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The Frequency Ranking of Occurrence of Individual Ingredients in Hair Care Cosmetics Available on the Polish Market

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Abstract: The Polish market of cosmetics is highly rich in different types of hair care preparations. A great number of Polish and foreign cosmetic companies and brands mean that finding care products ideal for a given person should be trouble-free. Unfortunately, a wide selection is both an advantage and a problem when a customer is doubtful about how a given cosmetic can work and what an individual's hair really needs. Reading the composition of cosmetics, the potential user can recognize the needs of their skin or hair, which affects taking more conscious care and choosing the right cosmetics with more attention. This article assesses which ingredients and types of ingredients are present in the largest number of preparations and in the highest positions in the composition. This is a comparison of ingredients present in the largest amounts between four groups of hair cosmetics: care products with washing properties (shampoos), care products without washing properties (conditioners), preparations that are aqueous solutions (water cosmetics), and preparations that are not aqueous solutions (waterless cosmetics). It was revealed that the vast majority of all high-ranking ingredients are substances responsible for the functionality of hair cosmetics: surfactants, rheology regulators, substances responsible for foaming properties, emulsifiers, and solvents. The huge number of substances that can be used in hair products imposes the fact that the ingredients of the highest rank will be substances with many applications and, at the same time, are those that form the base of the cosmetic.

Keywords: shampoos; conditioners; components ranking; hair care cosmetics; composition evaluation; hair growth; hair treatment; statistics

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1. Introduction

According to Cosmetics Europe's 2020 analysis [1] and Polish Investment & Trade Agency 2023 [2], Europe is the world's largest market for personal care and beauty products that classified as Beauty and Personal Care. Its value exceeds EUR 76.5 billion. According to the data of the Polish Investment & Trade Agency 2023, a European association that represents more than 4000 companies and national associations operating in the cosmetics industry, the sales value of cosmetics and beauty products in Poland is over EUR 6.5 billion, which ranks Poland in the 5th position in Europe, behind Germany (EUR 14 billion), France (EUR 11.5 billion), Great Britain (EUR 9.8 billion), Italy (EUR 9.7 billion), and Spain (EUR 6.4 billion). In 2022, the cosmetics market in Poland has grown by 2.2% y/y to EUR 4 billion, while it is expected to grow at a ±5.5% average annual rate between 2022 and 2026.

The change in customer preferences cause manufacturers not only in Poland but also in the whole of Europe to look for natural raw materials for the manufacture of cosmetics [3]. When international cosmetics companies appeared on the Polish market at the beginning of the 1990s, local manufacturers, wanting to stay in the game, had to invest in new technologies, research departments, and staff development. Over time, this has translated

into a higher quality of cosmetics, and the position of Polish manufacturers has strengthened despite strong competition from global brands, which is a unique phenomenon on a European scale.

The Polish market of cosmetics is extremely rich in hair care products [4]. A multitude of Polish and foreign companies, brands available in most stores and drugstores, both stationary and online, exclusive brands sold in selected drugstore chains or only in company stores or by hairdressers, and finally medicinal shampoos or shampoos for skin and hair with special needs (so-called "pharmacy" shampoos), are available in pharmacies; all of this means that finding cosmetics ideal for a given person should be trouble-free. Unfortunately, a wide selection is both an advantage and a problem when clients have no idea how a given cosmetic can work and what a person's hair really needs.

Reading the composition of cosmetics, the potential user can recognize the needs of their skin or hair, which affects taking more conscious care and choosing the right cosmetics with more attention. The INCI composition (the International Nomenclature of Cosmetic Ingredients) is a legally regulated list of substances that a given product contains [5,6]. The INCI gives the first insight into what kind of cosmetic we are dealing with. However, there is no information about the percentage of individual substances in the cosmetic. Some manufacturers give a percentage composition, but this is rare.

In order to learn the correct hair care ritual, it is worth getting information about professional comprehensive hair care used in cosmetic trichology [7–11]. Such care consists of:

- preventive treatments,
- scalp cleansing treatments,
- hair follicle stimulating treatments,
- conditioning treatments,
- regenerating treatments,
- anti-aging treatments,
- protective treatments.

Prevention includes the use of cosmetics tailored to our needs and to the condition of the scalp and hair. It is designed to protect the hair and maintain the effects of professional treatments.

Scalp cleansing should be understood as regular scalp scrubs and the use of shampoos that thoroughly cleanse the skin and hair without causing dryness or irritation [12]. Stimulation with preparations, massages, or apparatus treatments is used to increase blood flow within the hairy scalp, which will ensure its better nutrition and more efficient removal of unnecessary metabolic products. Both of these aspects will help keep hair in good condition [13,14].

Conditioning provides an immediate but short-term smoothing effect by closing the scales, and facilitates combing, so it is an essential element of comprehensive care. Even the best conditioning and regenerating treatment, combined with all the previous treatments, will not give long-term effects if each time while combing, the hair scales will break or the whole hair will break [7].

Regenerating treatments are essential in keeping the hair shafts in good condition. New, undamaged cells are formed in the follicles; however, when they leave the hair follicle, the dead parts of the hair are constantly exposed to a number of unfavorable factors, which means that they are constantly damaged to a greater or lesser extent.

Anti-aging care of the scalp and hair is an element that is still not very popular and rarely considered even among people who follow the idea of conscious care. This care is primarily to slow down the unfavorable mechanisms occurring in the skin and hair follicles, and at the same time support the proper course of beneficial mechanisms.

The last element is protective treatments applied to both hair and scalp, including protection against hairdressing chemicals, protection against ultraviolet radiation, environmental pollution, and color protection.

All the above elements of care overlap and when using one type of treatment, to some extent, another is involuntarily used. Nevertheless, it is worth being aware of all the above

elements to be able to design the hair care plan in a way that will implement all the above assumptions in the most comprehensive and compressed version that is possible [15].

The aim of this paper is to analyze the frequency of occurrence of ingredients that are used in the production of hair care products in the greatest amount; in other words, it is to assess which ingredients and types of ingredients are present in the largest number of preparations and in the highest positions in the composition. This is a comparison of ingredients present in the largest amounts between four groups of hair cosmetics: care products with washing properties (shampoos), care products without washing properties (conditioners), preparations that are aqueous solutions (water cosmetics), and preparations that are not aqueous solutions (waterless cosmetics).

2. Materials and Methods

The subject of analysis in this work were the compositions of 200 hair care products available on the Polish market, both stationary and online. The products were selected randomly. Information about their compositions was taken from the list of ingredients placed directly on the packaging of these cosmetics. The products were selected at random, but in such a way as to collect 100 shampoos and 100 non-shampoo care products. Styling products such as mousses, gels, hairsprays, and hair dyes were excluded from the analysis. The possible lack of other hair care products is a coincidence resulting from the random selection of the analyzed products.

The data collected for the purposes of this paper were compiled by grouping as follows:

1. A table was created collecting all 200 products along with their full list of ingredients, which were written down from the labels of the analyzed products;

2. All ingredients present in products with water (aqua) in the first place are grouped in one table, and in the second table-ingredients present in other products (i.e., those that are not aqueous solutions). These data were compiled using the ranking method described exactly below;

3. Separated into two different tables: ingredients present in shampoo products and broadly understood hair care, in this work referred to as conditioners. These data were compiled using the ranking method;

4. For the purposes of these tables, the first ten items in the list of ingredients of the 200 products analyzed were looked at in detail. In order to be able to carry out a qualitative and quantitative analysis, numerical values had to be obtained that reflected not only the frequency of a given ingredient, but also how high it was in the composition. These values were obtained after applying the ranking method—each substance's number of appearances in a specific location within the composition was tallied, and the total of these repeats was then multiplied by the coefficient relevant to that location. The values for the first ten ingredients in the composition were then summed for each component, yielding the eleventh value presented in tables, which represents the component's overall value or sum of rank;

5. The method of calculating the value of individual components is described in the formulas below:

W_{PC}—coefficient that (taking into account only the first ten positions) should be used to multiply the total number of times a specific ingredient appears in a given location in the composition list.

$$W_{PC} = 10 - (PC - 1)$$

PC—the position of the specified ingredient in the composition list (1–10)
NO_{PC}—the number of repetitions (occurrences) of a given ingredient at a given place in the composition list
R_{PC}—the rank of the ingredient on a given place (1–10) in the composition list

$$R_{PC} = NO_{PC} \times W_{PC}$$

Sum of ranks = ΣR_{PC}

R1—the rank of the ingredient in the first place in the composition list
R[..]—the rank of ingredients in places from the second to the ninth in the composition list
R10—the rank of the tenth ingredient in the composition list

$$NO_{10} \times 1 \sum_{PC=1}^{10} R_{PC}$$

These formulas show that if, e.g., butane appears 11 times in the first place in the composition, then it has a rank of 110 in that place ($11 \times (10 - (1 - 1)) = 110$). Since it does not appear in positions 2–10 in the compositions, its total rank is also 110. In turn, e.g., propane appears 4 times in position 2 ($4 \times (10 - (2 - 1)) = 36$) and 7 times in position 3 ($7 \times (10 - (3 - 1)) = 56$), which gives it a rank of 36 in position 2, a rank of 56 in position 3, and an overall rank of 92.

Comparing the total ranks allows us to determine which ingredients are the most important ingredients in hair care products, which ingredients are present most often, and/or in the largest amounts in formulas.

The described method of ranking was used to assess all ingredients appearing in the first ten items of composition of all 200 products. Then, they were divided according to the parameters described in points 3 and 4 and arranged in the appropriate tables according to the decreasing overall rank. Twenty-five substances from the top of each table were selected for detailed analysis, obtaining twenty-five substances with the highest overall ranks from each of the considering categories.

3. Results and Discussion

Generally, for the purposes of this study, the compositions of total 200 hair care products were analyzed. Each cosmetic preparate consisted of at least 1 ingredient. The highest number of ingredients in the analyzed products was 51 substances, and the average was 23. Half of the analyzed products consisted of 22 substances or less. Among the tested products, the composition most often consisted of 19 items. 25% Of the products analyzed consisted of 17 or fewer substances, and 25% had no fewer than 28 ingredients.

Among the hair care products mentioned above, 100 "Soap-like products" were analyzed, which consisted of at least 10 and a maximum of 51 ingredients. On average, "Soap-like products" consisted of 23 ingredients, with half of the analyzed Soaps consisting of 22 or less. Most often, the composition of "Soap-like products" consisted of 22 items, 25% of the analyzed "Soap-like products" consisted of 18 or less substances, and 25% had 28 or more ingredients. It follows that "Soap-like products" are more complex products that require the use of many substances to ensure their good functional properties.

The second group is "Conditioners". 100 Products from this group were analyzed, which consisted of the least 1 and the most of 44 ingredients. Each of the "Conditioners" tested consisted of an average of 22 substances, with half of them containing 20 or less. Among the surveyed "Conditioners", the composition most often consisted of 19 items, with 25% of "Conditioners" consisting of 15 or less substances, and 25% of 28 or more. From these data, it can be concluded that both single substances and complex products can be used as "Conditioners". All above statistics are summarized in Table 1.

Table 1. Statistics of the analyzed products.

Statistical Measure	"Soap-like Products"	"Conditioners"	All Products
Number	100	100	200
Min. number of ingredients	10	1	1
Max. number of ingredients	51	44	51
Arithmetic average	23	22	23
Median	22	20	22
Dominant	22	19	19
First quartile	18	15	17
Fourth quartile	28	28	28

Among the analyzed products, the largest group were traditional shampoos with water solutions, constituting 33% of all analyzed cosmetics. The second most common group was conditioners, which accounted for 19% of the analyzed products, followed by hair masks with a score of 11%. The least common groups of products with a score of 1% were balms and hair rubs from the "Conditioners" group and pharmacy shampoos from the "Soap-like products" group with a score of 2%. These data are summarized in Table 2.

Table 2. List of analyzed products, divided into product types.

Product		Number of Products	Percent of the Total
"Soap-like products"	Shampoo	65	33%
	Dry shampoo	12	6%
	Shampoo in the bar	10	5%
	X in 1	10	5%
	Pharmaceutical shampoo	3	2%
"Conditioners"	Conditioner	37	19%
	Mask	21	11%
	Oil	15	8%
	Hair serum	11	6%
	Leave-in conditioner	8	4%
	Spray conditioner	4	2%
	Balm	2	1%
	Rubbing conditioner	2	1%

The vast majority of all high-ranking ingredients are substances responsible for the functionality of hair cosmetics: surfactants (surface active agents), rheology regulators, substances responsible for foaming properties, emulsifiers, and solvents that enable the combination of ingredients into one product. Many of the substances included in the tables are emollients, and therefore the most important element of PEH (proteins, emollients, humectants) balance, which nourishes and protects the hair. At the same time, these emollients have a positive effect on the application properties of the cosmetic or have other useful properties. The tables also include many humectants, which, like emollients, are an element of PEH balance and have a positive effect on the cosmetic formula, e.g., prevent it from drying out or have a protective effect. Contrary to these two groups, ingredients classified as proteins according to PEH do not have such beneficial effects on the cosmetic formula, which explains the absence of this group in Tables 3–7.

The huge number of substances that can be used in hair products imposes the fact that the ingredients of the highest rank will be substances with many applications and at the same time those that form the base of the cosmetic. The fact that the tables include ingredients with nutritional properties is related to their wide application or particular usefulness in the production of a given type of cosmetics, e.g., shea butter used as a base for the production of shampoo bars.

The high rank of fragrance compounds collected under the common name of parfum might seem alarming, but the composition of parfum does not include fragrance compounds considered potentially allergenic, such as: benzyl salicylate, citronellol, geraniol, hexyl cinnamal*, limonene, linalool, or alpha-isomethyl ionone*, which must be listed separately in the composition (*when the concentration exceeds: 0.001% in a leave-on product or 0.01% in a rinse-off product). Therefore, under the word "parfum" there are substances that are not considered (potentially) particularly allergenic. The high rank of parfum fragrances is striking for another reason—insufficient information about the exact proportions of the ingredients of a given hair cosmetic and the awareness of its main purpose lead to the assumption that everything that comes after parfum is present in the preparation in trace amounts. And while in most of the analyzed cosmetics, it was actually

the last or one of the last ingredients, there were a few products where parfum was in the middle of the composition. Such location of this ingredient leads to the conclusion that the product not only does not have very good care properties, but also may prove to be highly irritating, especially for people sensitive to intense fragrances. Of course, as it has been emphasized several times, cosmetics composed of less than 10 ingredients were also analyzed, but their percentage is so small that parfum should be placed at least at the end of each table, especially water cosmetics and conditioners, because in shampoos and anhydrous cosmetics, dry shampoos with relatively short ingredients are responsible for the high rank of parfum.

The highest position among compound with washing properties (4th position in Table 7) has sodium laureth sulfate (SLES). It is an ingredient of almost every cosmetic intended for washing the face, body, and hair. It is said that this substance has a very negative effect on the skin. SLES belongs to the group of surfactants. In contact with the skin, it removes particles of dirt and impurities from its surface. Unfortunately, surfactants also remove lipids (fats)-necessary for the proper functioning of the skin. As a result of their action, the pH of the skin also changes from acidic to alkaline. As a result, the barrier function of the skin deteriorates. It becomes dry, rough, and prone to irritation. That is why it is so important to use a care cosmetic after each bath that will replenish lipid deficiencies.

However, there are reasons why its presence in cosmetics is justified. This component has very good washing and foaming properties. In addition, it is not an expensive raw material-that's why manufacturers willingly use it in their preparations. Fortunately, high places are occupied by protective ingredients-cetearyl alcohol (3rd position) and glycerin (5th position). Cetearyl alcohol is one of the most important representatives of good alcohols, improving the level of hydration and protecting against its loss. It is a natural emulsifier-a substance obtained from plants, e.g., from palm or coconut oil. It is created in the process of combining cetyl and stearyl alcohols, which also belong to the group of moisturizing fatty alcohols. Also, glycerin is an ingredient commonly used in cosmetics. It has, above all, a moisturizing and occlusive effect. Strengthens the protective barrier and prevents water from escaping from the epidermis.

4. Summary of All Products

Tables 3–7 should be analyzed based on the ranking system described in detail in Section 2. In short, the numbers obtained for each ingredient are the product of the number of occurrences (number of repetitions) of that ingredient in a given position (NO_{PC}) and the coefficient W_{PC} assigned to the position PC, as explained in Section 2, results in the rank of the ingredient in each position:

1. Position 1. $R_{PC} = NO_1 \times 10$
2. Position 2. $R_{PC} = NO_2 \times 10$
3. Position 3. $R_{PC} = NO_3 \times 10$
4. Position 4. $R_{PC} = NO_4 \times 10$
5. Position 5. $R_{PC} = NO_5 \times 10$
6. Position 6. $R_{PC} = NO_6 \times 10$
7. Position 7. $R_{PC} = NO_7 \times 10$
8. Position 8. $R_{PC} = NO_8 \times 10$
9. Position 9. $R_{PC} = NO_9 \times 10$
10. Position 10. $R_{PC} = NO_{10} \times 10$

$$NO_{10} \times 1 \sum_{PC=1}^{10} R_{PC}$$

Table 3 presents the ranks for all products:

Table 3. Ranks for all products—a list of the 25 ingredients most frequently found in the first 10 places in the composition of all analyzed hair care products (200).

No	Ingredient	Ranks for Substances										Sum of Ranks
		1	2	3	4	5	6	7	8	9	10	
1	*Aqua*	1550	0	8	7	18	15	8	0	6	1	**1613**
2	*Cocamidopropyl Betaine*	0	36	304	105	48	10	4	6	2	1	**516**
3	*Cetearyl Alcohol*	0	405	56	21	18	0	4	3	0	1	**508**
4	*Glycerin*	0	63	152	126	78	15	20	3	4	2	**463**
5	*Sodium Laureth Sulfate (SLES)*	0	414	48	0	0	0	0	0	0	0	**462**
6	*Parfum*	0	0	0	14	42	90	52	24	34	6	**262**
7	*Sodium Chloride*	0	0	32	98	72	30	12	6	0	1	**251**
8	*Cetrimonium Chloride*	0	0	88	14	24	20	24	12	4	6	**192**
9	*Cyclopentasiloxane*	110	9	0	21	12	10	12	0	0	0	**174**
10	-	0	27	24	21	18	15	16	15	14	7	**157**
11	*Alcohol Denat.*	0	63	16	28	36	5	4	0	0	0	**152**
12	*Behentrimonium Chloride*	0	0	56	49	24	0	8	3	2	0	**142**
13	*Panthenol*	0	0	8	14	18	35	28	18	12	7	**140**
14	*Dimethicone*	0	27	40	42	12	15	0	0	0	2	**138**
15	*Dimethiconol*	0	63	16	0	6	10	8	18	8	2	**131**
16	*Propylene Glycol*	0	9	24	21	24	20	4	12	12	4	**130**
17	*Cetyl Alcohol*	0	54	40	7	0	10	8	0	0	0	**119**
18	*Coco-Glucoside*	0	9	24	42	12	5	12	6	4	1	**115**
19	*Isobutane*	30	63	8	0	12	0	0	0	0	0	**113**
20	*Lauryl Glucoside*	0	36	40	21	6	0	4	3	2	0	**112**
21	*Butane*	110	0	0	0	0	0	0	0	0	0	**110**
22	*Glycol Distearate*	0	0	0	21	36	20	16	3	6	0	**102**
23	*Stearamidopropyl Dimethylamine*	0	0	40	28	18	10	0	0	0	1	**97**
24	*Sodium Lauryl Sulfate (SLS)*	0	27	48	14	0	0	4	0	0	0	**93**
25	*Propane*	0	36	56	0	0	0	0	0	0	0	**92**

Water was the most common ingredient among all products. As most cosmetic products are in liquid form, this was an expected result of the analysis. The appearance of water further than the first position in the composition was less expected. This was the case with bar shampoos and hair serums.

The water used in the production of cosmetics is present most often under the name aqua purificata-water purified by various methods. Less often it is specially obtained water, e.g., from glaciers or springs that have a unique set of macro-and microelements, aimed at giving the cosmetic better care properties. However, these waters are mostly used in face care cosmetics, while ordinary purified water is usually used in hair cosmetics. This water must meet a number of criteria, e.g.,: it must not have any color, it must be transparent and odorless, it should also be ion-free. In addition, it must be characterized by microbiological purity appropriate for a given product, and the residue after evaporation must be less than 10 μg/mL [16].

Among the 200 analyzed products, as many as 155 had water in the first place in the composition, so they were aqueous solutions. The value (rank) of aqua was distributed more or less evenly between shampoo and conditioner, in the case of its occurrence in the first place in the composition-out of 100 analyzed shampoos and 100 conditioners, the difference was 10 points-in favor of shampoos, which means 1 product. The case was slightly different with the presence of water in further positions in the composition, which was very rare in the case of conditioners, while among the shampoos there were many that were not aqueous solutions, and at the same time had water in their composition. This

is related to the process of manufacturing shampoo bars and dry shampoos, because in some of them water was found in the lower positions of the composition. For example, bar shampoos can be made by saponification of fat with lye (process similar to making soap), in which water is used. They can also be obtained in the form of a congealing emulsion using oils and e.g., a solid surfactant-sodium cocoyl isethionate, but they may also contain no water phase at all or contain it as part of, for example, a plant extract or hydrolate.

Conditioners are composed mostly of oils or powdered plants (e.g., cassia) and do not require the addition of water, neither because of the process of creation itself, nor because of the specificity of individual accompanying ingredients. Therefore, there are mainly two forms of conditioners: aqueous solutions and anhydrous conditioners based on oils.

Cocamidopropyl betaine turned out to be the most common detergent [17]. Due to its function, it appeared only in shampoos, and in addition it did not appear in anhydrous cosmetics. The popularity of its use can be explained by the fact that it alleviates the side effects of strong anionic detergents and also improves the foaming properties of the cosmetic. It was largely in the third place in the composition, in a few cases in the second place, and quite often in the fifth place, which emphasizes its use as an auxiliary detergent.

Among all products, a similar number of points as cocamidopropyl betaine was obtained by cetearyl alcohol. It is used as a rheology regulator, stabilizer and emulsifier. In conditioners, it usually appeared in second place in the composition, while in shampoos it appeared only from third place and appeared much less frequently than in conditioners. This ingredient is even present in anhydrous cosmetics, where it appeared in third and fourth place.

The highest scoring (highest rank) moisturizing ingredient among all cosmetics is glycerin, also used as a very good polar solvent for fats and lipids [18]. It is characterized by high hydrophilicity and hygroscopicity, thanks to which it binds water, protecting the skin and hair against water loss. When used in a concentration of 1–3%, it exhibits properties characteristic not only of humectants, but also of emollients. At a concentration of up to 5%, it has a moisturizing effect, above this concentration it may have a drying effect. Glycerol shows the ability to penetrate deep into the epidermis, which, combined with the function of a solvent, makes it an absorption promoter. In addition, glycerol prevents cosmetic products from drying out, e.g., at the mouth of the bottle. Glycerin in second place is found only in conditioners. More often is present in water-based products than in anhydrous products. Much more often, glycerin is in the 3rd, 4th and 5th place, where it is an ingredient of both shampoos and conditioners. Comparing the general rank of glycerin, it can be seen that it achieved a higher value in conditioners than in shampoo and water cosmetics than in anhydrous. The first disproportion may be associated with its density and high viscosity, which is not conducive to the washing process, or with the fact that the conditioner has longer contact with the hair than shampoo, so that the glycerin contained in the conditioner has a better chance of moisturizing the hair than it would be the case with therefore, the conclusion is that glycerin is added to shampoos mainly to prevent them from drying out and to a lesser extent to have a moisturizing effect. The situation is exactly the opposite in the case of conditioners, whose overriding task is generally understood hair care. The second disproportion is related to the fact that products that are not aqueous solutions do not need to be protected from drying out at the mouth of the bottle. If, nevertheless, glycerin is added to them, it is as a humectant or solvent.

The so-called primary surfactant (usually exist at the highest concentrations in products; in opposite to auxiliary or secondary surfactants) with the highest rank among all the products analyzed is sodium laureth sulfate (SLES) [19,20]. It occurs only in shampoos and water cosmetics, so it can be concluded that it is used mainly (or exclusively) in shampoos that are aqueous solutions, and its popularity is determined by a favorable balance between its good washing properties and the price. In addition, the high rank of cocamidopropyl betaine [21] and the proportions of these two ingredients in second and third place indicate that they are most likely very often present together in shampoos that are aqueous solutions, which is supposed to benefit the shampoo's foaming properties, but also to reduce possible

irritation caused by SLES. The analysis of the main table confirms this conclusion, because out of 38 cases of cocamidopropyl betaine in 3rd place in the composition, 28 times in 2nd place it was accompanied by SLES, and out of 15 cases of its appearance in 4th place-as many as 10 times it was accompanied by SLES in 2nd or 3rd place, and out of 8 cases of cocamidopropyl betaine in place 5th. SLES appeared three times in the composition.

The sixth ingredient with the highest rank among all ingredients, although almost half as low as SLES, turned out to be fragrance compounds collectively described as parfum. The analysis of their occurrence in shampoo and conditioner showed that in shampoo this ingredient is already one place higher than in conditioner-fourth vs. fifth. In both of these groups together, parfum is most often on the sixth place in the composition. In turn, in the case of anhydrous cosmetics, it is an ingredient of the highest rank, even higher than the propellant gas which is the basic ingredient of dry shampoos. In water cosmetics, parfum was ranked ninth in terms of overall value, so it is one of the ten basic ingredients of hair cosmetics.

The next ingredient, which scored slightly less than fragrance compounds, is sodium chloride. Sodium chloride is used in shampoos as a viscosity regulator, it thickens the preparation, which facilitates its dosing and application, but also reduces its foaming. It works by increasing the size of the forming micelles, however, it only works as described in the presence of fatty alcohol sulfates and fatty alcohol ethoxylates [22].

Cetrimonium chloride is a washing substance with light emulsifying properties, showing a protective effect as well as preventing static electricity. It is not surprising that a compound with so many functions is willingly used in cosmetics formulas, although despite being a surfactant, it was much more often found in conditioners due to its other properties-in this group it is the second, after water, ingredient with the greatest weight and a huge advantage it comes in second place in the composition of conditioners. This ingredient is also much more popular in water cosmetics than in anhydrous, where it occurs sporadically from 5th place.

Among the silicones, cyclopentasiloxane had the greatest value [23,24]. It is a volatile silicone that evaporates from the surface of the hair or skin over time, so it does not weigh down the hair. It is a rheology modifier-it reduces the viscosity of the product, which ensures easier application and distribution of the preparation on the skin and hair. It can also be used as a solvent. It creates a non-greasy occlusion that reduces water loss from the hair, additionally soothes and softens the hair, although due to its volatility this effect is short-lived. It is used only in conditioners, with a significant advantage in favor of non-aqueous products, where it is the first component that is the solvent for other substances. In water cosmetics, he appeared once in the second place of the line-up, but most often he appeared from fourth place (and in this position he appeared most numerously) to seventh place. No occurrence of this component in this group was observed in further places.

In the 10th place there was a "-" sign-as described in the Material chapter-it means that the cosmetic did not have an ingredient at a given place in the composition. In another way, it can be read in such a way that the cosmetic consists of ingredients in an amount 1 less than the item on which the minus sign appeared for the first time. Therefore, among all the analyzed cosmetics, there were 3 ($3 \times 9 = 27$) that were made of less than 2 ingredients (thus they were single-component).

Another solvent used in cosmetics is ethanol. In the course of the analysis, undenatured and denatured ethyl alcohol were not standardized in order to determine which is more popular. It turned out that denatured alcohol is the most used. It is allowed for use in cosmetics without a limited concentration [25], and flavoring, fragrance or coloring substances with a repulsive taste and smell are used as a contaminant in order to reject from consumption, however, these are substances tested for safety for use on the skin. It has a drying effect, so it is not recommended for people with dry skin or dry hair, it can also be irritating to sensitive skin, although it does not have an allergenic effect. Alcohol denat. occurs most commonly from 2 to 5th position. Contaminated ethanol is present in all analyzed groups, and in shampoos it is almost twice as high as in conditioners. In sham-

poos, it is the most numerous in the 5th place in the composition, in conditioners, in turn, almost exclusively in the 2nd place of water conditioners, a little less often in anhydrous conditioners. In anhydrous preparations it has twice the value than in water preparations, it also differs in the position in the composition on which it occurs. In anhydrous cosmetics, it is present in positions 2nd to 5th, while in aquatic-in the second, where it is the most numerous, and then in individual cases in places 5th to 7th.

Behentrimonium chloride is the second most popular surface active agent used in conditioners, very occasionally used in shampoos. In addition to washing properties, it is also a conditioning and protective substance, prevents static electricity and, like emollients, soothes and softens. It is most often found in 3rd and 4th place in the composition of conditioners, in shampoo it appeared only in 5th place. Unlike cetrimonium chloride, it is not present in anhydrous cosmetics.

It is not surprising that panthenol, as an active substance that cares for both hair and skin, is present in all the analyzed groups, although with a greater amounts in water cosmetics and in a very small amount in conditioners. Looking at the score distribution of this ingredient among all cosmetics, panthenol is equally common in each of the places in the 6–10 range. In conditioners, position 7th is the most common, in shampoos it is already 6th, the other positions have a similar distribution. It exhibits strong moisturizing properties, easily penetrates deep into the hair, skin and nails, soothes irritations, also it has anti-inflammatory properties and accelerates wound healing. Moreover, it facilitates combing because it closes the hair cuticles.

Dimethicone is the second of the three most popular silicones used in hair products. In addition to the typical properties of an emollient (creating a protective film, smoothing and softening the hair, facilitating combing and preventing static electricity), it is currently the most effective substance that treats head lice. It cuts off the parasites' access to oxygen, which causes them to suffocate and die. It occurs in compositions in places from 2 to 6, occasionally in 10, with the most numerous being in places 3 and 4. It is mainly used in conditioners, where it is most popular in position 3 of the composition. In non-water products, it occurs only in places 2–4 in similar proportions. On the other hand, in water cosmetics it does not appear in the second position, and in positions 3–6 with a similar frequency in each of them.

The third of the silicones is dimethiconol, occurring with the highest frequency in conditioners, moreover, more often in anhydrous products than in water products. As a silicone, it is a dry emollient that gives elasticity and shine to the hair, prevents static electricity. As a rheology modifier, it reduces viscosity, additionally acts as a foam stabilizer, reducing foaming of washing products. Occurs in positions 2–10 with the omission of 4, with the most numerous presence in place 2. In this position it occurs only in conditioners that are not aqueous solutions.

The second most popular humectant turned out to be propylene glycol, which also acts as a polar solvent. It is a polyhydric alcohol with strong hygroscopic properties. It is miscible with water, 95% ethanol, acetone, chloroform or glycerol. At a concentration of 5–80%, it acts as a solvent, while at a concentration of 15–30% it can be used as an extracting and protective agent. What is more, it can be used as a carrier of odors, it is also an absorption promoter. It creates a non-drying film on the surface of the skin, reducing trans epidermal water loss from the epidermis (TEWL) or hair. There is a risk of causing an allergic reaction, moreover, in vitro, propylene glycol at a concentration above 5% has a cytotoxic effect. In hair cosmetics, it appears in places 2–10, most numerously in position 9. It appears in all analyzed groups, but with a predominance in conditioners and water cosmetics.

Cetyl alcohol is a wax that acts as a W/O co-emulsifier, stabilizes emulsions and increases the viscosity of the cosmetic [26]. In cosmetics, it was ranked 2–4 and 6–7, with domination of places 2 and 3. Cetyl alcohol appeared almost exclusively in conditioners and water cosmetics. It appeared in shampoos once, in the second place in the composition and it was a shampoo bar. It was also the only case of this alcohol in anhydrous cosmetics.

Coco-glucoside is very gentle on the skin and mucous membranes. Soothes possible irritation caused by anionic surface active agent. It is a washing substance found only in shampoos and almost exclusively in water shampoos. Occurs in positions 2–10 with a 4th place advantage.

Lauryl glucoside is an emulsifier, solubilizer and foaming agent. It stabilizes the emulsion and increases the viscosity of the cosmetic. It occurs almost exclusively in shampoos, in positions 2–9, in conditioners it appears only in position 7. It occurs only in water cosmetics.

Glycol distearate is a substance with many applications [27]. It improves the foaming properties of the cosmetic and the durability of the foam, supports the creation of emulsions, is a surfactant and emollient, what is more, it improves the rheological properties of the cosmetic. Glycol distearate appears in positions 4–9, with the fifth position in the composition being the most popular for it. In the vast majority, it is used in shampoos, less often in conditioners, where it appeared only twice: in 4th and 6th place. It is only found in water cosmetics, which was an expected result, taking into account its functions.

Stearamidopropyl dimethylamine also has many uses. It is a washing and foaming emulsifier substance, stabilizes both emulsions and foam, and is used as a binder and viscosity regulator. Stearamidopropyl dimethylamine has a soothing effect on the scalp, nourishes and makes the hair more elastic, and additionally prevents static electricity. It can be found on the 3rd place in the composition, although only in conditioners, and in addition only in water cosmetics. Most often it occupies places 3–6, but it is more often in the higher ones. As in the case of glycol distearate, its occurrence in these particular groups coincided with the predictions based on its properties. The high position among conditioners is also not surprising-it was 12th in a row (11, not including "-").

The penultimate of the twenty-five leading substances used in hair care cosmetics was the second of the not-so-famous SLS's. Sodium lauryl sulfate (SLS) is an anionic surfactant used in many different products, not only personal care. SLS is safe for short-term use, after which it is thoroughly rinsed off the skin, but if it remains on it, there is a high risk of skin irritation. In the composition of hair care cosmetics, it is found mainly in positions 2–4, with a huge advantage in favor of the 3rd place. SLS is present only in shampoos and mainly in water cosmetics, where it took position 17 out of 25. In water cosmetics, it appeared only in positions 2–3 (mostly) and 7 (once). In anhydrous cosmetics, it appeared twice on the 4th place.

The distribution of SLS scores leads to the conclusion that it often occurs in a duet with another strong primary surface active agent. The analysis of the main table confirms that SLES always appears in position 2, while position 4 is occupied by cocamidopropyl betaine, sodium chloride or glycol distearate. The first of them is designed to mitigate the adverse effects of SLS on the skin, the second-thickens, and the last mainly improves the foaming properties of the cosmetic. Therefore, the first four places in the composition of these cosmetics are occupied by substances that make the product deal with fat, foam nicely and be thick enough. Of course, these are important features for a shampoo, but at the same time it makes the product very aggressive for hair and skin and significantly reduces its care values.

Analyzing the ranks, it can be seen that the most frequently used propellant is isobutane, which achieved an overall rank of 113 points. The second place in this group was taken by butane with a rank of 110, and the third by propane with a score of 92. Interestingly, butane took second place in this ranking, despite the fact that it was present only in the first place of the composition of the analyzed cosmetics. Isobutane, in turn, appeared mainly in the second place, occasionally also in the first, third or fourth place. Propane with a definite advantage occupied the third place of the compositions. All three were present in dry shampoos, only isobutane was also sporadically present in conditioners.

4.1. Shampoos

Table 4 presents the ranks for Shampoos:

Table 4. Ranks for Shampoos-a list of the 25 ingredients most frequently found in the first 10 places in the composition of all analyzed shampoos (100 products).

No	Ingredient	The Place on the Ingredients List										Sum of Ranks
		1	2	3	4	5	6	7	8	9	10	
1	*Aqua*	780	0	8	7	18	15	4	0	4	0	**836**
2	*Cocamidopropyl Betaine*	0	36	304	105	48	10	4	6	2	1	**516**
3	*Sodium Laureth Sulfate (SLES)*	0	414	48	0	0	0	0	0	0	0	**462**
4	*Sodium Chloride*	0	0	32	98	66	30	12	6	0	1	**245**
5	*Glycerin*	0	0	40	63	48	15	16	3	2	1	**188**
6	*Parfum*	0	0	0	14	12	45	32	15	18	5	**141**
7	*Coco-Glucoside*	0	9	24	42	12	5	12	6	4	1	**115**
8	*Butane*	110	0	0	0	0	0	0	0	0	0	**110**
9	*Lauryl Glucoside*	0	36	40	21	6	0	0	3	2	0	**108**
10	*Alcohol Denat.*	0	9	16	28	36	5	0	0	0	0	**94**
11	*Sodium Lauryl Sulfate (SLS)*	0	27	48	14	0	0	4	0	0	0	**93**
12	*Isobutane*	10	63	8	0	12	0	0	0	0	0	**93**
13	*Propane*	0	36	56	0	0	0	0	0	0	0	**92**
14	*Glycol Distearate*	0	0	0	14	36	15	16	3	6	0	**90**
15	*Sodium Coco-Sulfate(SCS)*	10	54	8	0	0	0	0	0	0	0	**72**
16	*Panthenol*	0	0	0	7	0	25	8	12	6	5	**63**
17	*Sodium C14-C16 Olefin Sulfonate*	0	54	0	0	0	0	0	0	0	0	**54**
18	*Triticum Vulgare Starch*	30	0	16	7	0	0	0	0	0	0	**53**
19	*Sodium Cocoyl Isethionate(SCI)*	10	27	16	0	0	0	0	0	0	0	**53**
20	*Cocamide DEA*	0	0	0	28	18	5	0	0	0	0	**51**
21	*Oryza Sativa Starch*	0	0	8	42	0	0	0	0	0	0	**50**
22	*PEG-7 Glyceryl Cocoate*	0	0	0	14	12	15	4	0	0	0	**45**
23	*Cocamide MEA*	0	0	8	7	0	10	8	3	4	0	**40**
24	*Propylene Glycol*	0	0	0	14	6	5	0	6	6	2	**39**
25	*Disodium Lauryl Sulfosuccinate*	30	9	0	0	0	0	0	0	0	0	**39**

In addition to the ingredients discussed in the Section 5, 9 other ingredients appeared in the shampoos, moreover, only one of them also appeared in the conditioners table.

The first of these ingredients is sodium coco-sulfate (SCS), an anionic surface active agent that is the most numerous in the second place in the composition, but there were also single cases of its occurrence in the first and third place. In the shampoos table, it took 15th place, in waterless cosmetics it took place 22nd, and in cosmetics that are aqueous solutions it did not appear often enough to be included in the table. His rank in shampoos was 72, in waterless cosmetics-28, so the remaining 44 points fall on the table collecting water-based cosmetics. What's more, the distribution of points shows that it occurs most often in the second position, which makes it the primary surfactant, since it is the first component after water. SCS is also an emulsifier, foaming agent and foam stabilizer. It also has an antistatic effect, which makes it a potentially good washing ingredient in shampoos. In cosmetics, it is safe to use when present in concentrations from 0.3% to 29.0% [9] SCS has a 15% lower skin irritation potential than SLS, and at the same time it interacts more strongly with skin lipids than SLS, which makes them easier to wash out. The effect of SLS and SCS on keratinocyte metabolism was also assessed and it was observed that SLS caused a greater decrease in proliferation of these cells than was the case with SCS [28].

The second is another anionic surfactant-sodium C14–C16 olefin sulfonate. In addition to the washing function, it also acts as an emulsifier and foaming agent. It occurs only in shampoos, in water cosmetics and only in the second place in the composition, which clearly makes it a primary surfactant. In shampoos, it was ranked 17th, while in water cosmetics-21st. It is used in shampoos at a maximum concentration of 16%. Its absorption by healthy skin is negligible, but significant by damaged skin. Short-term toxicity studies in rats and mice showed no consistent effects. Concentrations above 10% caused moderate eye irritation in rabbits. Oral and dermal carcinogenicity studies were negative. Various animal studies and clinical studies have shown that this compound can cause irritation and sensitization. Sodium C14–C16 olefin sulfonate is safe to use in rinse off products [29].

The product Triticum vulgare starch was ranked 18th in shampoos. Wheat starch is present only in shampoos and anhydrous cosmetics and is placed in positions 1, 3 and 4 of their ingredients. It acts as an adsorbent, binder and viscosity regulator. It has the ability to absorb moisture and has abrasive properties. It was found in the composition of shampoo bars.

Oryza sativa starch is also found only in shampoos and anhydrous cosmetics, although mainly on the 4th position of the composition. Rice starch was present only in dry shampoos. In addition to the function of a binder and viscosity regulator, it has a number of care and soothing properties. Although the most important thing in dry shampoos is its ability to adsorb sebum, as it is the basis of the mechanism of action of these cosmetics.

Sodium cocoyl isethionate (SCI) is another of the ingredients characteristic of shampoos. It appears here in the 19th position, mostly found in anhydrous cosmetics, although it can also be found in water cosmetics. Occurs in the first three places in the compositions of shampoos. Sodium cocoyl isethionate is a synthetic detergent that is used in preparations in bars, showing a mild effect on the skin and hair. In vitro and in vivo studies [30] have shown that SCI is mild and less damaging to the skin barrier than soaps and surfactants such as sodium dodecyl sulfate (SDS). These studies have shown that the radius of SCI micelles is greater than the pores of the skin, so there is a spherical obstacle and the micelle cannot penetrate through the pores into the skin, which determines the gentleness of this surfactant for the skin. In addition, these studies have demonstrated that SCI skin penetration is dose-independent, further confirming that SCI cannot cause skin barrier disruption. It is a biodegradable and environmentally friendly solid substance.

Cocamide DEA-fatty acid diethanolamides from coconut oil-it is a foaming agent and foam stabilizer, classified as non-ionic surfactant. It exhibits greasing properties and is considered safe, provided that its maximum concentration in the finished product is up to 0.5%. It is found only in shampoos and only in water cosmetics in positions 4–6, with a predominance of the fourth. In shampoos, it was ranked only 20th, and in the case of water cosmetics, it closes the twenty-five-ingredient table.

PEG-7 glyceryl cocoate is one of the nine substances that is also present in conditioners, although it does not rank high enough to be included in Table 5. It improves the quality of the forming foam and, like cocamide DEA, lubricates. It occurs only in water cosmetics, occupying positions 4–7, in similar proportions.

Cocamide MEA is a fatty acid mixture monoethanolamide derived from coconut oil. It is a non-ionic surface active agent and foam stabilizer. This substance increases the viscosity and density of the cosmetic. It has moisturizing properties, and is used as an excipient. Animal tests have shown that the application of Cocamide MEA to the skin at a concentration of 50% causes no or only slight irritation. Cocamide MEA is safe for use in rinse-off products and safe in concentrations up to 10% in leave-on products [31]. It is only found in Table 4, where it ranked at position 23 with a rank of 40, appearing most frequently in the roster at positions 6, 7, and 9, though some single occurrences at positions 3, 4, and 8 have been observed.

The shampoos Table ends with the anionic surfactant disodium lauryl sulfosuccinate. It is a washing and foaming substance, stabilizes the formula of the cosmetic and prevents the formation of sediment. Unlike opacifiers, disodium sulfosuccinate increases the clarity

of the cosmetic. It is considered a milder version of SLS. It occurs only in shampoos, and in addition only in anhydrous cosmetics, where it took place 14 out of 25. The analysis of the main table showed that it was present only in shampoo bars, where it was on the first and second place of the composition.

4.2. Conditioners

Table 5 presents the ranks for conditioners:

Table 5. Ranks for conditioners-list of 25 ingredients most frequently found in the first 10 places in the composition of all analyzed non-shampoo care products (100 products).

No	Ingredient	The Place on the Ingredients List										Sum of Ranks
		1	2	3	4	5	6	7	8	9	10	
1	*Aqua*	770	0	0	0	0	0	4	0	2	1	**777**
2	*Cetearyl Alcohol*	0	405	32	7	18	0	4	3	0	1	**470**
3	*Glycerin*	0	63	112	63	30	0	4	0	2	1	**275**
4	*Cyclopentasiloxane*	110	9	0	21	12	10	12	0	0	0	**174**
5	*Cetrimonium Chloride*	0	0	88	14	24	20	12	6	2	4	**170**
6	-	0	27	24	21	18	15	16	15	14	7	**157**
7	*Behentrimonium Chloride*	0	0	56	49	18	0	8	3	2	0	**136**
8	*Parfum*	0	0	0	0	30	45	20	9	16	1	**121**
9	*Dimethiconol*	0	63	16	0	0	5	8	12	6	1	**111**
10	*Cetyl Alcohol*	0	45	40	7	0	10	8	0	0	0	**110**
11	*Dimethicone*	0	27	32	21	12	10	0	0	0	1	**103**
12	*Stearamidopropyl Dimethylamine*	0	0	40	28	18	10	0	0	0	1	**97**
13	*Propylene Glycol*	0	9	24	7	18	15	4	6	6	2	**91**
14	*Panthenol*	0	0	8	7	18	10	20	6	6	2	**77**
15	*Caprylic/Capric Triglyceride*	20	18	24	7	0	5	0	0	0	0	**74**
16	*Stearyl Alcohol*	0	36	8	14	0	0	8	0	0	0	**66**
17	*Isopropyl Myristate*	0	0	16	28	12	0	4	0	2	0	**62**
18	*Alcohol Denat.*	0	54	0	0	0	0	4	0	0	0	**58**
19	*Helianthus Annuus Seed Oil*	20	0	0	7	0	10	4	9	2	3	**55**
20	*Cocos Nucifera Oil*	0	0	0	21	18	5	0	3	4	3	**54**
21	*Argania Spinosa Kernel Oil*	0	0	8	14	6	15	0	3	2	1	**49**
22	*Quaternium-87*	0	0	16	0	12	5	0	0	2	0	**35**
23	*Phenoxyethanol*	0	0	0	7	0	5	8	9	4	2	**35**
24	*Citric Acid*	0	0	0	7	12	10	0	3	2	1	**35**
25	*Amodimethicone*	0	0	0	28	6	0	0	0	0	0	**34**

The conditioners contained 10 substances that did not appear in Tables 3 and 4.

The base of ingredients characteristic only for conditioners is opened by triglycerides of caprylic/capric acid, i.e., caprylic/capric triglyceride [32]. They are a fatty component, a comedogenic emollient, a rheology modifier, causing an increase in the viscosity of cosmetics, at the same time they facilitate slip, thus improving the application properties of the cosmetic. They are also used as a solvent to extract essential oils. Triglycerides are found mainly in the first four places in the composition of conditioners, appearing in conditioners, masks, oils and hair serums, which was an expected result due to the fact that all these types of products should be easy to apply, and having the consistency of a cream

or thick oil would be difficult to spread on the hair. Conditioners in form of lotions and balms have a more liquid consistency, and spray conditioners do not require spreading. It's a bit of a surprise that caprylic/capric acid triglycerides have never appeared in leave-in conditioners, as they should also be easy to spread on the hair. Their absence in this type of products may be due to several reasons: the comedogenic nature of this ingredient, greasiness, which can result in excessive weight and the effect of greasy hair, or the fact that among the eight leave-in conditioners analyzed, this particular ingredient did not appear even once. In the case of the division into cosmetics that are aqueous solutions and non-aqueous solutions, judging by the rank value, the division is more or less half, however, in the first and second place they occur only in waterless cosmetics, and in the 3rd, 4th and 6th places only in cosmetics that are aqueous solutions, although they did not occupy any position in Table 7.

The second component characteristic for conditioners is stearyl alcohol, which appeared there on the 16th position, at the same time it appeared only in water cosmetics, where it was placed on the 19th position. It appeared in the composition on the 2–4th and 7th positions. Stearyl alcohol is a viscosity regulator, O/W type and greasy emollient. It can be used as an opacifying and foam extinguishing substance.

The third one is isopropyl myristate, which is a lipid component and an emollient. It creates a non-greasy protective film on the hair, also works well as a solvent for fragrances. It is a rheology regulator, reduces the viscosity of the cosmetic. In conditioners, it appears from the third position, and most often in the fourth position. It achieved a greater rank in cosmetics that are aqueous solutions than in those that do not have water in the first place in the composition. It was not included in Table 7, while in Table 6 (anhydrous cosmetics) took position 23 and appeared there only in places 3–5 of the composition. In addition, it appeared in one dry shampoo, but ranked so low there that it was not included in any of Tables 3–7. Like caprylic/capric triglyceride, isopropyl myristate appeared in conditioners, oils and masks, but not in hair serums or leave-in conditioners.

Helianthus annuus seed oil appeared mainly in conditioners, oils, masks and hair serums, but also appeared in a shampoo bar [33]. In conditioners, it took place 19, but it did not appear in cosmetics only in positions 2, 3 and 5, it appeared on the others at least once. Sunflower seed oil is a lipid component and a fatty emollient. Its main component is unsaturated linoleic acid (72%), it also contains oleic acid (16%), palmitic acid (6%) and small amounts of behenic, linolenic, lignoceric and gamma-linolenic acids. It is rich in vitamin E, and also contains waxes, lecithin and carotenes. It is a good oil for medium and high porosity hair.

Cocos nucifera oil appeared in the same types of conditioners as sunflower seed oil, additionally it appeared several times in shampoos, and bar shampoos. In conditioners, it was ranked 20th, in waterless cosmetics-18th, while in anhydrous cosmetics it appeared at the very beginning, in the middle and at the end of the range consisting of ten analyzed composition items. Coconut oil is rich in saturated fatty acids: oleic, lauric, myristic, palmitic, caprylic, capric and stearic acids, as well as unsaturated linoleic acid from the omega-6 group [34]. Coconut oil is an emollient ideal for low porosity hair.

On the 21st position of conditioners, there is an oil ideal for medium porosity hair, e.g., Argania spinosa kernel oil. Argan oil contains significant amounts of oleic and linoleic acids, plus some stearic acid, isoflavones, tocopherols and over 100 other compounds. It helps fight dandruff and prevents brittle hair and nails. It has a regenerating and soothing effect, thanks to which it can be used even by allergy sufferers and children. In conditioners, he appears from the third place in the composition and this is the only table in which he appeared. The analysis of the main table showed that argan oil appears in: shampoos, spray conditioner, hair serum, oils, conditioners, leave-in conditioners and balm, so it is a wide cross-section of preparations.

Another component from a rich family of washing compounds, which is at the forefront of ingredients in hair care preparations, is quaternium-87. It is also the first cationic surfactant to be included in the analyzed tables. In chemical terms, it is a quaternary

ammonium salt synthesized on the basis of compounds of plant origin and propylene glycol. In addition to washing properties, thanks to which it facilitates rinsing the product from the hair, it is characterized by conditioning, antibacterial and antistatic properties, it also gives better application properties to the final product. It creates a protective film on the hair and facilitating combing. It occurs only in conditioners, the analysis of the main table did not show any cases of it appearing in "soap-like products". He has been in the lineup since 3rd place.

Position 23 in conditioners was taken by phenoxyethanol, which is the first fragrance compound to be included in the analyzed range. In addition to giving the cosmetic a floral fragrance, it protect it and acts as a solvent for other protective agents, e.g., parabens or other fragrances. It has also antibacterial and preservative activity [35,36]. It appears both in conditioners and "soap-like products", although with a predominance of the first-40 and 21 appearances, respectively. It appears in the compositions from the 4th place, and its concentration in the cosmetic may not exceed 1%. It has a weak allergenic effect. It is present in most of the analyzed leave-in conditioners (6 out of 8 cases), in 16 out of 36 conditioners, in both analyzed hair conditioners and in 7 out of 11 hair serums, so it is particularly popular in leave-on products.

The last but one in the conditioners is a pH regulator that also act as protective and acidifying agent-citric acid. It complexes metal ions that can negatively affect the appearance and/or stability of a cosmetic product, which increases the durability of this product. It is present in 54 out of 100 conditioners and in 67 out of 100 "soap-like products", appearing in the compositions 121 times in total, so it was present in over 60% of the analyzed cosmetics. It has been in the ingredients since the 4th place.

The Table of conditioners is completed by the hydrophobic emollient amodimethicone. It is a cross-linked organosilicon gel polymer, in other words it is a silicone [37]. It has a protective function, also an antistatic effect, straightens and soothes the hair. It appeared in 19 out of 200 analyzed cosmetics, appearing 13 times in conditioners and 6 times in "soap-like products". He is usually fourth in line-ups, although there was also a single case where he was fifth.

When comparing the compositions of shampoos and conditioners (Figure 1), it can be noticed that only one care substance is present in both types of preparations. This ingredient is panthenol. The remaining common ingredients perform auxiliary functions-as solvents. These are: aqua, alcohol denatured, and glycerin-as solvent for fats and lipids. The second group are parfums-compounds giving pleasant scent to cosmetics.

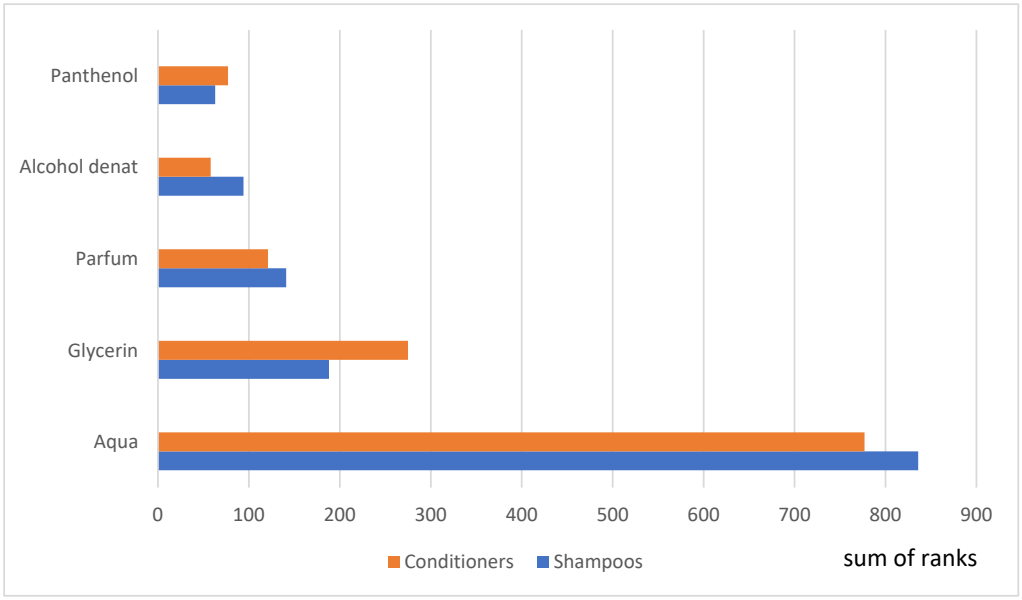

Figure 1. The comparison of ranks for shampoos and conditioners common substances.

Other substances included in shampoos and conditioners are characteristic of a given type of cosmetics and are not common to these two care products.

4.3. Products That Are Not Aqueous Solutions

Table 6 presents the ranks for products that are not aqueous solutions:

Table 6. Ranks for products that are not aqueous solutions. List of the 25 most common ingredients among the first 10 ingredients of the analyzed care products without water in the first place (45 products).

No	Ingredient	The Place on Ingredients List										Sum of Ranks
		1	2	3	4	5	6	7	8	9	10	
1	-	0	27	24	21	18	15	16	15	14	7	**157**
2	*Parfum*	0	0	0	0	24	50	28	6	8	5	**121**
3	*Isobutane*	30	63	8	0	12	0	0	0	0	0	**113**
4	*Butane*	110	0	0	0	0	0	0	0	0	0	**110**
5	*Cyclopentasiloxane*	110	0	0	0	0	0	0	0	0	0	**110**
6	*Alcohol Denat.*	0	27	16	28	30	0	0	0	0	0	**101**
7	*Propane*	0	36	56	0	0	0	0	0	0	0	**92**
8	*Dimethiconol*	0	63	16	0	0	0	0	3	2	0	**84**
9	*Dimethicone*	0	27	16	21	0	0	0	0	0	0	**64**
10	*Aqua*	0	0	8	7	18	15	8	0	6	1	**63**
11	*Triticum Vulgare Starch*	30	0	16	7	0	0	0	0	0	0	**53**
12	*Oryza Sativa Starch*	0	0	8	42	0	0	0	0	0	0	**50**
13	*Helianthus Annuus Seed Oil*	20	0	0	7	0	10	4	3	0	0	**44**
14	*Disodium Lauryl Sulfosuccinate*	30	9	0	0	0	0	0	0	0	0	**39**
15	*Caprylic/Capric Triglyceride*	20	18	0	0	0	0	0	0	0	0	**38**
16	*Cetearyl Alcohol*	0	0	24	14	0	0	0	0	0	0	**38**
17	*Sodium Cocoyl Isethionate*	10	18	8	0	0	0	0	0	0	0	**36**
18	*Cocos Nucifera Oil*	10	0	0	7	12	0	0	3	0	2	**34**
19	*Aluminium Starch Octenylsuccinate*	0	0	8	7	18	0	0	0	0	0	**33**
20	*Butyrospermum Parkii Butter*	0	9	0	7	6	0	8	0	0	0	**30**
21	*Cetrimonium Chloride*	0	0	0	0	12	5	4	6	0	2	**29**
22	*Sodium Coco-Sulfate*	10	18	0	0	0	0	0	0	0	0	**28**
23	*Isopropyl Myristate*	0	0	8	7	12	0	0	0	0	0	**27**
24	*Disiloxane*	0	9	16	0	0	0	0	0	0	0	**25**
25	*Glycerin*	0	9	0	0	6	10	0	0	0	0	**25**

Among waterless cosmetics, there were three ingredients that did not appear in any of the other tables.

The first is the 19/25 item aluminum starch octenylsuccinate desiccant [38]. This compound does not occur in conditioners, while in "soap-like products" it appeared 5 times, only in dry shampoos, being found in 5 out of 12 analyzed products. Aluminum starch octenyl succinate is an emulsifier, binder, thickens the final product and stabilizes the formula-acting when used in aqueous products. As a component of dry shampoos, its primary function is the absorption of excess sebum and anti-caking function. Occurs in positions 3–5 of the line-up, with the last one being the most popular.

The second new ingredient is the fatty emollient butyrospermum Parkii Butter, or shea butter [39]. It is a known nourishing and conditioning ingredient that softens both hair and skin, and is rich in vitamins. It additionally acts as a rheology modifier, increasing the viscosity of the product. It is also a natural UV filter. In "soap-like products" it appeared 7 times, mainly in shampoo bars, which was an expected application due to its solid form and insolubility in water. In conditioners it also appeared 7 times, mainly in masks and conditioners starting from second place.

The last component discussed is disiloxane silicone, the simplest of siloxanes [23]. Similarly to other substances from this group of compounds, it has a film-forming function, and it is a conditioning substance. Moreover, it reduces the foaming of the final product, also it is used as an auxiliary substance. It appeared in two spray conditioners and one hair oil, on the second and third position of the composition.

4.4. Products That Are Aqueous Solutions

All components of Table 7 have been discussed in previous analysis steps. In total, 47 different components appeared in Tables 3–7. Of course, water is the most common ingredient in this group of cosmetics. The second place is occupied by cocamidopropyl betaine [40]. It soothes the effects of SLS (17th position) in cosmetics and this is one of the reasons why it appears in e.g., natural hair shampoos. On the other hand, the combination of cocamidopropyl betaine with cationic agents improves the cleansing properties of the cosmetic and can improve their antistatic properties.

Table 7. Ranks for products that are aqueous solutions. A list of the 25 most common ingredients among the first 10 composition items of the analyzed care products with water in the first place in the composition (155 products).

Nr	Ingredient	The Place on the Ingredients List										Sum of Ranks
		1	2	3	4	5	6	7	8	9	10	
1	*Aqua*	1550	0	0	0	0	0	0	0	0	0	**1550**
2	*Cocamidopropyl Betaine*	0	36	304	105	42	10	4	0	0	1	**502**
3	*Cetearyl Alcohol*	0	405	32	7	18	0	4	3	0	1	**470**
4	*Sodium Laureth Sulfate (SLES)*	0	414	48	0	0	0	0	0	0	0	**462**
5	*Glycerin*	0	54	152	126	72	5	20	3	4	2	**438**
6	*Sodium Chloride*	0	0	32	98	72	30	12	6	0	1	**251**
7	*Cetrimonium Chloride*	0	0	88	14	12	15	20	6	4	4	**163**
8	*Behentrimonium Chloride*	0	0	56	49	24	0	8	3	2	0	**142**
9	*Parfum*	0	0	0	14	18	40	24	18	26	1	**141**
10	*Propylene Glycol*	0	9	24	21	24	20	4	9	10	4	**125**
11	*Panthenol*	0	0	8	7	12	30	28	15	12	6	**118**
12	*Lauryl Glucoside*	0	36	40	21	6	0	4	3	2	0	**112**
13	*Cetyl Alcohol*	0	45	40	7	0	10	8	0	0	0	**110**
14	*Coco-Glucoside*	0	9	16	42	12	5	12	6	4	1	**107**
15	*Glycol Distearate*	0	0	0	21	36	20	16	3	6	0	**102**
16	*Stearamidopropyl Dimethylamine*	0	0	40	28	18	10	0	0	0	1	**97**
17	*Sodium Lauryl Sulfate (SLS)*	0	27	48	0	0	0	4	0	0	0	**79**
18	*Dimethicone*	0	0	24	21	12	15	0	0	0	2	**74**
19	*Stearyl Alcohol*	0	36	8	14	0	0	8	0	0	0	**66**
20	*Cyclopentasiloxane*	0	9	0	21	12	10	12	0	0	0	**64**
21	*Sodium C14-C16 Olefin Sulfonate*	0	54	0	0	0	0	0	0	0	0	**54**
22	*Citric Acid*	0	0	0	7	12	10	4	6	8	7	**54**
23	*PEG-7 Glyceryl Cocoate*	0	0	0	21	12	15	4	0	0	0	**52**
24	*Alcohol Denat.*	0	36	0	0	6	5	4	0	0	0	**51**
25	*Cocamide DEA*	0	0	0	28	18	5	0	0	0	0	**51**

5. Conclusions

In all analyzed groups (All products, shampoos, conditioners, anhydrous cosmetics, aqueous cosmetics) 51 different ingredients were counted, arranged in various configurations in a total of 125 (5 × 25) items in the tables. The ranking provided information on the prevalence and importance of a given ingredient in a given group of cosmetics.

The ingredients with a significant rank advantage over the others were:

Among all cosmetics: aqua, cocamidopropyl betaine, cetearyl alcohol, glycerin, and sodium laureth sulfate (SLES),

Among shampoos: aqua, cocamidopropyl betaine and sodium laureth sulfate (SLES),

Among conditioners: aqua and cetearyl alcohol,

Among anhydrous cosmetics, the ranks were distributed quite proportionally; the highest rank turned out to be the parfume, isobutane and butane. Among aquatic cosmetics: aqua, cocamidopropyl betaine, cetearyl alcohol, sodium laureth sulfate (SLES) and glycerin.

To sum up, despite the dynamically developing cosmetics industry related to the popularization of the conscious hair care trend, there are still many hair shampoos on the market that, apart from good foaming, strong washing properties and a pleasant smell, do not have much to offer. The problem with such properties results from the drying of the scalp and hair due to the use of such strong preparations without balancing their effects with appropriate conditioners. Sometimes, however, such a strong cleansing is useful, especially in case of conditioners containing silicones, because they need to be removed from the surface of the hair and scalp before applying cosmetics that are supposed to nourish them. Therefore, it is important to be able to distinguish shampoos with strong and weaker cleansing properties-if someone washes their hair every day, they should avoid strong shampoos, if once or twice a week, they should not dry out their hair and scalp so much. If someone wants to delve deeper into conscious care, they should familiarize themselves with at least the most popular emollients, humectants, and silicones, collected in this work, so as not to choose hair care products by chance. The challenges in the further development of the production of hair cosmetics, especially shampoos, should be aimed at obtaining products that would allow multi-functional treatments with fewer chemicals. Also, more natural ingredients should be use to ensure the proper level of moisture and avoiding dryness. Moreover, formulations should support natural hair properties and provide improvement of their condition.

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