Exploring the Use of Antioxidant Ingredients in Hair Creams in Nigeria

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Abstract

Background: Antioxidants (AOs) are chemical substances that play a crucial role in preventing cellular damage due to the transfer of free radicals to other molecules by oxidizing agents. Endogenous or exogenous AOs have been proven beneficial in hair care. When incorporated into routine hair care, AOs stimulate hair growth and reduce hair dryness, frizzes, breakages, and greying. They achieve this by preventing the oxidation of hair lipids and proteins by UV radiation and increasing blood flow to the scalp, promoting healthier and stronger hair.

Aim: To assess the presence and types of antioxidants in hair creams (HC) used for black hair types at the end-user level rather than at the sale outlets.

Methodology: One hundred and thirteen (113) volunteers were recruited in alopecia studies in blacks at the Dermatology Clinic of Obafemi Awolowo University Teaching Hospitals Complex. The volunteers filled in their biodata, HC names, and ingredients in a questionnaire. Antioxidant ingredients (AOIs) presence and types were assessed in each HC. Each ingredient was considered an entity as some are single AO units (like vitamin E) or compounds containing many antioxidants, such as shea butter. Each ingredient was assessed through publications, literature and online digital platforms for their antioxidant property.

Results: The age range was 17-42 years, and 70.8% were females. There were 98 AO ingredients in 46 of the 47 HCs, constituting 22 - 100% of the components. About 70% of HCs have >50% of their total ingredients as AOs, while 15% contain only one ingredient. The most common AOIs, in 30-40% HCs, were mineral oil, coconut milk protein, menthol and shea butter. Less common ones (10 - 30%) were oils - castor, olive, peppermint, almond, vitamins, sulphur, jojoba, paraben, glycerin, propylene glycol, and aloe vera.

Conclusion: There were 98 antioxidants in the 47 hair creams used by respondents. Mineral oil, coconut milk protein, shea butter, menthol, castor oil, olive oil, and vitamins A, C, and E were the most common.

Keywords: Antioxidant, Hair growth, Alopecia, Hair treatment, UV-radiation.

Exploration de l'utilisation d'ingrédients antioxydants dans les crèmes capillaires au Nigéria

Résumé

Contexte : Les antioxydants (AO) sont des substances chimiques qui jouent un rôle crucial dans la prévention des dommages cellulaires dûs au transfert de radicaux libres à d'autres molécules par des agents oxydants. Les AO endogènes ou exogènes se sont avérés bénéfiques dans les soins capillaires. Lorsqu'ils sont incorporés dans les soins capillaires de routine, les AO stimulent la croissance des cheveux et réduisent la sécheresse, les frisottis, les cassures et le grisonnement des cheveux. Ils y parviennent en empêchant l'oxydation des lipides et des protéines des cheveux par les rayons UV et en augmentant le flux sanguin vers le cuir chevelu, favorisant des cheveux plus sains et plus forts.

Objectif : Évaluer la présence et les types d'antioxydants dans les crèmes capillaires (HC) utilisées pour les cheveux noirs au niveau de l'utilisateur final plutôt qu'au niveau des points de vente.

Méthodologie : Cent treize (113) volontaires ont été recrutés dans des études sur l'alopécie chez les Noirs à la clinique de dermatologie du complexe hospitalier universitaire Obafemi Awolowo, au Nigeria. Ils ont été invités à remplir leurs données biographiques, les noms des HC et les ingrédients dans un questionnaire. La présence et les

types d'ingrédients antioxydants (AOI) ont été évalués dans chaque HC. Chaque ingrédient a été considéré comme une entité car certains sont des unités AO uniques (comme la vitamine E) ou des composés contenant de nombreux antioxydants, comme le beurre de karité. Chaque ingrédient a été évalué par le biais de publications, de littérature et de plateformes numériques en ligne pour sa propriété antioxydante.

Résultats : La tranche d'âge était de 17 à 42 ans, et 70,8 % étaient des femmes. Il y avait 98 ingrédients AO dans 46 des 47 HC, constituant 22 à 100 % des composants. Environ 70 % des HC ont plus de 50 % de leurs ingrédients totaux contenant un AO, tandis que 15 % ne contiennent qu'un seul ingrédient. Les AOI les plus courants, dans 30 à 40 % des HC, étaient l'huile minérale, la protéine de lait de coco, le menthol et le beurre de karité. Les moins courants (10 à 30 %) étaient les huiles de ricin, d'olive, de menthe poivrée, d'amande, les vitamines, le soufre, le jojoba, le parabène, la glycérine, le propylène glycol et l'aloe vera.

Conclusion : Il y avait 98 antioxydants dans les 47 crèmes capillaires utilisées par les répondants. L'huile minérale, les protéines de lait de coco, le beurre de karité, le menthol, l'huile de ricin, l'huile d'olive et les vitamines A, C et E étaient les plus courants.

Mots-clés : antioxydant ; croissance des cheveux ; alopécie ; traitement capillaire ; rayonnement UV.

Introduction

Exposure of the hair to variable factors with potentially hazardous effects regularly necessitates antioxidants in hair cream. Antioxidants (AOs) neutralize free radicals - unstable molecules that can harm the body cells if their levels are too high.[1] Free radical generation adversely affects DNA, lipids, protein formation, and functions and instigates various human pathological conditions.[2] Applying AOs from external sources provides additional support in combating oxidative stress.[3] Alopecia areata, seborrheic dermatitis, psoriasis, lichen planus, and skin cancers are diseases that affect hair and scalp known to be associated with oxidative stress.[4] Hair proteins and pigment degradation occur on prolonged exposure to wavelengths of 254-400 nm (UVA - 315–400 nm and UVB - 280–315 nm).[5, 6]

UVA rays cause the release of reactive oxygen species (free radicals) from endogenous photosensitizers and colour changes in the hair.[6, 7] UVB damages hair proteins and melanin components of the hair.[6, 8] Excessive or prolonged exposure to UV radiation results in dryness with rough surface texture, reduced hair strength, stiff and brittle hair, and loss of colour and lustre.[8] The mechanical stability of the hair fibre and its chemical resistance result from an extensive cross-linking of disulfide bonds in amino acids such as cysteine.[9] Photo-oxidation of hair fibre causes the fracture of carbon-sulfide (C–S), and disulfide linkages, oxidation of hair lipids and melanin granules, and degradation of tryptophan in keratin.[8,10] Human hair protein extracts that contain amino acids such as cysteine provide the maintenance of cell viability and reduced free radical production.[10,11]

Antioxidant ingredients (AOIs) can also be incorporated into routine hair care through regular topical application of hair care products, such as shampoos, conditioners, creams, serums, and masks.[11]

Based on the various benefits of AOs, the study assessed whether AOIs are incorporated into hair care products, particularly stay-on products like HCs that are not washed off. The assessment is carried out at the end-user level rather than at the sale outlets, documenting the products consumed and the actual AOIs in use. With the proliferation of cosmetic products, particularly hair and body creams, in this environment and exposure to a regular hot weather climate, it is imperative to know what our population uses for their hair care. This study explores and elucidates the use of antioxidant ingredients in hair creams by the black populace and at the end-user level.

Aim

This study determines the usage, presence, quantity, and types of antioxidants in hair creams used for black hair types. Research questions investigated include:

A. What is the age and sex distribution of those using HC among the young age group?
B. Are there differences between genders in the use of HC?
C. How many of the HCs have AOIs?
D. How many HCs have each type of AOI? What percentage of the total HCs in use contain every kind of AOI?

E. What percentage of the ingredients in each HC have AO activity?
F. What are the types of AOIs used for HC in this environment?
G. How common are the AOIs?

Materials And Methods

This is a descriptive cross-sectional survey conducted over three weeks in December 2022. Volunteers recruited in ongoing clinical-trichoscopic alopecia studies in blacks at the Dermatology Clinic of Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, Osun State, Nigeria, were the target study population. Study participants were students of the Obafemi Awolowo University, Ile-Ife. The undergraduates studied form a large population of youths in this setting and can provide the required data for this study. The young age group selected are potential respondents for the study on the beneficial effects of antioxidants on hair growth and prevention of hair damage or loss. Participants who used multiple hair creams were excluded from obtaining the prevalence of each AOI based on using a single hair cream type per person and for further evaluation of the effect of this HC and AOI components.

Inclusion criteria: Age group 16-45 years, Undergraduate students, and participants without hair or scalp disorders. Exclusion criteria: Age above 45 years, listing hair cream names without reporting the ingredients, and participants who used multiple hair creams concurrently. Each person was required to use one cream to determine each AOI's prevalence, so we included people who used only one cream.

Participants chose to bring their hair cream to the clinic or to fill out the questionnaire at home. Interviewer-administered questionnaires request biodata, hair cream names, and the ingredients in their hair creams/oils; hence, participants brought the HC currently in use to the clinic. Those who filled out the questionnaires filled out the HC contents from the label. Each ingredient listed was screened for antioxidant properties through literature reviews, research publications and medical/ pharmacological/toxicology reports.

Statistical Analysis: The presence and type of antioxidant ingredients (AOIs) in each hair cream (HC) and other data were analyzed with descriptive statistics using SPSS (Statistical Package for Social Sciences) (IBM Corp., Armonk, NY, USA) version 22.0.

The analysis assessed each research question to provide comprehensive details about the AOIs used in this environment.

A—Age and sex distribution and B—HC usage were obtained from bivariate analysis of the relationship of usage with age and gender. The likelihood ratio was employed to determine significance.

C – To assess the AOIs' presence in hair creams, a list of antioxidants from the product labels was compiled. Objective D was to determine how many HCs have a particular AOI and the frequency of use of a specific AOI in HC production in this environment. The AOI in each HC was documented to determine the frequency of use. In assessing how many HCs contain each type of AOI, all AOIs in all the HCs were obtained from their labels.

D – This assesses the number of HCs with each type of AOI. The percentages of total HCs containing every kind of AOI give the prevalence of an AOI as shown in Table 3 column b. This refers to the number of HCs with a particular AOI relative to the total number of HCs. The number of times an AOI was found on the labels when combined gives its distribution among HCs. See the example below.

E – The number and percentage of the AOIs found on each HC label relative to the total number of ingredients in the hair cream (HCI) was analyzed to determine the AOI content of each HC.

F – A compilation of all AOIs was done. These were divided into the natural and synthetic AO types.

G – The relative use of an AOI among all the AOIs was analyzed to show the most commonly used. See the example below.

> Examples: y = Total number of the different types of HC = 47; z = Sum of all a* = 274 = total number of times AOIs were used in Hcs.
>
> a* = Number of HCs with each AOI. Example: a* Coconut milk protein (CMP) = all HCs containing CMP = 17
>
> Objective G: b* = Percentage of HCs containing a particular AOI in all HCs: b* = a*/y.
>
> b* (Percentage of HCs containing CMP) = a*/y = 17/47 x 100 = 36.2%, i.e., 36.2% of all HCs have CMP.

Objective H: c* = Percentage of a particular AO among all AOs = number of times a specific AO occurs in all HCs/total number of AOs = a/z.

c* (Percentage of CMP among all AOIs) = a*/z =17/274 x 100 = 6.20%

Results

We reported the result according to the stated objectives of the study. There were 113 participants with filled questionnaires. Age ranges from 17 to 42 years (Table 1). Mean age was 22.2 ± 3.2 years SD. About 94.7% (107) of these are youths (<25 years), and all are in the young age group (<45 years). There was no significant difference between the age distribution of the males and the females (p = 0.197) (Table 1). All participants reported their gender. The females were almost 3 times the males, constituting 70.8% of the study participants, most between the ages of 20-25 (Table 1).

In analyzing the usage of all HCs, 47 different hair creams were reported, and the number of hair cream types used varied more with the female gender. Females used 63.8% of all the various types of HC (Table 2 column a). Females used HCs more frequently than males. The varied difference between both genders in the use of hair cream was found to be significant (p = 0.026). HCs such as So-fine type 2 and Soulmate type 1 were common to both genders. So-fine type 2 and MEDIRIT-3 were the most common in males and females, respectively (Table 2 column a). A significant difference was found using Hair-wonder, MEDIRIT-3 and Hair monitor HCs with a predominantly female preference (Table 2 column a).

On assessing the AOI presence in hair creams (Table 2 column b), AOIs were present in 46 of 47 HCs. Afro-American HC was the only HC without any AOI among the three ingredients.

There were 98 AOIs in the overall 47 HCs (Tables 2 and 3). Figure 1 shows the frequency of the AOIs in all HCs: each of 54 out of all the 98 AOIs occurred in only 1 HC type, respectively. For example, flax seed was found in only Afroblack HC, and onion extract was found in only Ustraa HC. Another 15 different AOIs were found to occur in 2 different HC types. For instance, Bergamot oil was found on Dax HC and Soulmate type 3 HC labels, while Tea tree oil was only listed on Apple HC and Monitor HC labels. Table 3, column A shows the distribution.

The percentages of HCs with each type of AOI give the prevalence of an AOI, as shown in Table 3, column b. This refers to the number of HCs with a particular AOI relative to the total number of Hcs.

The AOI content of each HC – number and the percentage of AOIs in each HC are shown in Table 2. Hair Wonder and Sulphur are HCs with the highest frequencies of AOIs. The highest concentrations of antioxidant agents with 100% ingredients as AOIs include Mega Growth Break Face.

The antioxidant ingredients of HCs ranged from 22%-100% of the total ingredients in each HC. About 70% have AOIs as >50% of the total ingredients. According to the list of antioxidants from the product labels, AOI present in HC in percentages relative to their total number of ingredients showed that in:

2.1% HCs - 0% ingredient is antioxidant (AO);

2.1% HCs - 1-25% ingredients are AOIs;

25.5% HCs - 26-50% ingredients are AOIs;

40.4% HCs - 51-75% ingredients are AOIs and,

29.9% HCs - 76-100% ingredients are AOIs.

Types of AOIs in HCs found on the labels (AOI type in Table 3) include oils from seeds, leaves, flowers, aloe vera, vitamins A, C, and E, placenta, linalool, and glycerin. There were 71 natural AOIs, 10 synthetic AOIs, and 17 natural and synthetic AOIs.

Table 3 column c shows the frequencies of each AOI. Coconut milk protein and mineral oil (each in 17 HCs and 6.2% of all AOIs) are the most frequently used.

Discussion

The non-significance of the age-to-sex distribution shows that the age distribution among the male and female participants is similar. Females participated more in this study as they use most cosmetics for skin health, beautification, and anti-ageing. However, Tengli et al. reported a similarity between men and women in their cosmetics purchase behaviour due to the increasing trend of male cosmetics use.[12]

Switching between various cosmetics products often occurs among females.[13] Females in this study used more varieties of HCs than men.

The AOIs of the HCs found were relatively high. More than half the ingredients on the labels of 70% HCs are AOIs. These HCs would provide adequate protection for the hair and scalp. Solar radiation's UV,

Table 1: Age and gender distribution of the study population

Age in years	Gender		
	Male	Female	Total
16-20	7	22	29
21-30	26	56	82
>30	0	2	2
Total	33	80	113
	(29.2%)	(70.8%)	(100%)
Likelihood Ratio* 17.056 df = 13 $p = 0.197$			
Mean age = 22.2 ± 3.2 years SD			

*19 cells (67.9%) have expected count less than 5. The minimum expected count is .29.

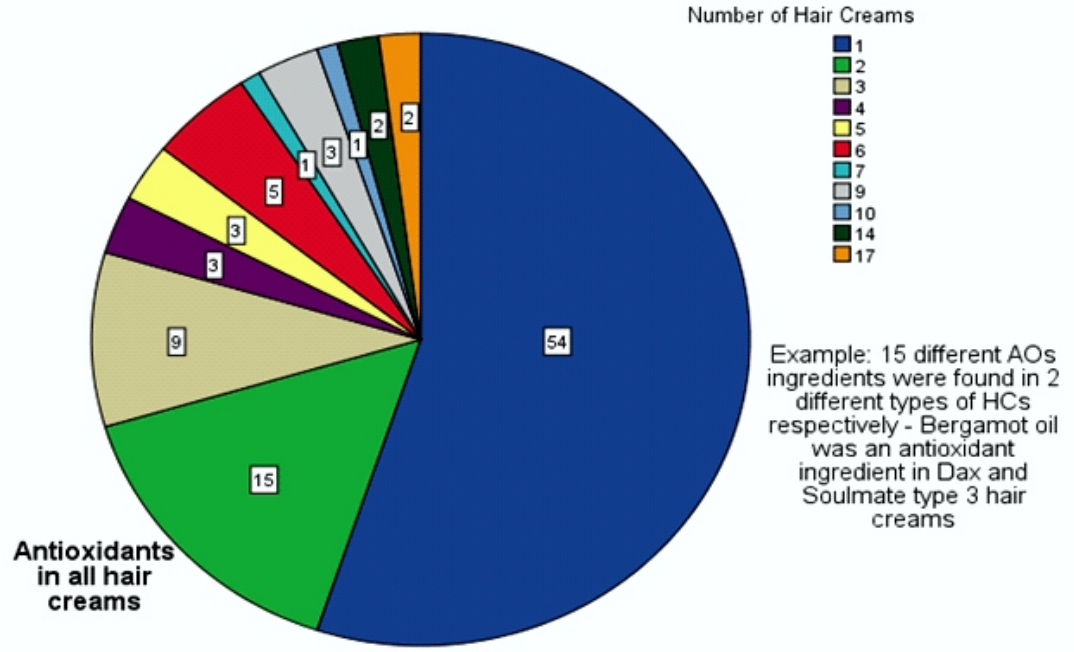

Figure 1: Frequency of all antioxidants in all hair creams: 54 out of 98 AOIs were found in only one HC type (47 types) for the blue colour segment. For the green colour segment, 15 out of the remaining AOIs were found in 2 different HCs.

visible, and infrared wavelengths affect hair colour, shine, mechanical properties, surface roughness, protein content, and growth.[14] Melanin is the only natural protection from free radicals produced by UV radiation on skin and hair.[15] External antioxidants that are either synthetic or natural compounds provide further AO protection from reactive oxygen species (ROS) from sunlight, pollution, and chemicals.

When assessing how many HCs contain each type of AO, two AOs occur in 17 HCs, while 54 AOs were each found in one HC. Many ingredients have intense AO activity. Shea butter and coconut oil are used as AOs in many HCs, even though they can be used as single-ingredient HC as they have many AO phytochemicals.

The AO content of each HC varies according to manufacturers' preferences. Consumers often cannot determine the exact phytochemical or synthetic ingredients required for their hair needs. The higher the AO content, the more beneficial the HC. One of the HCs has no antioxidant component, hence the need for examining the ingredients and regulating the contents of cosmetics by consumers and regulatory bodies, respectively.

Types of AOs in HCs in this environment vary widely from natural (primary) to purely synthetic compounds (secondary), and some occur in both forms. Natural antioxidants consist of plant-based (phytochemicals) antioxidants: Vitamins (mostly B, C, and E) and minerals (such as zinc, selenium, iron, manganese, and copper). The most common types are polyphenols, terpenes (such as carotenoids and essential oils), stilbenes (for example, resveratrol), flavanols, and flavonoids (for example, quercetin). Synthetic antioxidants are manufactured chemicals such as butylated hydroxytoluene (BHT), butylated hydroxy anisole (BHA), tertiary butylhydroquinone, nordihydroguaiaretic acid, propyl gallate, and different metal chelating agents.[16] Natural products are usually a complex mixture of compounds, although pure natural compounds like resveratrol can be used singly in a cosmetic formulation.

The extraction process can be complex, and total antioxidant activity (TAA) is difficult to estimate,[17] but they require fewer additives and have fewer side effects. Synthetic products mainly occur as single chemical products, resulting in low production costs, time effectiveness, good quality control, and stringent production regulations. However, the safety and efficacy of synthetic products have been a dilemma as their effects may be unpredictable. The result is that more than 80% of the people in developing countries depend on natural products due to their time-tested safety and efficacy.[18] Natural antioxidants have many synergistic roles in the body—a mineral antioxidant functions as a cofactor of enzymatic antioxidants. Vitamin C regulates collagen synthesis and prevents lipid peroxidation in the stratum corneum barrier, providing photo-protection with vitamin E.[19] The synthetic antioxidants neutralize free radicals and thereby terminate oxidative chain reactions.

Some AOIs, such as shea butter, are powerhouses of AOs. Shea butter contains many phytochemicals such as flavonoids, saponins, terpenoids, tannins, alkaloids, and cardiac glycosides that are beneficial as AOs to skin, hair, and other body systems.[20] The AO effects on hair and scalp, as seen by the ingredients in this study, are diverse. Panthenol, caffeine, and niacinamide increase total hair count by reducing hair shedding trans-epidermal water loss (TEWL), improving values of scalp biomarkers, and improving hair retention.[21, 22]

The most frequent AO types found in this study are:

Terpenes and terpenoids are the main bioactive compounds in essential oils that have potential applications as natural AOs in vast areas of human health. Terpenoids include limonene, carvacrol, citronellal, geraniol, linalool, linalyl acetate, piperine, menthol, and thymol.[23] Monoterpenes constitute a category of terpenoids called isoprenoids, frequently incorporated in many agricultural, cosmetic, food, and general antiseptic products.[24] Terpenes and terpenoids have diverse pharmacological properties, including antibacterial, antifungal, antioxidant, anticancer, vasorelaxant, hypotensive, and antispasmodic effects.[20] They were found in many HCs in this environment. Some of these of these are:

i. Camphor, though not commonly used in the HCs, is another powerhouse of AOs. *Cinnamomum camphora* (camphor tree) produces terpenoids consisting of four main chemotypes: linalool, eucalyptol, camphor, and borneol.[25]
ii. Citral has therapeutic properties such as antioxidant, anticancer, antimicrobial, anti-diabetic, and anti-inflammatory. It is one of the main components of lemongrass oil, which contains nerol, citronellal, geraniol, geranyl acetate, myrcene, terpinolene, and terpinol methylheptenone.[26]
iii. Linalool is an aromatic monoterpene alcohol in essential oils or chemically synthesized and widely used in perfumes, surfactants, emulsifiers, and cosmetics.[27, 28] it has anti-inflammatory, anticancer, antioxidant, antinociceptive, antiallergenic, and other systemic activities.[20,29,30,31]

Limonene is a monoterpene in many citrus fruits and essential oils. It increases tissue antioxidants like catalase and vitamin C.[20,27, 32]

Various oils are highly antioxidants and provide fatty acids that form ceramides, the stratum corneum's main barrier lipids.

i. Argan oil fatty acids - oleic and linoleic acid – stimulate hair growth and prevent protein loss. It has tocopherols, polyphenols (such as ferulic acid, catechol, and resorcinol), squalene, sterols, and triterpene alcohols, which protect against harmful hair cosmetics and UV damage.[33, 34]
ii. Almond oil– sweet almond oil (SAO) (*Prunus amygdalus dulcis* oil) contains high amounts of

lipids - both MUFA and PUFA, which are mainly oleic acid (about 86%), and linoleic acid (up to 30%), and saturated fatty acids primarily palmitic acids (about 9%) respectively.[35] Other minor components in almond oil include phenolic acids, flavonoids, proteins, triacylglycerides, sterols, vitamins E (mainly α-tocopherol) and K, squalene, and minerals such as magnesium.[36] SAO stimulates skin regeneration, reduces ageing effects on skin and hair, and maintains skin elasticity.[32] It is very suitable for all skin types and is often used in aromatherapy and massage therapy.

iii. Avocado oil is a rich source of unsaturated fatty acids (e.g., oleic, linoleic, and palmitic acid), acetogenins, phytosterols, phytostanols, chlorophylls, carotenoids, tocopherols, tocotrienols, phenolic compounds (e.g., stigmasterol), organic acids (e.g., citric and ascorbic) and sugars (e.g., sucrose and mannoheptulose). A pH of about 5.5 confers slight acidity similar to the skin pH and prevents bacterial and fungal growth in hair and scalp.[37] It prevents hair breakage, reduces dandruff, and detangles hair.[33]

iv. Castor oil is a non-oilseed product that is highly nutritious due to the abundant amount of monounsaturated fatty acid (MUFA) (90%) with some bioactive active compounds – tocopherols or tocotrienols, phenolics, and phospholipids. The MUFA are 90% ricinoleic, 1% stearic, 3% oleic, 4% linoleic, and less than 1% linolenic fatty acids.[38] The presence of tocopherols confers it with anti-inflammatory and anti-proliferative properties.[39] It stimulates hair growth and hair thickness.[40]

v. Canola oil is a vegetable oil made from the pressed seeds of rapeseed. It contains the highest amount of tocopherol after soya bean oil and corn oil, next to olive oil in oleic acid content, high in carotenoids, and intermediate among other plant-based oils in polyunsaturated fatty acid (PUFA).[41] It is used in hair treatments as an excellent remedy for hair dryness, as a moisturizer, and to prevent split ends and frizzy hair.[31]

vi. Jojoba oil (JJO) consists of straight-chain esters of MUFA and long-chain primary fatty alcohols. Oleic acid and 11-eicosenoicacid are predominant. JJO is currently known as 'liquid wax', which constitutes approximately 40%–60% of jojoba seeds.[42] The liquid wax is a high-carbon ester of fatty acids with sebum-like qualities that can decrease trans-epidermal water loss (TEWL) and enhance SC moisturization.

vii. Olive oil contains olein, linolein, palmitin and arachin.[43] Others are sterols, triterpenic oils, carotenoids, flavonoids, phenolic compounds, lignans, and secoiridoid.[39] It prevents hair dryness as an emollient and has antiaging, UV protection, and antifungal properties.[39] Dermatologists use it to treat scalp psoriasis due to its antioxidant contents and the effect of hydroxytyrosol in stimulating apoptosis and inhibiting cellular proliferation.[39] The antioxidant activity results from active compounds belonging to the three phenolic compounds, secoiridoids, and lignans.[44]

viii. Peppermint oil (PEO) (*Mentha piperita L.*) comprises menthol, menthone, methyl acetate, limonene, and other ingredients. Peppermint oil promotes faster hair growth than jojoba oil and minoxidil.[41] It increases dermal thickness, follicle number, and follicular depth more than minoxidil.[41] Peppermint oil has antiviral, antibacterial, antifungal, anti-inflammatory, antiallergenic, antitumor, and antioxidant activities with anaesthetic properties that relieve skin discomfort.

ix. Rosemary oil (*Rosmarinus officinalis*) comprises borneol, α-pinene, camphor, verbenone, and cineole.[42]Benefits include stimulating blood flow in the hair follicle, antioxidant, antibacterial, antiphlogistic action, antimutagenic, cytotoxic, and chemo-preventive in traditional medicine and as cosmetical. Epileptic patients, pregnant, primary hypertensive, and diabetic individuals should avoid the use of Rosemary oil.[42,]

x. Tea tree oil (*Melaleuca alternifolia*) components include terpinene-4-ol, delta-terpinene, cineole, alpha-terpineol, linalool, terpinolene, alpha-pinene, beta-pinene alpha-terpinene, and p-cymene.[42] It has anti-inflammatory, antifungal, antibacterial, and anticancer activity. Tea tree oil reduces alpha-tumor necrosis factor production. Hence, many topical formulations for treating cutaneous infections incorporate tea tree oil as

Table 2: Hair cream types, gender distribution of HC usage by likelihood ratio, and AOIs of HCs in percentages

Hair creams (HCs) with antioxidant ingredients	Column a: Gender differences in the use of HC Likelihood Ratio = 66.471 df=46 p = 0.026				Column b: HC ingredients (HCI) and *AOI presence in HC		
	Male	Female	Total HC	Percent (Total HC/113x100%) [Chi square χ^2; p value]	AOI	HCI	Percent (%) (AOI/HCI x 100)
Sporting waves	0	1	1	0.9 [1.004; p = 0.316]	7	13	53.8
Hair Wonder	0	7	7	6.2 [7.224; p = 0.007]	20	21	95.2
TCB naturals	2	3	5	4.4 [0.205; p = 0.651]	11	16	68.2
Toke carrot shea butter	0	1	1	0.9 [1.004; p = 0.316]	4	5	80.0
Mega growth type 1	0	1	1	0.9 [1.004; p = 0.316]	7	13	53.8
Mega growth type 2	0	1	1	0.9 [1.004; p = 0.316]	11	13	84.6
Apple HC	0	1	1	0.9 [1.004; p = 0.316]	5	12	41.7
Family care	0	1	1	0.9 [1.004; p = 0.316]	2	5	40.0
MEDIRIT-3	1	8	9	8.0 [5.670; p = 0.017]	4	9	44.4
Sulphur 8	1	0	1	0.9 [1.004; p = 0.316]	12	17	70.6
Dax	0	1	1	0.9 [1.004; p = 0.316]	4	7	57.1
Dallas	2	2	4	3.5 [0.000; p = 1.000]	3	9	33.3
Mega Growth Break Face	1	1	2	1.8 [0.000; p = 1.000]	3	3	100.0
Mega Growth Type 3	0	1	1	0.9 [1.004; p = 0.316]	7	14	50.0
Afro black	1	0	1	0.9 [1.004; p = 0.316]	9	10	90.0
Cindy Crystar Herbal	0	2	2	1.8 [2.018; p = 0.155]	4	7	57.1
Hair monitor	0	4	4	3.5 [4.072; p = 0.044]	9	16	56.3
Sporting Black Magic	1	0	1	0.9 [1.004; p = 0.316]	1	4	25.0
MSM	1	1	2	1.8 [0.000; p = 1.000]	5	9	55.6
Penduline	1	0	1	0.9 [1.004; p = 0.316]	6	6	100.0
Apple hair food	0	2	2	1.8 [2.018; p = 0.155]	4	11	36.4
Shea butter	0	4	4	3.5 [1.004; p = 0.316]	1	1	100.0
Dermatol	2	2	4	3.5 [1.004; p = 0.316]	6	9	66.6
Cacatin type 2	0	1	1	0.9 [1.004; p = 0.316]	3	5	60.0
Hair Wonder type 2	0	2	2	1.8 [2.018; p = 0.155]	4	6	66.7
Natural coconut oil	0	2	2	1.8 [2.018; p = 0.155]	1	1	100.0
White secret	1	0	1	0.9 [1.004; p = 0.316]	5	11	45.5
Eco style	1	0	1	0.9 [1.004; p = 0.316]	7	13	53.8
Oriflame hair conditioner	0	1	1	0.9 [1.004; p = 0.316]	13	16	81.3
Homemade oil	0	1	1	0.9 [1.004; p = 0.316]	4	4	100.0
Wonder grow Indian hemp	0	2	2	1.8 [2.018; p = 0.155]	8	10	80.0
Coconut oil base cream	1	0	1	0.9 [1.004; p = 0.316]	3	5	60.0
Garrby hair cream	0	1	1	0.9 [1.004; p = 0.316]	7	15	46.7
So fine type 1	0	1	1	0.9 [1.004; p = 0.316]	2	9	22.2
Parachute Advanced Female	0	1	1	0.9 [1.004; p = 0.316]	4	5	80.0
Soulmate Type 3	0	1	1	0.9 [1.004; p = 0.316]	5	10	50.0
Viroz	1	0	1	0.9 [1.004; p = 0.316]	6	14	42.9
Natural hair growth oil	0	1	1	0.9 [1.004; p = 0.316]	7	7	100.0
Afro American Hair	0	2	2	1.8 [2.018; p = 0.155]	0	3	0.0
Brylcrum hair	0	1	1	0.9 [1.004; p = 0.316]	9	14	64.3
Natural field magical growth	0	1	1	0.9 [1.004; p = 0.316]	9	14	64.3
Ustraa hair	0	1	1	0.9 [1.004; p = 0.316]	6	6	100.0
Vaseline	0	1	1	0.9 [1.004; p = 0.316]	1	3	33.3
Soulmate type 1	4	6	10	8.8 [0.419; p = 0.518]	8	12	66.6
Petals	0	2	2	1.8 [2.018; p = 0.155]	4	6	66.6
Soulmate type 2	3	2	5	4.4 [0.311; p = 0.577]	9	13	69.2
So fine type 2	9	6	15	13.3 [0.643; p = 0.423]	6	11	54.5
Total of gender	33	80	113	100			
Number of hair cream types	17	39	47				

Table 3: Antioxidant components of all hair creams

Names and Types of Antioxidant ingredients (AOIs) on labels (total AOIs = 98)	Number of HCs in which AOI is found [a*]	Percentage of HCs containing AOI [b* (%)]	Percentage of a particular AOI among all AOIs [c* (%)]
Natural types			
Alpha-hydroxy acids (AHA), Amla oil Aspartic acid, Black seed oil, Brassicamidopropyl dimethylamine, Capric triglyceride, Cedarwood oil, Centella asiatica, Cinnamal, Citronellol, Coconut oil, Coffee bean, Coumarin, Cypress oil, Elcipta alba, Eugenol, Flax, Garlic, Germ protein, Ginger, Hemp seed oil, Honey, Lavender, Hemp Leaf oil, Lemon grass, Methane, Milk protein, Mint leaves, Moringa oleifera, Nutrilan, Onion extract, Hydrolyzed conchiolin protein, Purpurogallin, Prunus amygdalus, Rapeseed oil, Seed oil – Hemp, Soy protein, White powder (hemp), Zingiber officiale	1	2.12	0.36
Bergamot oil, Carrot oil, Geraniol, Herbs and herb extract, Indian hemp, Neem, Palm kernel oil (PKO), Panthenol, Pahax ginseng, Tea tree oil, Triticum vulgare – wheat	2	4.25	0.72
Argan oil, Avocado butter or oil, Cinnamal – hexylcinnamal, Dulcis oil, Polysorbates Sunflower oil	3	6.38	1.09
Rosemary oil, Soya oil, Wheat protein	4	8.51	1.45
Aloe barbadensis, Linalool, Limonene	5	10.63	1.82
Almond oil, Jojoba oil	6	12.76	2.19
Peppermint oil	7	14.89	2.55
Olive oil, Sulphur, Vitamin E & others	9	19.14	3.28
Castor oil	10	21.27	3.64
Shea butter – B. parkii	14	29.79	5.10
Coconut milk protein	17	36.2	6.20
Synthetic types			
Benzoate, Calcium hydroxide, Disodium EDTA, Hydroxyethyl-cellulose, Piroctone olamine, Sodium benzoate, Tetrasodium EDTA, Triethanolamine	1	2.12	0.36
Paraben, Propylene glycol	6	12.76	2.19
Both natural and synthetic types			
Alcohol – stearyl alcohol, Behenic acid, Benzoic acid, Butylated hydroxytoluene (BHT), Ethanol, Isopropyl palmitate, Methylsalicylate	1	2.12	0.36
Acetate, Benzyl alcohol, Camphor, Phenoxyethanol	2	4.25	0.72
Citral, Glycine, Placenta	3	6.38	1.09
Glycerin	6	12.76	2.19
Menthol	14	29.79	5.10
Mineral oil	17	36.2	6.20

z = Sum of all a* = 274; N = natural AOI; S = synthetic AOI; B = both natural and synthetic AOI

an active ingredient.[42]

xi. Sunflower oil, amla oil, fenugreek oil, *Pelargonium graveolens* (Geranium oil), *Lavandula angustifolia* (Lavender oil), *Matricaria chamomilla L.* (Chamomile oil), *Citrus bergamia* (Bergamot oil), *Eucalyptus globulus* (Eucalyptus oil) are other common essential oils often incorporated into HCs.[42]

The prevalence of an AO was shown by the percentages of HCs that used the AOI - Table 3 (column b*). The topmost are coconut milk protein, mineral oil, menthol, shea butter, castor oil, vitamins, olive oil, and Sulphur.

i. Mineral oil (MO) was one of the most common ingredients in all the HCs. It is a colourless, odourless oil derived from crude oil at a low cost of production with low toxicity and a high production volume compared to vegetable oils.[49] Some synonyms are paraffin, paraffin wax, liquid petrolatum, liquid paraffin, paraffin oil, white MO, white oil, paraffinum liquidum, heavy MO, and light MO.[45] There are two types – the crude industrial grade MO and the refined food grade MO used in food and pharmaceutical industries, and for cosmetics.[50] The refined food grade MO type has antioxidant activities.[51] Mineral oil mainly has physical effects on the skin and hair. Its moisturizing efficacy occurs through the occlusivity of the stratum corneum, which results in many beneficial biological effects.[45] Its use in cosmetics varies from moisturizer to a protectant, binder, extender, and pharmaceutical vehicle.[45] MO is mainly hydrocarbons without any affinity for proteins. As a result, it cannot penetrate the hair and prevent protein loss from the hair, unlike coconut oil.[52]

ii. Coconut oil is an edible oil from the seed of coconut trees.[53] It is principally a triglyceride of lauric acid with a low molecular weight and a straight linear chain.[48] Reye et al.[48] reported that this attribute enables the oil to penetrate the hair shaft, reducing protein loss remarkably when used as a pre-wash and post-wash grooming product for undamaged and damaged hair. Coconut milk is an aqueous extract of coconut's solid endosperm (kernel).[54] It contains vitamins (B1, B3, B5, C, E), minerals (iron, calcium, sodium, magnesium, selenium, phosphorus, and magnesium stearate), proteins including sulphur-containing cysteine, and fatty acids (mainly lauric, myristic, and palmitic acids), and phenolic compounds.[55] Coconut oil and milk reduce hair dryness, flakes, and frizzy hair and stimulate hair growth[51] Lauric acid, the highest fatty acid component, strengthens the cuticle and works as an antiviral, antibacterial, and anti-inflammatory agent.[51]

iii. Shea butter has anti-inflammatory properties.[56] It mainly consists of triterpene alcohols –fatty acids (primarily stearic oleic with small amounts of linoleic, palmitic, and arachidic) attached to glycerol backbone. It also contains hydrocarbons, sterols, and other minor components such as amino acids (it has 17 amino acids, which include asparagine, threonine, serine, glutamine, proline, glycine, cysteine), minerals (calcium, potassium, magnesium, manganese, sodium, phosphorus, copper, iron, zinc), and vitamins (A, B, C, E and F).[52]

iv. Sulphur (S) is the fourth major plant nutrient (nitrogen, phosphorus and potassium are the first three).[57] Cysteine and methionine - amino acids containing Sulphur (SAAs) are significant human sources. Others are thiamine (produced only in plants), biotin, glucosinolates, glutathione, and alliin/allicin, all from plant sources. Cysteine and methionine are needed for keratin and collagen synthesis, while methionine prevents hydrogen peroxide accumulation in hair follicles. Glutathione (GSH) is a potent detoxifier of ROS and peroxides and is involved in inflammatory processes through prostaglandins (PGS) synthesis.

v. Parabens are derived from para-hydroxybenzoic acid (PHBA) and are found naturally in fruits and vegetables, such as blueberries, cherries, cucumbers, carrots, and onions. They function as antioxidants that preserve ingredients in hair creams and other cosmetics, personal hygiene products, pharmaceuticals and food products.[58] These chemicals are considered safe in levels up to 25%, and the most common types are Butyl-, propyl-, methyl-, ethyl-, isopropyl-, and isobutyl

paraben.[59] Parabens increase AO enzymes such as superoxide dismutase, glutathione peroxidase, and glutathione reductase,[60]

vi. Aloe vera contains amino acids, saccharides, vitamins, minerals, enzymes (such as cyclooxygenase, lipoxygenase, and carboxypeptidase), salicylic acids, saponins, lignins, anthraquinones, and isoprenoids (like terpenes, phytosterols steroids, and carotenoids).[61] The AO and anti-inflammatory function occurs through enzyme activities, inhibition of transcription factors activities, and prevention of prostaglandin E2 synthesis from arachidonic acid.[57] The juice has photo-absorbent properties with maximum absorption around 294 nm^3, and aloin has a sunscreen effect that blocks 20-30% UV radiations from the sun.[62] These effects are more with fresh juice than processed aloe vera juice.[58]

vii. Glycerin (Glycerol, 1,2,3-Propantriol, or Glycerin ester) is produced synthetically or as a by-product from biodiesel or obtained naturally in fermented foods and beverages, such as beer, wine, honey, and vinegar.[63] It functions in HCs and other cosmetics mainly as a denaturant, humectant, fragrance, viscosity-decreasing agent, and hair and skin conditioning agent.[64]

viii. Propylene glycol (PG) is an aliphatic alcohol with several derivatives – dipropylene, tripropylene and polypropylene glycols. It is non-toxic, non-carcinogenic, and derived from petroleum and plants (soybeans and canola oil). Propylene glycol is a skin and hair antioxidant, viscosity-decreasing agent, humectant, and solvent for other ingredients, fragrances, and emulsion stabilizers (tripropylene glycol).[65]

ix. Among the ten most common AOs preferred by producers of HCs were vitamins A, C, and E and some minerals. These are either added directly or as components of other ingredients, such as essential oils. Vitamins and minerals used in cosmetics are diverse. The most common are vitamins A, B (such as folate, B12, and biotin), C, D, and E, and the minerals iron, zinc and selenium.[66]

Micronutrients are critical elements in the cellular turnover of the hair bulb's matrix cells, ensuring the formation of normal hair follicles. These provide exogenous protection against solar UV radiation effects in a hot climate region, reducing hair damage and greying. There are supportive studies of the use of vitamin and mineral supplementations for treating alopecia. Iron, Vitamins C, and D help treat androgenetic alopecia (AGA) and telogen effluvium (TE).[62] Supplements and products with iron, folate, selenium, vitamin D, and B12 can improve premature greying.[67] Conversely, excess vitamin A (through retinoid treatments or supplements) and selenium can result in alopecia.[63]

Vitamin A can be present in hair creams as carotenoids from plant sources and as preformed vitamin A from animal sources.[68] Carotenoids produce pigmentation in animals, plants, and microorganisms with high antioxidant activity.[64] Retinoic acid (RA) also regulates hair follicle stem cells (HFSCs) by activating retinoic acid receptors (RARs) and retinoid X receptors (RXRs).[63] These are nuclear transcription factors, potent regulators of the cell cycle, cellular differentiation, proliferation, and apoptosis.[63] Vitamin E is well accepted as nature's most effective lipid-soluble, chain-breaking antioxidant, protecting cell membranes from free-radical mediated peroxidative damage.[69] The main action is to terminate the chain reaction of lipid peroxidation.[70] Vitamin E consists of tocopherols and tocotrienols. The most common form is α-Tocopherol, a peroxyl radical scavenger that protects polyunsaturated fatty acids in membranes and lipoproteins.[71] Cereals, nuts, seeds, greens, and vegetable oils are major sources.[72]

Conclusion

Many hair creams have antioxidants, while one lacks these beneficial components, predisposing consumers to the harmful effects of UV radiation from the sun and ageing. Significant variations of hair cream types exist within the female gender, showing that females use a diverse range. Manufacturers frequently use naturally occurring antioxidants. There were 98 antioxidants comprising 22-100% of the components in hair creams. The ten most commonly used are mineral oil, coconut milk

protein, shea butter, menthol, castor oil, olive oil, vitamins A, C, and E, Sulphur, peppermint, and almond oil.

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