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Article

A Review on Cosmetic Formulations and Physicochemical Characteristics of Emollient and Day Cream Using Vegetable Based-Wax Ester

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***Abstract*— The cosmetic sector is one of the fastest-growing industries and continuously evolving as new technology is established. Skincare, haircare, make-up, and body care items were among the products available. Cosmetic formulas have progressed in recent years, allowing for the creation of more beneficial cosmetics. In chemistry, solids, liquids, and gases are primarily physicochemical characteristics. These are typically determined by a density, refractive index (RI), oxidation state, and vibrational frequency measurement. Physical and chemical qualities show a distinct feature that aids in the formulation of an enhanced emollient and day cream. This paper focuses on physicochemical characteristics such as RI, saponification value (SV), iodine value (IV), and acid value (AV). As for this review, the use of synthesised vegetable-based wax ester was utilised to formulate emollient and day cream. The esterification of vegetable-based waxes was performed by synthesising oleic acid from vegetable-based products and oleyl alcohol in the solvent.**

***Keywords*— cosmetic, emollient, day cream, physicochemical characteristics**

I. INTRODUCTION

This paper discusses the efficiency and efficacy of natural wax compared to synthetic wax, which is more prominent in formulating the emollient and day cream through its physicochemical characteristics. Physicochemical properties are the knowledge of the intrinsic properties of potential chemicals that are required to evaluate their alternatives. Due to the lack and infrequent knowledge about physicochemical properties, these properties will be the center of this study.

Synthetic waxes are more commonly used in cosmetics than natural waxes. They consist of ethylene glycol diesters or long-chain fatty acid testing agents (C18-C36) that can be used to provide rigidity for sticks and to modify the crystallinity of the product [1]. However, natural wax components like n-alkanes, alkenes, primary alcohols, and fatty acids could be helpful estimators but are limited in practical applications [2]. Plant wax in an open system or in the food processing industry can be used as a sustainable bio-lubricant. The supply chain of agro-waste and organic lubricants meets the aim of cleaner production and technical processes [3].

For many non-food applications, wax esters are of great interest as ingredients in cosmetics and other personal care items. Wax esters, usually employed as lubricants and protective coatings, on the other hand, are limited by their much higher costs [4]. Furthermore, vegetable oils offer many prospective natural characteristics such as good lubricity, good shear strength, high flash point, high viscosity index, and low evaporative oils loss [5].

Natural ingredients are used to produce cosmetic products that are environmentally friendly instead of synthetic chemical products, which will harm the skin [6]. The physicochemical features of the substances among the numerous organoleptic characteristics can greatly impact the propagation of an emollient, which is defined as the ability to cover a skin region over time [7]. Emollients are widely used due to their concentration ranging from 5% to 30% of Oil-in-Water (O/W) emulsions, and in a formula after water, they represent the second-largest group of ingredients [8]. After a single, realistic application of the daily cream SPF15, the faces of consumers remain protected at least 5 times on average by midday that is probably exposed to the maximum levels of UV rays exposure [9].

Cosmetic emulsions consist of water/hydrophilic basis material, oil/hydrophobic base material, surfactant/amphiphilic substances, and materials adding or improving functionality, perfume, sensory sensitivities, and quality control cosmetic emulsions (for example, shelf-life and viscosity) [10]. O/W emulsions consist of an oil phase scattered throughout the aqueous phase like droplets containing the emulsifiers. For the initiation of formation, stability, and desirable physicochemical properties of emulsions, emulsifiers are essential [11]. Water-in-Oil (W/O) emulsion type is a dispersed phase, while oil acts as a dispersive medium. Furthermore, it is also more humidifying since they create an oily barrier to water loss from the outermost layer of the cornea stratum of the skin [12, 13].

This review paper was conducted by reviewing and analysing selected articles on the physicochemical study focusing on an acid value (AV), ester value (EV), iodine value (IV), saponification value (SV) and refractive index (RI). Currently, the physicochemical study is crucial and necessary because it will show the properties that will give useful information to formulate cosmetics and evaluate the compositional quality of the product.

II. EMOLLIENT AND PROPERTIES

A. Emollient

Emollients are cosmetic compounds that contribute to keeping the skin soft, smooth, and malleable [14]. In addition, emollients help moisturise the skin, enhance the state of the skin and can help to strengthen the lipid barrier and improve a variety of skin disorders [15]. Emollients are the second crucial element in skincare emulsions, after water, and are used at levels ranging from 3% to 20% (w/w) [16].

Emollients have a strong sensory impact on physicochemical features of cosmetic emulsions, such as consistency and spreadability, which are crucial for obtaining adequate efficacy and consumer approval [16]. In addition, the polarity of the emollients and the association of different substances have an impact on the mechanism of interactions with the skin, as well as the emulsion's structural organisation and organoleptic features [16].

B. Properties

Moisturising effects of emollients are usually the largest non-water fraction of skincare emulsions, closely related to the sensorial properties of formulas associated with several specific organoleptic features of end-users, including smear, elasticity, diffusibility, gloss, and/or matteness [7]. Emollient creams typically contain occlusive substances like paraffin oil and petrolatum to reduce water loss and promote epidermal barrier regeneration while providing intense protection [15]. Emollients, under their lubricating qualities, reduce the emulsion's friction coefficient and affect its spreading properties when applied to the skin. As a result, one of the sensory aspects often examined during emulsion application is spreadability [16].

III. DAY CREAM AND PROPERTIES

A. Day Cream

The use of day cream is seen as the most efficient method of preventing skin neoplasms [17]. After a single, realistic application of the daily cream SPF15, consumers' faces remain protected at least 5 times on average by midday. They are probably exposed to the maximum levels of UV rays [9].

Inorganic in nature, UV filters are often solid in water or lipids and are opaque and insoluble. Organic filters, oppositely, are aromatic compounds that mainly absorb UV radiation [17]. Titanium oxide, which comes in particle sizes ranging from 15 to 80 nm, is the most prevalent physical (mineral) filter. UVB and UVA radiation are both absorbed by these particles. They do not leave a white residue on the skin due to their microscopic size, which is a benefit to customers. As for the chemical, filters are defined by their absorption coefficient, which is a unit measure of a chemical filter layer's ability to absorb light radiant energy and their wavelength at absorption maximum [18]. Allergic contact dermatitis, irritative dermatitis, and photosensitivity are all known to be caused by chemical filters [18]. Most filters are lipophilic in nature, and the size of their chemical structures may allow the adhesion to the stratum corneum. However, other compounds, such as benzophenone-3, octyl- methoxycinnamate, and benzylidene camphor, are lipophilic and are small enough to get through the corneocytes and then disperse throughout the epidermis's many layers [18].

B. Properties

Day cream cannot be considered a therapeutic treatment due to its different properties that are mainly designed to protect and support the skin throughout the day as they contain SPF for avoiding photo-ageing and burning [12]. Higher SPF values offer superior UVB protection and, as a result, reduce the risk of sunburn [18]. A day cream with UV filters would provide sun protection, and adding film formers, such as biosaccharide gum, would prevent pollution particles from adhering to the skin during the day [19].

Triglyceride oils are found to be absorbent in the UV region so that they can be used as emollients in the formulation of day cream [20]. Otherwise, wide protection of the spectrum is possible only by the incorporation of titanium oxide and zinc oxide with additional UVB absorbers such as para-aminobenzoic acid, cinnamon, and salicylates [21]. Seaweed day cream, which is made up of natural ingredients, moisturises the skin with seaweed extract, regenerates the skin with chitosan, provides antioxidants with sea pandan, and provides UV protection with mangrove seed extract. It also has a high level of resistance to free radicals and UV radiation, both of which are known to cause skin cancer [22].

IV. FORMULATION OF COSMETICS

Water and oil-based components are frequently used in cosmetic formulations. Animal fats and vegetable oils are used to make the oil-based components, which are obtained naturally or synthetically [23]. The green trend, for example, maybe account for customers' increased interest in sustainable products. In cosmetics and personal care for "natural" ingredients products.

Biosurfactants have a lot of potential in this approach because they are renewable and long-lasting resources [24]. Many bio-surfactants can be good emulsifiers, which gives the processing of green cosmetic products a further advantage. Lactobacillus paracasei, a biosurfactant, has been employed as a stabilising factor in oil-in-water emulsions containing essential oils [25].

UV penetration causes various peroxidation events on the skin's surface, resulting in reactive oxygen species that can react with DNA, proteins, or fatty acids, causing oxidative damage and degradation of the antioxidant system. Dermatological illnesses such as inflammations, irritations, dermatitis, and cancer are caused by these oxidative reactions. The current trend in the cosmetics industry is to use natural goods rich in bioactive chemicals, such as plant oils, and nanochemistry to develop safe and sophisticated technologies compositions with a broad photoprotective range and sufficient antioxidant activity to protect the skin against peroxide free radicals. Due to their high richness in bioactive substances such as unsaturated fatty acids, tocopherols, related phenols, and other compounds, the performance of various fractions of plant oils (obtained using acceptable procedures for processing herbs and seeds) was reviewed [26].

Many natural products with cosmetic potential are unable to penetrate the skin, are environmentally unstable, poorly bioavailable and soluble, and have a fast metabolism. As a result, they cannot be used in cosmetic formulations due to their inability to carry out their biological activity. To address this issue, some delivery mechanisms are employed because of their safety and biodegradability, food-grade proteins, lipids, and polysaccharides are used [27].

Pumpkin seed oil is a bioactive natural product with a chemical profile rich in fatty acids, particularly linoleic and oleic acids, phytosterols, and tocopherols. The higher amount of ω-6 and ω-9 fatty acids resulted in a renewing effect on the skin, as well as an emollient and regenerative skin action (wound healing effect) and improved moisture.

Because of its high nutritional value, shea oil has become marketable to the industry in Europe, Asia, and North America to create a wide range of products. It is used as a moisturiser and for hairstyling as a cosmetic. Shea butter is also used to defend against the weather and the sun. It also has therapeutic effects [28].

Cosmetic emulsions consist of water/hydrophilic basis material, oil/hydrophobic base material, surfactant/amphiphilic substances, and materials adding or improving functionality, perfume, sensory sensitivities, and quality control cosmetic emulsions (for example, shelf-life and viscosity) [10].

V. VEGETABLE-BASED WAX ESTER

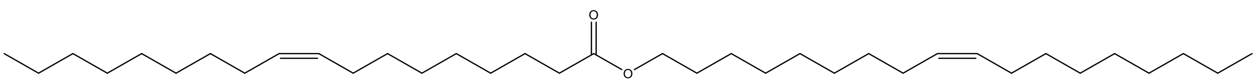
A. *Wax Ester*

Long-chain esters of fatty acids esterified to fatty alcohols with a chain length of 12 carbons or more are known as wax esters. Wax esters are used in the candle, cosmetics, lubricant, moisturiser, and food sectors because of their non-toxic properties, biodegradability, and excellent surface wetting behaviour. Animal and vegetable-derived materials, such as beeswax, jojoba oil, and carnauba waxes, are natural sources of wax esters. However, the chemical or enzymatic manufacturing of wax esters from basic renewable materials could give long-term alternatives [29].

Wax esters materials are held as commodity items in cosmetic companies. However, synthetic wax esters synthesised via an enzymatic pathway have recently attracted a lot of interest from cosmetic researchers because of their potential use in the industry. Wax esters are made chemically utilising immobilised lipases, which rely on the chemical synthesis of fatty alcohols, which drives up the cost of production considerably [30]. Biocatalysts also impart standards and grades that are required for cosmetic use [31].

The chemical technique has several disadvantages, including significant energy consumption, product degradation, and the use of caustic acids. Due to the specificity of the enzymes utilised, enzymatic synthesis is a sustainable process because it uses mild reaction conditions, consumes little energy, and produces high-quality products. These benefits make these enzymes (lipases) suitable for producing a variety of interesting compounds, such as wax esters and other molecules [29].

Wax esters are of great interest as components of cosmetics and other personal care products for many non-food applications. The use of wax esters as lubricants and protective layers, nonetheless, is limited by their significantly higher prices [4]. However, wax ester production has shown development in genetically modified oil have been made, and successful trials have been reported [31]. Scheme 1 shows the chemical structure of wax ester.



Scheme 1. The Chemical Structure of Wax Ester

B. Vegetable-based Wax Ester

Vegetable oils are a durable renewable feedstock that has attracted increased efforts in research as a feedstock to produce petrochemical-friendly alternatives [32]. Furthermore, vegetable oils offer many prospective natural characteristics such as good lubricity, shear strength, high flash point, high viscosity index, and low evaporative oils loss [5]. In addition, vegetable oils also give skin revitalisation, protection against free oxygen radicals, healing, softening, rejuvenating, and sunscreen benefits due to their bioactive content [27].

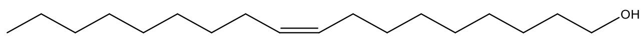
Vegetable oils are gaining more attention than ever before due to their numerous medicinal benefits as well as their usage in the development and improvement of organic and environmentally friendly cosmetics. Rosehip oil, for example, includes a high amount of trans-retinoic acid, which has regeneration properties [23]. Jojoba oil consists mainly of linear wax esters (95%) instead of TAG s. It is used for a broad range of uses, such as cosmetics and pharmaceutical products [33].

The special properties of jojoba wax ester make it particularly valuable in cosmetics, lubricants, and the biofuel industry. Jojoba wax ester is preferred for skincare, medicines, as a synthetic polymer alternative, and as a natural raw material for biofuel manufacturing due to its texture and durability [30]. The jojoba wax ester has also been shown to be extremely compatible with human sebum and improve skin moisture retention as they are widely used in various cosmetic products [34]. Jojoba oils also are well-known for their strong mechanical lubricity features, such as stability at high temperatures and pressures, antifoaming, antiwear, antirust capabilities, and oxidative stability. This adds to their importance in the cosmetics sector. Because of its high oil content, economic worth, and ability to grow in hot, arid conditions (35° to 48°C), jojoba has attracted a lot of attention for domestication in some of the world's most inhospitable locations [34].

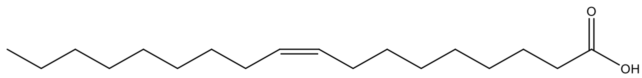
Vegetable oils are chosen over mineral oils because of their biocompatibility and biodegradability, as well as their efficiency in protecting the skin from UV rays, irritation, insect bites, germs, and viruses. Furthermore, vegetable oils have a lower viscosity and molecular weight than mineral oils, making them less occlusive. Triglycerides make up most of the chemicals in vegetable oils (95–98%) (esters of glycerol with three fatty acid molecules). Unsaturated fatty acids, particularly ω-3 and ω-6, were found to have the greatest aesthetic benefit. The most significant oils in skincare are those high in linoleic acid (ω-6) and α-linoleic acid, as they are the least comedogenic and help to prevent eczema [35].

Minor components of vegetable oils (less than 5%: fatty alcohols, phytosterols, vitamins, fatty acids) are also of interest because of their intriguing biological features, which are exploited in the pharmaceutical and nutraceutical sectors. The kind and percentage of fatty acids in the oil used for cosmetic purposes vary depending on the plant species. Fatty acids are divided into saturated, mono-, and poly-unsaturated fatty acids based on their saturation degree [35].

Due to their lower proclivity for producing free radicals during oxidation, highly saturated vegetable oils are also useful components in cosmetic and medicinal compositions. Coconut oil, for example, has been discovered to be ideal for the manufacture of cosmetics due to its high amount of saturated fatty acids (lauric, 50%, and myristic, 20%) and little content of caprylic acid, which has antifungal activity [35]. Schme 2 shows the chemical structure of oleyl alcohol, and Scheme 3 shows the chemical structure of oleic acid.



Scheme 2. Chemical Structure of Oleyl Alcohol



Scheme 3. Chemical Structure of Oleic Acid

VI. SYNTHESIS OF VEGETABLE WAX ESTER

Partial or full hydrogenation is the most frequent process for generating vegetable oil-based waxes. The material, however, cannot be used directly in demanding applications such as corrugated cardboard coating without significant structural adjustments. To compete with highly optimised petroleum-based waxes, vegetable oil-based waxes must have equivalent physical and thermal properties [36].

The process can produce products with various physical and thermal properties by altering the fatty acid mix and chain length. With sodium methoxide as the catalyst, fully hydrogenated soybean oil (FHSO) was transesterified with stearyl alcohol and triacetin at a molar ratio of 9:7:15, yielding a wax with 31% diacetyl-monoacylglycerols, 12% monoacetyl-monoacylglycerols, 32% diacylglycerols, and 11% acylglycerols; because of its great hardness and cohesiveness, this substance might be utilised as a beeswax or paraffin alternative [37].

Transesterification utilising free fatty acid (FFA) or free fatty alcohol (FFAL): When pure FFA and FFAL generated from vegetable oil are utilised as starting materials, pure fatty acid esters can be formed. Many of these wax esters have physical properties similar to petroleum-based or natural waxes, making them suitable for application in cosmetics, lubricants, and foods. Esterification of 9-decenol with oleic acid or 9-decenoic acid with oleyl alcohol yields similar jojoba wax-like esters [36].

VI. OIL IN WATER EMULSIONS

Oil-in-Water (O/W) emulsions consist of an oil phase scattered throughout the aqueous phase like droplets containing the emulsifiers. For the initiation of formation, stability, and desirable physicochemical properties of emulsions, emulsifiers are essential [11]. The composition of an emulsion has great consequences for its physical properties, which in turn influence the product behaviour [37].

It is known that emulsion texture is significant for consumers' preference regarding the application [37]. Due to its hydrophobic, dimethicone is added to the oil phase as an antifoaming agent in current O/W emulsions. It is also widely employed in preparations for topical barriers [12].

When compared to Water-in-Oil (W/O) emulsion, O/W emulsions, such as milk, foams, or creams, give a reduced oily sensation when applied to the skin. This is because cationic polymers (such as polyquaternium 35 or polyquaternium 40) are used in most of these emulsions, which do not have an oily feel. This sort of emulsion can be eliminated by bathing, sweat, and/or friction in the absence of these polymers. As a result, adding polymers to such compositions may improve their water resistance [18].

VII. WATER IN OIL EMULSION

Water-in-Oil (W/O) emulsion type is a dispersed phase and oil as a dispersive medium and is also more humidifying since they create an oily barrier to water loss from the outermost layer of the cornea stratum of the skin [12]. The most frequently used method of demulsification for petroleum emulsions (W/O) separation is chemical demulsification [13].

The molecular simulation has shown mechanisms for the stability and volatility of the olive-water emulsions moisturised by the interfacially active asphaltenes (IAA). It is found that IAA can accumulate on the interface with the oil-water and automatically form a viscoelastic interface film by stacking π-π, hydrogen bonds (intermolecular and intermolecular), and other non-covalent bonds [13].

W/O emulsion offers a higher UV protection capacity than Oil-in-Water (O/W) preparations due to the lipophilic character of the outer phase of the W/O emulsions, which allows for even diffusion of the oily sunscreens. Due to a reduction in transepidermal water loss (TEWL), such formulations may also aid in moisturisation. For the same proportion of sunscreen, W/O emulsions are more effective with a higher SPF [18]. Furthermore, because the W/O emulsion is more water-resistant than O/W emulsions, they are favoured in sunscreen products.

IX. PHYSICOCHEMICAL STUDIES

This paper will review the physicochemical study of the refractive index (RI), saponification value (SV), acid value (AV), iodine value (IV), and ester value (EV). This physicochemical study is crucial and necessary because it will show the properties that will give useful information to formulate cosmetics and evaluate the product's compositional quality. The physical and chemical properties of oil depend on the compositional quality [38].

The sensory analysis offers information about the main properties of a cosmetic formulation when in touch with the skin, such as softness, moisture, and oiliness, in addition to the physical and chemical characteristics. After immediately applying the emulsions, the sensory evaluation revealed that the formulation containing sunflower seed oil was mostly described as "consistent" and "absorbent" while spreading the product over the skin [39].

Consumer acceptability of a cosmetic product is heavily influenced by its appearance and sensory performance. Classic sensory analysis, on the other hand, is time-consuming, costly, and does not provide information on the target group's preferences. Olive oil emulsions are assigned three sensory-like properties, including firmness, work of shear, and stickiness. Olive oil emulsions were consistently thicker, more difficult to spread, and stickier [40].

Based on the physicochemical study of emollients, in the context of sensory assessments, hydrocarbon emollients can decrease the lubricity of a formula, which gives the skin a pleasant and light feel (Chao et al., 2018). Therefore, according to their physicochemical properties, the seed oil of L. comberi has potential for application in various industrial sectors like cosmetics and pharmaceuticals. However, further testing is necessary [38].

A. *Refractive Index (RI)*

The RI of oil is determined by its molecular weight, acid chain length, insaturation, and conjugation [41]. In addition, the RI of vegetable oils is related to the degree of saturation and can be affected by the incident light used in the study because of the cis-trans double bonds [42].

The physical parameters of samples with a shea butter RI of 1.461 and a fluted pumpkin seed oil RI of 1.463 were considerably ($p<0.05$) greater than the control crude palm oil [43].

Apart from that, the RI of shea butter oil was tested and found to be 1.464, according to another paper. These results were discovered to be within the range of a normal shea nut oil RI (1.463-1.467) [43]. The RI of fluted pumpkin seed oil was reported to be 1.467 [44].

As the chain length and the number of double bonds in the oil increase, the RI of fat increases. The RI of oil is influenced by its degree of unsaturation and conjugation. The RI of the fluted pumpkin seed oil is higher than that of shea butter and palm oil, implying that it contains more unsaturated fatty acids [45].

B. *Saponification Value (SV)*

The SV is a measurement of the triglyceride molecular weights in the oil. Fatty acid chain length and molecular weight are inversely proportional [38]. As a result, the higher the SV, the shorter the chain.

The SV of shea nut oil was (227.94 mgKOH/g). This value relates to (227.49 mgKOH/g) recorded for groundnut. Note that the SV of (227.94 mgKOH/g) was significantly ($p<0.05$) higher than (200.47 mgKOH/g) given by the control (CPO) sample [43].

Shea nut oil has an SV of (227.94 mgKOH/g) compared to (227.49 mgKOH/g) for groundnut oil. The SV of (227.94 mgKOH/g) was substantially ($p<0.05$) greater than the control (CPO) sample's (200.47 mgKOH/g) [43].

Thus, substances with long-chain fatty acids have a low SV because they are primarily composed of short-chain length fatty acids, shea nut oil, and fluted pumpkin seed oil generated in this paper have high SV (C16 and C18) [29].

The volatility of oil increases as the SV rises. Increased SV improves the oil quality because it reveals the existence of a smaller molecular weight 1 g of oil contains the following weight components. The number of milligrams of potassium hydroxide required to neutralise the fatty acids released during complete hydrolysis or saponification of 1g of oil is referred to as the SV [46].

C. Acid Value (AV)

The AV is the amount of potassium hydroxide (mg) required to neutralise the free acids in 1 g of fat. The AV of unrefined shea butter is (1.76 mgKOH/g). This value relates closely to (1.2 mgKOH/g) as reported earlier. The unrefined fluted pumpkin seed oil has an AV of 1.41 mgKOH/g. Correspondingly, this figure is lower than previous reports of (3.97, 3.56, 3.48, and 2.22 mgKOH/g) [43, 47-50]. Lower acid levels of 0.76mgKOH/g have also been reported [40]. Shea butter and fluted pumpkin seed oil had much lower AV than the control (crude palm oil), which had an AV of (7.29 mgKOH/g).

The presence of fewer free acids in an oil sample with a low AV reduces the likelihood of rancidification [43]. Therefore, low acid readings in shea butter and fluted pumpkin seed oil indicate that they are suitable for use in food and other industrial applications.

AV was used to determine the amount of free fatty acids (FFA) in the oil, which indicates the existence and extent of hydrolysis by lipolytic enzymes and oxidation. The higher the value, the more unstable the oil will become over time and will be less resistant to rancidity and peroxidation [46]. A low acid level is preferred in general since larger amounts of low acid increase wax esters oxidation [29].

D. Iodine Value (IV)

The IV, which is represented as g of iodine used per 100 g of a chemical compound, describes the degree of unsaturation of the substance. The substance's double bonds react with iodine, and the higher the IV, the higher the substance's double bonds [29].

Shea nut oil (shea butter) had an IV of (70.00 g/100g). This amount was substantially greater ($p<0.05$) than crude palm oil, which is (57.33 g/100g). In addition, shea butter with an IV of (83.3g/100g) had also been reported [43].

The IV of (70.00g/100g) was greater than the previously reported values of (60.37 g/100g), (61.00 g/100g), and (61.31 g/100g) [51-53]. Shea butter with an IV of (83.3 g/100g) had also been reported [37]. The IV of 70 falls within the allowed range of IV for shea butter at the worldwide level is reported as 58–72 g/100g [43].

Shea nut oil's iodine content was significantly ($p<0.05$) lower than fluted pumpkin seed oil (119.67 g/100g). Another paper reported that fluted pumpkin seed oil recorded an IV of (119.85g/100g) [45].

Conversely, the low IV of shea nut oil shows that it is high in saturated fatty acids, which ensures that foods produced with the oil remain stable against oxidation and rancidity [54]. This could be because the seeds contain natural antioxidants such as vitamins A and C, as well as other phytochemicals such as flavonoids [55]. It can also be used to make shortening and margarine because it is a good source of solid fat.

E. Ester Value (EV)

The amount of alkali required for complete saponification of esters in oil is known as the EV [55]. Shea nut oil has an EV of (226.17 mgKOH/g), which is substantially ($p<0.05$) greater than crude palm oil (193.18 mgKOH/g). The fluted pumpkin seed oil has an EV of (177.63 mgKOH/g). Therefore, the EV of shea butter and fluted pumpkin seed oil is high, indicating that they are suitable for culinary application.

A high EV also indicates that the molecular fatty acid content is high in ester and low in weight [56]. Hence, changes in the EV regarding Canola oil convention heating are gradually decreasing while repeatedly frying with carbohydrates has been shown an increase [57].

Table 1.1 shows the physicochemical properties of shea butter and Fluted pumpkin seed oil.

Physicochemical Characteristics	**Vegetable Oil**	
	Pumpkin Seed Oil	***Shea Butter***
Refractive Index	1.463	1.461
Saponificatio Value	227.94 mgKOH/g	179.04mgKOH/g
Acid Value	1.41mgKOH/g	1.76mgKOH/g
Iodine Value	119.67g/100g	70.00g/100g
Ester Value	177.63mgKOH/g	226.17mgKOH/g

X. CONCLUSION

The compositions, stability to some physical factors, susceptibility to environmentally induced chemical deterioration, and suitability for human consumption of some commercially available vegetable oils have all been revealed through various investigations into their physical and chemical properties. Physicochemical characteristics such as refractive index (RI), saponification value (SV), iodine value (IV), ester value (EV) and acid value (AV) were reviewed throughout this paper. The use of synthesised vegetable-based wax ester was utilised to formulate emollient and day cream.

The creation of a worldwide available biodegradable base stock and its consistent supply and ideal physicochemical qualities are key challenges in this review. Any changes in the physicochemical parameters of the final product could result in a change in the yield. This could be avoided by fine-tuning the chemical alteration processes. On the other hand, developing diverse biodegradable industrial cosmetics could result in a substantial shift in the cosmetics industry. Furthermore, because the bio-based wax esters created had applications similar to natural waxes, they might be researched further for culinary applications such as edible coatings.

Aligning measurable formulation technology with consumers' perceptions of cosmetic products is a continuing requirement in the cosmetic and personal care sector. Furthermore, developing innovative products that target certain customer groups with well-defined wants and expectations is highly desired. If preferences can be researched and tackled with good design, this information is valuable enough to develop into practical inventions or demand-pull advances.

Shea nut oil has a high recovery rate (58.00%) and is chemically safe for cooking. Its physicochemical properties make it more suited for human consumption and other industrial applications like medications and cosmetics. It is a stable solid at room temperature due to the high concentration of long-chain solid fat components (stearic acids), making it useful in preparing margarine and bread shortenings.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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REFERENCES

[1] Macel, M., Visschers, I. G., Peters, J. L., van Dam, N. M., & de Graaf, R. M. (2020). High concentrations of very long chain leaf wax alkanes of thrips susceptible pepper accessions (Capsicum spp). *Journal of chemical ecology*, *46*(11), 1082-1089. doi.org/10.1007/s10886-020-01226-x

[2] Bachmann, M., Hepp, J., Zech, M., Bulang, M., & Zeyner, A. (2018). Application of natural wax markers in equine nutrition studies–current state, limitations and perspectives. Livestock Science, 208, 77-89. doi.org/10.1016/j.livsci.2017.12.010

[3] Xie, M., Cheng, J., Zhao, G., Liu, H., Zhang, L., & Yang, C. (2020). Natural wax from non-medicinal aerial part of Codonopsis pilosula as a biolubricant. Journal of Cleaner Production, 242, 118403. doi.org/10.1016/j.jclepro.2019.118403

[4] Shirani, A., Joy, T., Lager, I., Yilmaz, J.L., Wang, H.L., Jeppson, S., Cahoon, E.B., Chapman, K., Stymne, S. and Berman, D., 2020. Lubrication characteristics of wax esters from oils produced by a genetically-enhanced oilseed crop. Tribology International, 146, p.106234. doi.org/10.1016/j.triboint.2020.106234

[5] Gnanasekaran, D., & Chavidi, V. P. (2018). Vegetable Oil as a Multifunctional and Multipurpose Green Lubricant Additive. In Vegetable Oil based Bio-lubricants and Transformer Fluids (pp. 49-62). Springer, Singapore. doi.org/10.1007/978-981-10-4870-8_3

[6] Sadiq, M., Adil, M., & Paul, J. (2021). An innovation resistance theory perspective on purchase of eco-friendly cosmetics. Journal of Retailing and Consumer Services, 59, 102369. doi.org/10.1016/j.jretconser.2020.102369

[7] Bom, S., Fitas, M., Martins, A. M., Pinto, P., Ribeiro, H. M., & Marto, J. (2020). Replacing synthetic ingredients by sustainable natural alternatives: a case study using topical O/W emulsions. Molecules, 25(21), 4887. doi.org/10.3390/molecules25214887

[8] Chao, C., Génot, C., Rodriguez, C., Magniez, H., Lacourt, S., Fievez, A., Len, C., Pezron, I., Luart, D. and van Hecke, E., 2018. Emollients for cosmetic formulations: Towards relationships between physico-chemical properties and sensory perceptions. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 536, pp.156-164. doi.org/10.1016/j.colsurfa.2017.07.025

[9] Diffey, B. L., O'Connor, C., Marlow, I., Bell, M., & O'Mahony, M. M. (2018). A theoretical and experimental study of the temporal reduction in UV protection provided by a facial day cream. International Journal of Cosmetic Science, 40(4), 401-407. doi.org/10.1111/ics.12480

[10] Sakamoto, K., Lochhead, H., Maibach, H., & Yamashita, Y. (Eds.). (2017). Cosmetic science and technology: theoretical principles and applications. Elsevier.

[11] Loi, C. C., Eyres, G. T., & Birch, E. J. (2019). Effect of mono-and diglycerides on physical properties and stability of a protein-stabilised oil-in-water emulsion. Journal of Food Engineering, 240, 56-64. 10.1016/j.jfoodeng.2018.07.016

[12] Mohiuddin, A. K. (2019). Skin Care Creams: Formulation and Use. Dermatol Clin Res, 5(1), 238-271.

[13] Ma, J., Yang, Y., Li, X., Sui, H., & He, L. (2021). Mechanisms on the stability and instability of water-in-oil emulsion stabilized by interfacially active asphaltenes: Role of hydrogen bonding reconstructing. Fuel, 297, 120763. doi.org/10.1016/j.fuel.2021.120763

[14] Terescenco, D., Picard, C., Clemenceau, F., Grisel, M., & Savary, G. (2018). Influence of the emollient structure on the properties of cosmetic emulsion containing lamellar liquid crystals. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 536, 10-19. doi.org/10.1016/j.colsurfa.2017.08.017

[15] Moldovan, M. L., Ionuț, I. U. L. I. A., & Bogdan, C. Ă. T. Ă. L. I. N. A. (2021). Cosmetic products containing natural based emollients for restoring impaired skin barrier: formulation and in vivo evaluation. Farmacia, 69(1), 129-134. doi.org/10.31925/farmacia.2021.1.17

[16] Gore, E., Picard, C., & Savary, G. (2018). Spreading behavior of cosmetic emulsions: Impact of the oil phase. Biotribology, 16, 17-24. doi.org/10.1016/j.biotri.2018.09.003

[17] Mota, M. D., Costa, R. Y. S., e Silva, L. C. R. C., & Chinalia, F. A. (2019). Guava-fruit extract can improve the UV-protection efficiency of synthetic filters in sun cream formulations. Journal of Photochemistry and Photobiology B: Biology, 201, 111639. doi.org/10.1016/j.jphotobiol.2019.111639

[18] Pouillot, A., & Ametsitsi, R. (2016). Formulating a Day Cream with SPF: A Case Study. Handbook of Formulating Dermal Applications, 611.

[19] Messaraa, C., Robertson, N., Walsh, M., Hurley, S., Doyle, L., Mansfield, A., Daly, L., Tansey, C. and Mavon, A., 2020. Clinical evidences of benefits from an advanced skin care routine in comparison with a simple routine. Journal of cosmetic dermatology, 19(8), pp.1993-1999. doi.org/10.1111/jocd.13252

[20] Wang, S.Q., Hu, J.Y., Quirin, K.W., DeJohn, A., Rosen, M.R., Greentech, B., Gorder, P.F. and Yi, A., 2011. We're taking a (super) critical look at extract quality.

[21] Santhanam, R. Kumar, Akhtar, M. T., Ahmad, S., Abas, F., Ismail, I. S., Rukayadi, Y. & Shaari, K. (2017). "Utilization of the ethyl acetate fraction of Zanthoxylum rhetsa bark extract as an active ingredient in natural sunscreen formulations". Industrial Crops and Products. Vol 96. pp. 165–172. doi.org/10.1016/j.indcrop.2016.11.058

[22] Putri, A. K., & Retnaningsih, R. (2016). Analysis of the Seaweed Day Cream Product Buying Intention: Theory of Planned Behavior Approach. Journal of Consumer Sciences, 1(2), 43-55. doi.org/10.29244/jcs.1.2.43-55

[23] Aziz, A. A., Nordin, F. N. M., Zakaria, Z., & Abu Bakar, N. K. (2022). A systematic literature review on the current detection tools for authentication analysis of cosmetic ingredients. Journal of Cosmetic Dermatology, 21(1), 71-84. doi.org/10.1111/jocd.14402

[24] Vecino, X., Cruz, J. M., Moldes, A. B., & Rodrigues, L. R. (2017). Biosurfactants in cosmetic formulations: trends and challenges. Critical reviews in biotechnology, 37(7), 911-923. doi.org/10.1080/07388551.2016.1269053

[25] Ferreira, A., Vecino, X., Ferreira, D., Cruz, J. M., Moldes, A. B., & Rodrigues, L. R. (2017). Novel cosmetic formulations containing a biosurfactant from Lactobacillus paracasei. Colloids and Surfaces B: Biointerfaces, 155, 522-529. doi.org/10.1016/j.colsurfb.2017.04.026

[26] Lacatusu, I., Arsenie, L. V., Badea, G., Popa, O., Oprea, O., & Badea, N. (2018). New cosmetic formulations with broad photoprotective and antioxidative activities designed by amaranth and pumpkin seed oils nanocarriers. Industrial Crops and Products, 123, 424-433. doi.org/10.1016/j.indcrop.2018.06.083

[27] Dini, I., & Laneri, S. (2021). The new challenge of green cosmetics: natural food ingredients for cosmetic formulations. Molecules, 26(13), 3921. doi.org/10.3390/molecules26133921

[28] Abagale, S. A., Oseni, L. A., Abagale, F. K., & Oseifosu, N. (2016). Chemical analyses of shea butter from northern ghana: assessment of six industrially useful chemical properties.

[29] Aguieiras, E. C., Papadaki, A., Mallouchos, A., Mandala, I., Sousa, H., Freire, D. M., & Koutinas, A. A. (2019). Enzymatic synthesis of bio-based wax esters from palm and soybean fatty acids using crude lipases produced on agricultural residues. Industrial Crops and Products, 139, 111499. doi.org/10.1016/j.indcrop.2019.111499

[30] Alotaibi, S. S., Elseehy, M. M., Aljuaid, B. S., & El-Shehawi, A. M. (2020). Transcriptome analysis of jojoba (Simmondsia chinensis) during seed development and liquid wax ester biosynthesis. Plants, 9(5), 588. doi.org/10.3390/plants9050588

[31] Jaiswal, K. S., & Rathod, V. K. (2019). Enzymatic synthesis of cosmetic grade wax ester in solvent free system: optimization, kinetic and thermodynamic studies. SN Applied Sciences, 1(8), 1-11. doi.org/10.1007/s42452-019-0955-9

[32] Zhu, L.H., Krens, F., Smith, M.A., Li, X., Qi, W., Van Loo, E.N., Iven, T., Feussner, I., Nazarenus, T.J., Huai, D. and Taylor, D.C., 2016. Dedicated industrial oilseed crops as metabolic engineering platforms for sustainable industrial feedstock production. Scientific Reports, 6(1), pp.1-11. doi.org/10.1038/srep22181

[33] Anzenberger, C., Li, S., Bouzidi, L., & Narine, S. S. (2016). Synthesis of waxes from vegetable oil derived self-metathesized aliphatic esters. Industrial Crops and Products, 89, 368-375. doi.org/10.1016/j.indcrop.2016.05.043

[34] Sturtevant, D., Lu, S., Zhou, Z.W., Shen, Y., Wang, S., Song, J.M., Zhong, J., Burks, D.J., Yang, Z.Q., Yang, Q.Y. and Cannon, A.E., 2020. The genome of jojoba (Simmondsia chinensis): A taxonomically isolated species that directs wax ester accumulation in its seeds. Science advances, 6(11), p.eaay3240. 10.1126/sciadv.aay3240

[35] Dănilă, E., Moldovan, Z., Kaya, M. G. A., & Ghica, M. V. (2019). Formulation and characterization of some oil in water cosmetic emulsions based on collagen hydrolysate and vegetable oils mixtures. Pure and Applied Chemistry, 91(9), 1493-1507. doi.org/10.1515/pac-2018-0911

[36] Fei, T., & Wang, T. (2017). A review of recent development of sustainable waxes derived from vegetable oils. Current Opinion in Food Science, 16, 7-14. doi.org/10.1016/j.cofs.2017.06.006

[37] Dubuisson, P., Picard, C., Grisel, M., & Savary, G. (2018). How does composition influence the texture of cosmetic emulsions?. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 536, 38-46. doi.org/10.1016/j.colsurfa.2017.08.001

[38] Nduka, J. K. C., Omozuwa, P. O., & Imanah, O. E. (2021). Effect of heating time on the physicochemical properties of selected vegetable oils. Arabian Journal of Chemistry, 14(4), 103063. doi.org/10.1016/j.arabjc.2021.103063

[39] César, F. C., & Maia Campos, P. M. (2020). Influence of vegetable oils in the rheology, texture profile and sensory properties of cosmetic formulations based on organogel. International Journal of Cosmetic Science, 42(5), 494-500. doi.org/10.1111/ics.12654

[40] Huynh, A., Garcia, A. G., Young, L. K., Szoboszlai, M., Liberatore, M. W., & Baki, G. (2021). Measurements meet perceptions: rheology–texture–sensory relations when using green, bio-derived emollients in cosmetic emulsions. International Journal of Cosmetic Science, 43(1), 11-19. doi.org/10.1111/ics.12661

[41] Kamila, P. K., Ray, A., Sahoo, A., Nayak, S., Mohapatra, P. K., & Panda, P. C. (2018). Physicochemical characteristics of the Lasiococca comberi Haines seeds. Natural product research, 32(19), 2352-2355. doi.org/10.1080/14786419.2017.1408091

[42] Ospina, J. D., Tovar, C. D. G., Flores, J. C. M., & Orozco, M. S. S. (2016). Relationship between refractive index and thymol concentration in essential oils of Lippia origanoides Kunth. Chilean journal of agricultural & animal sciences, 32(2), 127-133.

[43] Samuel, C. B., Barine, K. K. D., & Joy, E. E. (2017). Physicochemical properties and fatty acid profile of shea butter and fluted pumpkin seed oil, a suitable blend in bakery fat production. International Journal of Nutrition and Food Sciences, 6(3), 122-128.

[44] Samuel, C. B., Barine, K. K. D., & Joy, E. E. (2018). Comparative assessment of the physicochemical properties and fatty acid profile of fluted pumpkin seed oil with some commercial vegetable oils in Rivers State, Nigeria. Research Journal of Food and Nutrition, 2(2), 32-40.

[45] Datti, Y., Musa, I., Isma'il, S., Mustapha, A., Muhammad, M. S., Ado, A. S., & Ahmad, U. U. (2020). Extraction, production and characterization of biodiesel from shea butter (Vitellaria paradoxa CF Gaertn) obtained from Hadejia, Jigawa State, Nigeria. GSC Biological and Pharmaceutical Sciences, 11(3), 208-215. doi.org/10.30574/gscbps.2020.11.3.0168

[46] Ekpe, O. O., Bassey, S. O., Udefa, A. L., & Essien, N. M. (2018). Physicochemical properties and fatty acid profile of Irvingia gabonensis (Kuwing) seed oil. Int J Food Sci Nutr, 3(4), 153-156.

[47] Akubugwo, I. E., Chinyere, G. C., & Ugbogu, A. E. (2008). Comparative studies on oils from some common plant seeds in Nigeria. P Bello, E. I., Anjorin, S. A., & Agge, M. (2005). Production of biodiesel from fluted pumpkin (Telfairia occidentalis Hook F.) seeds oil. International Journal of Mechanical Engineering, 2(1), 22-31.akistan Journal of Nutrition, 7(4), 570-573.

[48] Samuel, C. B., Barine, K. K. D., & Joy, E. E. (2017). Physicochemical properties and fatty acid profile of shea butter and fluted pumpkin seed oil, a suitable blend in bakery fat production. International Journal of Nutrition and Food Sciences, 6(3), 122-128.

[49] Samuel, C. B., Barine, K. K. D., & Joy, E. E. (2017). Physicochemical properties and fatty acid profile of shea butter and fluted pumpkin seed oil, a suitable blend in bakery fat production. International Journal of Nutrition and Food Sciences, 6(3), 122-128.

[50] Bello, M. O., Akindele, T. L., Adeoye, D. O., & Oladimeji, A. O. (2011). Physicochemical properties and fatty acids profile of seed oil of Telfairia occidentalis Hook, F. Int. J. Basic Appl. Sci, 11(6), 9-14.

[51] Jude, U. O., Roland, D. A., Ibiso, O., Vivien, O., Emmanuel, A. O., & Tonbra, O. (2014). A two â€“year seasonal survey of the quality of shea butter produced in Niger state of Nigeria. African Journal of Food Science, 8(2), 64-74.

[52] Olaniyan, A. M., & Oje, K. (2007). Quality characteristics of shea butter recovered from shea kernel through dry extraction process. Journal of Food Science and Technology-Mysore, 44(4), 404-407.

[53] Ikya, J. K., Umenger, L. N., & Iorbee, A. (2013). Effects of extraction methods on the yield and quality characteristics of oils from shea nut. Journal of Food Resource Science, 2(1), 1-12.

[54] Samuel, C. B., Barine, K. K. D., & Joy, E. E. (2017). Physicochemical properties and fatty acid profile of shea butter and fluted pumpkin seed oil, a suitable blend in bakery fat production. International Journal of Nutrition and Food Sciences, 6(3), 122-128.

[55] Badejo, P. O., Olagunju, E. O., Afolabi, S. O., Olatunbosun, O. S., Olawoyin, F., Olayiwola, R., ... & Badejo, J. A. (2016). Effect of solvents extraction on the yield and physicochemical properties of dehulled Hunteria umbellata seed oil. Journal of Pharmacy and Biological Sciences, 11(3), 83-88.

[56] Belsare, G. W., & Badne, S. G. (2017). Study on physico-chemical characterization of edible oils from agencies of Buldhana district. International Journal of Research in Pharmacy and Chemistry, 7(4), 525-529.

[57] Naz, S., & Saeed, R. (2018). Oxidative Stability of Canola Oil by Physico-Chemical Analysis and FT-IR Spectroscopy. Asian Journal of Pharmaceutical Research and Development, 6(1), 9-15.