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EFFECT OF DIFFERENT THICKENING AGENTS ON THE TEXTURE PROFILE OF HAIR GEL FORMULATION.

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ABSTRACT - *This study is carried out to examine the texture profile of hair gel formulation in comparison with the similar available products in the market. Eighteen hair gel formulated with different type of gelling agents and concentration were used to compare with the texture profile of five commercial products. The results showed that the spreadability and work of shear for commercial products were 296.53 g - 538.85 g and 228.74 g.sec - 428.92 g.sec, respectively. On the other hand, the spreadability and work of shear value for formulated hair gels were 8.42 g - 376.17 g and 8.12 g.sec - 364.99 g.sec, respectively. Even though some of the thickening agents such as polyacrylic acid gave similar texture profile as a commercial product at a certain concentration, we prefered to combine different gelling agent to improve the product properties. The suitable thickener should, therefore, be selected based on its other useful properties and their quality.*

***Keywords*:** Cosmetic product, spreadability, texture profile, thickener.

INTRODUCTION

Gelling agents are used as thickeners, stabilizers, or to bind water in food, cosmetics, and pharmaceutical products to improve their performance and texture. The thickening effect and the function of the agent is depending on several factors such as concentration, type of gelling agent, the product system which corresponding to the alkalinity or acidity, temperature, and light sensitivity(Glibowski *et al.*, 2008). The mechanism of the gelling agentis by formation of a microgel structure network and cohesive internal in a solution. Other gelling agents can act as mechanical thixotropic additives (Hair care cosmetics, 1997).

In aqueous, polymer such as polyacrylic acid (PA) only loses its proton at a neutral pH and acquired negative charges by absorbing, retaining the water and swelling many times from original volume. The PA become polyelectrolytes and can be manipulated through the pH of the product. Consequently hydrocolloids such as Xanthan gum (XG) can increase the viscosity of the targeted product. This occurrence as XG is a hydrophilic compound with a large number of the hydroxyl group and easily binding water molecules to produced dispersion and exhibits the properties of colloid (Islam *et al*., 2004.

Single or combination usage of the different gelling agents can produce various type of texture profile on the targeted product. For example, the hairstyle range product is divided by two types of a based which are the oil-based and the water-based. These two different bases can be categorized into a get product in small container, a liquid or powder product in a spray bottle (Karsheva *et al*., 2007). All this type of classification is used as a different gelling agent not only focus on the consumer preferable but including a filling process during the manufacturing.

The current work aimed to study the texture profiling of the different gelling agents and to understand the texture profiling of the commercial product as a reference in a formulation of a hair styling gel.

MATERIAL AND METHODS

Materials and chemicals

The thickener used in this study was natural thickener such as different type of Xanthan gum (XG1 and XG2. Synthetic thickeners such as polyvinylpyrrolidone (PP), polyacrylic acid (PAA 1 and PAA 2), and polyvinylalcohol (PA). Other ingredient such as distilled water and preservative . Five commercial product labeled as a C1,C2,C3,C4,and C5 were used as a comparison. All chemicals were either analytical or cosmetic grades. The brand and trade name ingredient of the formulation and commercial product will not be published due to the conflict of interest. List of ingredient of the commercial product were listed in the Table 1.

No	Sample	Ingredient
1	C1	Water, Polysorbate 20, Propylene Glycol, Triethanolamine, VP/Methacrylamide Copolymer, Panthenol, Carbomer, Diazolidinyl Urea, Perfeum, Trisodium Ethylenediamine Disuccinate, Sodium Methylparaben, Benzophenone-4, Sodium Ethylparaben, C1 19140 and C1 42051
2	C2	Water, Glycerin, PVP, Triethanolamine, Carbomer, PPG-1-PEG-9 Lauryl Glycol Ether, Fragrance, Oleth-10, Quaternium-15, and Tetrasodium EDTA.
3	C3	Water,Acrylates/hydroxyesters Acrylates Copolymer, Acrylates/Steareth-20 Methacrylate crosspolymer, Aminomethyl Propanol, Helianthus Annuus Seed Oil, Tocopherol, PEG-40 Hydrogenated Castor Oil, Cetearth-20, Poloxamer 231, Trisodium EDTA, Sodium Benzoate, Benzoic Acid, Phenoxyethanol, Citronellol, Coumarin, Alpha-isomethyl Ionone, Parfum.
4	C4	Water, Alcohol, PVP, PEG-6, PEG-32, PPG-9 Glyceryl Ether, PEG-8,Carbomer, Triethanolamine, Methylparaben, PEG-50 Hydrogenated Castor Oil, Fragrance, Disodium EDTA, Panthenol.
5	C5	Water, PVP, Glycerin, Dipropylene Glycol, Polyquaternium-11, Caceth-7,PPG-1-PEG9 Lauryl Glycol Ether, Hydroxyethylcellulose, PEG-40 Hydrogenated Castor Oil, Citric Acid, Sodium Hydroxide, Sodium Cocoyl Amino Acids, Potassium Dimethicone PEG-7 Panthenyl Phosphate, Fragrance, DMDM Hydantoin.

Sample preparation.

Each thickener was weighed and added to the known volume of distilled water at room temperature. The sample was then manually mixed and left for 24 hours at room temperature. The concentration of different thickening agentwere prepared as in Table 1.

Table 1: The Spreadability and work of shear on different gelling agents and commercial products.

No	Sample	Spreadability (g)	Work of Shear (g.sec)
1	0.1% XG 1	9.58	10.76
2	0.5% XG 1	17.84	15.79
3	1.0% XG 1	41.71	43.71
4	0.1% XG 2	9.58	10.34
5	0.5% XG 2	12.36	2.66
6	1.0% XG 2	22.25	20.41
7	0.1% PAA 1	13.83	8.12
8	0.2% PAA 1	248.64	215.93
9	0.3% PAA 1	376.17	364.99
10	0.1% PAA 2	20.42	23.54
11	0.2% PAA 2	200.33	224.90
12	0.3% PAA 2	350.21	370.71
13	1.0% PP	8.42	9.77
14	3.0%PP	9.50	10.41
15	5.0%PP	9.35	11.18
16	1.0%PA	8.50	9.78
17	3.0%PA	9.11	9.13
18	5.0%PA	9.27	9.97
19	C1	371.54	300.3
20	C2	441.06	285.14
21	C3	296.53	228.74
22	C4	512.35	289.14
23	C5	538.85	428.92

Determination of texture profile analysis (TPA) of the gel base

The TPA was evaluated by using a method from Glibowski, Zarzycki, and Krzepkowska, (2008). The Texture Analyser with a probe 90° male cone with matches female cone was used to perform the test. About 5g of the sample was used by filling the female cone. Any air pockets was eliminated and the sample surface was levelled.. Next, the male cone was pressed against the female cone and the data were recorded through the software. Textural parameters such as spreadability and work of shear, can be obtained from the TPA curve as shown in Figure 1. The TPA curve was defined as:

A) Spread ability/Firmness- the peak force of the first compression process.

B) Work of Shear – the value of total area calculation from the first compression process.

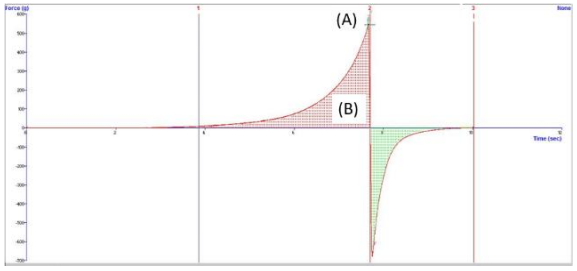

Figure 1: standard TPA curve (A) spreadability and (B) work of shear

Statistical analysis

Data were evaluated using one-way analysis of variance (ANOVA) using Tukey test by Minitab Software version 14.

RESULTS AND DISCUSSION

Textural Analysis of spreadability

The experiment relating this two aspects in measurement the spreadability of the product were compared with the five commercial hairstyle gels where the C1 to C4 was using a synthetic thickener, while the C5 was using natural thickener only.

The data showed that the PP and PA samples were significant with p-value equal to 0.022 ($p<0.05$) on a different concentration. The study for PP and PA were included in the experiment due to its usage as a thickener and adhesion to the gel cosmetic product such as nail veneer and hair gel. On the other hand, the natural thickener such as XG 1 and XG 2 were focused on the thickening the gel without gave any adhesive effect to the sample. Besides that, The XG thickener gave a slimy texture compared to the synthetic thickener.

The spreadability can be defined as the thickness of the sample which were compressed between two cones and leaves on the surface of the female cone. This producing film with higher spreadability was good to make a high quality cosmetic. The range of the spreadability according to the commercial sample product was in the range of 296.53g to 538.58g. This range will be used as the references to formulate the hair gel. The selection of the good gelling agent was a based knowledge to formulate the gel based cosmetic (Razak *et al*., 2018; Safaei *et al.*, 2019).

From table 1, the spreadability value for samples 1 to 18 was in between 8.42g and 376.17 g. Synthetic thickener PAA was widely used in the cosmetic product due to its properties of gelling texture (Santos *et al*., 2017) compared to the natural thickener. The ingredient of PAA can be find in sample C2, C3, and C4. The concentration can be changed due to the brand, name trade and grade of PAA. This can be shows the different grade in XG. Even though the data was similar for 0.1% XG 1 and 2, but the XG 2 gave clearer gel compared to the XG 1 more cloudiness gel. The storage of the ingredient and cosmetics also played an important role to obtain high value from the ingredient (T.A.R.E, 2019).

The sample C5 and C4 texture of the product was different. The C5 used PP and a natural thickener such as cellulose as a base of the cosmetic. The physical texture of the C5 was thick and look like water. The present of PP type in the C5 was to improve the adhesion of the thickener. On the other hand, the C4 has used synthetic thickener as a gel base. By combing with the PP and PA type of ingredient it can create a texture like a high viscosity of fruit jam. The sample tested on the XG type were not give significant value with p-value equal to 0.142 ($p>0.05$) on the spreadability at below 0.5% concentration. But at the higher concentration, the XG type can be used combining with other thickeners to change its physical texture on to the product.

3.1.Textural Analysis on work of shear

This test was used to measure the work of the shear of the gel. The term shear refers to the male cone press against the female cone of contact, with the applied force tangential to the segment where the sample will move tangentially away from the point of the female cone. The data and graph of this term can be portrait the profile of the shearing during the spreadability. The data obtained for the sample were in a range of 2.66g.sec to 64.99g.sec while the commercial sample was in a range of 228.74g.sec to 428.92g.sec.

The high-value shear shows that the spreadability of the product was easy to apply to the targeted area. While the low value of work of shear shows the opposite effect (Tunick, 2000). The smooth line of the work of the shear of the product shows the texture of the product either the product in the form of a gel or a product in a form of high viscosity of water. The smoother line also can indicate the consistency of the products which can be approved from a different analysis.

From the observation, a good work of shear value was similar to the spreadability value. For example, PPA 0.1% showed a different value between spreadability and shear value. This was because of the texture of the sample. The PPA 0.1% texture in a high viscosity water form. The lower value of the shear shows that the concentration of the thickener was not enough to give a gelling effect to the aqueous sample. Other examples were the C4 sample where the value of each aspect was different where the C4 sample was not easy to apply to the targeted area.

Besides the properties of the thickener itself, the other ingredient was influencing the texture profile of the product (Zięba *et al.*, 2017). In formulation, humectant, surfactant, emulsion, and other ingredients were used to improve the quality of the product.

CONCLUSION

In this study, eighteen samples and five commercial samples were studied its texture profile in terms of spreadability and work of shear. Various trade names of the same ingredient, different ingredients on similar function, and the effect on other ingredients to the base thickener were shown a different texture profile of the product. Thus a proper experimental design can be used to study its correlation between ingredients to improve the texture profile of the product.

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