stability over time by minimizing the interactions that can lead to coalescence. In addition, nonionic surfactants are less sensitive to changes in pH and ionic strength, making them suitable for stabilizing emulsions in a wide range of formulations. The balance between hydrophobic chain length and the size of the hydrophilic headgroup is crucial for optimizing emulsion stability.[87]

## CONCLUSION

Consumer trends in the cosmetics market have influenced the growth of product research in this sector, leading to an increase in patent filings, especially for emulsifiers. The geographical analysis of these patents highlights China as the leading country in terms of the number of patents published. Furthermore, this review leads to the conclusion that the development of new cosmetic emulsifiers is focusing on integrating compounds of natural origin into formulations as well as taking advantage of the synergy of different compounds to produce better emulsifying compositions. Research on the types of systems that form emulsifiers, emulsion orientation, particle size, and ionic character is key to optimize existing emulsifiers to provide more stable emulsions with a better impact on functionality and, in general, better products for the consumer.

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