Dynamic sensory evaluation of skin creams during application using Temporal Dominance of Sensation (TDS)

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Abstract

A thorough assessment of the evolving sensory characteristics of skin creams during application is essential. This study introduces an innovative temporal technique, Temporal Dominance of Sensations (TDS) to effectively examine the dynamic sensory attributes of skin creams during application. It explores the rheological properties, friction behaviour, adhesion, and spreadability providing an understanding of their sensory profiles. The creams were evaluated by 31 semi-trained panellists in duplicate sessions utilising the TDS methodology. Six sensory attributes were assessed: smoothness, stickiness, oiliness/greasiness, spreadability, cooling sensation, and absorbency. The temporal profiles were interpreted through instrument analysis, and correlated with differences in their formulations, confirming the reliability of data collected using TDS with semi-trained panellists. Key findings include: (1) The initial predominant characteristics of moisturizing (C, D) and ointment (A) creams were their ease of spreading, directly linked to consumers' initial tactile perception. (2) Product A exhibited a pronounced sticky or tacky sensation at the onset of application, while product D displayed this attribute towards the end, attributable to product thickness and skin adherence. (3) Product B uniquely showed significant dominance in smoothness, owing to specific formulation constituents (e.g., petrolatum and mineral oil) (4) Greasiness or oiliness was perceived at various stages of application, aligning with friction coefficient results. Skin cream B exhibited the lowest friction coefficient at high sliding speeds (>100mm/s). (5) All creams exhibited pronounced shear-thinning behaviour, crucial for even dispersion on the skin. This research underscores the potential of TDS in characterising dynamic sensory attributes of skin creams and opens new opportunities for similar sensory assessments within the skincare industry. Beyond skin creams, these findings hold significant implications for product development, innovative marketing strategies, and enhancing consumer preferences across the broader skincare product landscape.

Keywords: Temporal Dominance of Sensation, skin creams, dynamic sensory evaluation

1. Introduction

The sensory attributes of medicinal and cosmetic topical products applied to the skin are crucial factors for consumers. Cosmetic topical products encompass a wide variety of skincare formulations, including gels, oils, emulsions, lotions, and creams (Savary et al., 2013). The skincare products are formulated to offer many advantages to the skin, such as cleaning, hydrating, nourishing, maintaining the skin's protective barrier, and providing anti-aging effects (Abamba, 2000). Therefore, the cosmetic industry is increasingly emphasizing sensory features when developing marketing and communication strategies for these products, recognizing sensory characterization as a highly effective tool (Giboreau, 2007). Commonly assessed properties of skin creams include absorbency, greasiness, oiliness, roughness, silkiness, smoothness, spreadability, stickiness, thickness, viscosity, cooling, wetness, melting, tingling, and waxiness (Boinbaser et al., 2015).

During application, the sensory attributes of skin cream products depend on the physicochemical qualities of the film that remains on the skin and its interaction with the skin (Guest et al., 2013). These characteristics are time-dependent and change during application due to several simultaneous processes. To fully evaluate skin-cream products, it is necessary to measure the product, substrate, and their interaction in a thorough and systematic manner. Temporal methodologies, which investigate these factors sequentially, are effective in this regard. These approaches quantify variations in the intensity of sensory perception over time. Unlike conventional descriptive techniques, temporal methodologies provide additional information such as the duration of a specific sensation, the change in intensity of a specific sensation with time, the change in quality of sensation, and differing intensities in quality over time. Household personal care items can be analyzed using progressive profiling, discrete time-intensity (DTI), and multiple sampling techniques (Dooley et al., 2009). For instance, Parente et al. (2008) conducted a study on emollients to assess the extent of spreading, glossiness, and stickiness immediately after application and evaluated the attributes of residue and oiliness at intervals of five and ten minutes using the progressive profiling method. However, alternative approaches such as continuous time-intensity, temporal dominance of sensations (TDS), and temporal check-all-that-apply (TCATA) are less commonly employed but possess practical utility.

TDS, developed by Pineau et al. (2003), tracks changes in the quality and intensity of sensation perceived during consumption. While extensively utilized in food and beverage items, its application in domestic personal care products, such as skin cream, has been limited. Thus, the unique characteristics of TDS, which captures the most dominant attribute at any given time, suggest that multiple dominant sensations might be perceived when applying skin creams. The primary characteristic is the one that captures the focus at a certain moment., which may not necessarily be the most intense but could be a newly emerged characteristic.

The present study aims to evaluate the applicability of a novel temporal methodology, TDS, for characterizing the dynamics of the sensory properties of skin creams during application initially; specific terminologies and scales were developed to accurately describe the sensory attributes of various lotions and creams available in the market. The panelists were trained to evaluate these characteristics and became familiar with the software and devices. Four marketed creams were assessed using this partially trained panel. The novelty of our study lies in the development of an original methodology to characterise the sensory properties of skin creams during application using TDS. Additionally, we provide a comprehensive analysis of the texture, flow properties, and frictional behaviour of skin creams using instrumental methods.

2. Materials and methods

2.1. Materials

Four different commercial skin cream products were used in this study: two ointment skin creams (Cream A and B), and two moisturizer skin creams (Cream C and D) purchased from Chemist Warehouse (Australia). The formulation details of the samples are presented in Table I.

Table I. Formulation of the skin cream

Skin creams	Ingredients
A	Purified water, wool fat (anhydrous lanolin), liquid paraffin, white soft paraffin, dexpanthenol (pro-vitamin B5), almond oil, white beeswax, cetyl alcohol, stearyl alcohol, protegin XN.
B	Petrolatum, Paraffinum Liquidum (Mineral Oil)
C	Purified Water, Glyceryl Polymethacrylate (and) Propylene Glycol, Paraffin Soft White, Dicaprylyl Ether, Peg-5 Glyceryl Stearate, Glycerol, Dimethicone (and) Dimethiconol, Cetyl Alcohol, Sweet Almond Oil, Acrylates/C10-30 Alkyl Acrylate Crosspolymer, Alpha Tocopherol Acetate, Phenoxyethanol, Benzyl Alcohol, Disodium Edetate, Sodium Hydroxide, Lactic Acid.
D	Glycerol 10% w/w Light liquid paraffin 85% w/w Soft white paraffin 10% w/w Preservative: Methyl hydroxybenzoate 0.04% w/w dichlorobenzyl alcohol 0.1%

2.2. Temporal Dominance of Sensations (TDS)

2.3.1. Selection and training of panelists

The study included 31 semi-trained panelists (ages 20-50 years). Ethical approval was received by Human Research Ethics Committees (2010000300) at the University of Queensland to conduct the study, and informed consent was obtained from all panelists. Three training sessions (20 minutes each session) were aimed at familiarizing the skin cream attributes and introducing the concepts of TDS to the panelists. In the first training session, panelists were presented with a list of sensory attributes and their descriptors, the instructions for the test procedure, and reference products (Table II) according to previous studies (Dubuisson et al., 2018) and the author's experience. The last two training sessions were devoted to familiarising the panellists using TDS software to register their textural perception over time. Panelists were required to press the "Start" button and evaluate immediately as soon as the sample was placed in the skin by rubbing the sample within the circle with their fingers at a rate of two times per second. They were instructed to choose the dominant sensations at a given point of time and score the intensity during application, although the TDS technique does not consider intensity as the key information recorded during a TDS task. They were also trained that not all attributes ought to essentially be chosen as dominant and that a given attribute can be chosen as predominant a few times during the assessment. The TDS measurement was set for 60 seconds per sample, following previous methods described in Ningtyas et al. (2019) with slight modifications.

Table II. Attributes and their definitions

Attribute	**Definition**	**Reference - Low**	**Reference - High**
Spreadability	Easy to move the product over the skin	Untreated skin	Nivea rich nourishing body moisturizer
Absorbency	Impression of the rate of absorption of the product into the skin.	Johnson's baby oil	Nivea creme
Stickiness	Degree of which the sample feels sticky – the force required to separate the finger from the skin	Nivea rich nourishing body moisturizer	Cole's petroleum jelly

Smoothness	The degree to which the product feels smooth/silky on the fingers and skin	Untreated skin	Invite vitamin E cream
Oiliness/ Greasiness	The degree to which the product feels oily/greasy/slippery	Garnier micellar water	Cole's petroleum jelly
Cooling	The degree to which the product feels cold on the skin	Johnson's baby oil	Aveeno active naturals skin relief cream

2.3.2. Data collection

Sensory perception was evaluated for perceptional attributes during application on the four commercial skin creams (A, B, C, D). Each sample (0.05g) was presented to panelists in a spoon and coded with 3-digit random numbers. Before applying the cream, the panelists were asked to clean their skin using Isocol rubbing alcohol (64% v/v). The sensory attributes were evaluated at two specific circular measurement sites (d = 5 cm) on each volar forearm, positioned 5.5 cm away from the wrist and elbow, and spaced 2 cm apart from each other. Each circle was affixed with a sticker bearing a 3-digit code that corresponded to the randomized sequence. Following the assessment of each sample, panelists used Isocol to cleanse their index fingers and allowed them to dry before analyzing the subsequent sample. The panelists used their dominant hand to provide the samples, simultaneously identifying the prevailing characteristics they perceived during the examination. Simultaneously, another individual will select the attributes by clicking on them as the panelists vocalize them. Each of the 4 samples was assessed twice.

2.3.3. TDS data analysis

The data was collected using the RedJade® software (RedJade Sensory Solutions LLC, California Corporation, USA). The primary attribute and the exact duration of its dominance were recorded for each panelist in all sessions. The TDS curves were used to calculate the dominance rate of a sensation for a sample at the panel level at each point in time (Lenfant et al., 2009). In order to extract more information from TDS curves, two lines were plotted: the chance level (P0) and the significance level (Ps) (Pineau et al., 2009). The chance level refers to the rate at which an attribute can be obtained just by random chance. The value of P0 is equal to 1 divided by the number of attributes (P0=1/p, where p is the number of attributes). The significance level is the minimum value for the rate to be considered significant, which is calculated based on an equation as follows:

$$Ps = Po + 1.645\sqrt{\frac{Po(1 - Po)}{n}}$$

where Ps is the lowest significant proportion value (α=0.05) at any point of time for a TDS curve; n is the number of subjects; x is the number of replications.

2.4. TPA

The creams' texture properties were measured by penetration and spreadability tests using a Texture Analyzer TA.XTplus (Stable Micro System Co., UK). Cream samples were placed in specimen containers (70 mL, 43 mm diameter), which were then adhered to the platform with double-sided tape. All tests were performed at ambient temperature (22–25 °C) and in triplicate. The penetration tests were conducted with cylindrical probe TA11/1000 (25.4 mm diameter, 35 mm length). The following test parameters were used: pre-test speed of 1 mm/s, test speed of 5 mm/s, and trigger force of 5 g. Spreadability tests were carried out using cone probe TA15/1000 (30 mm diameter, 45°). The parameter settings were as follows: pre-test speed of 1 mm/s, test speed of 3 mm/s, and trigger force of 5 g.

2.5. Rheology

AR-G2 rheometer (TA Instrument, USA) equipped with a 40mm steel plate geometry was used to determine the rheological properties of the four creams based on flow tests, oscillation strain sweep tests. Prior to tests, a slightly overabundant amount of the sample was loaded onto the plate, and the excess was removed with cardboard after the geometry reached the preset position (gap 1000 μm). The temperature was maintained at 25°C throughout the measurement. The cream samples were equilibrated for 2 min before each measurement. In flow tests, shear stress and viscosity were recorded when the samples were sheared at increasing shear rates ranging from 0.01 to 1000 s^{-1} for 60 s with 10 points per decade. In Oscillation strain sweep tests, a frequency of 1 rad/s was applied with a strain range of 0.01 to 100% (Gilbert et al., 2013). Several parameters were obtained from the oscillation curves, including elastic modulus (G'), viscous modulus (G''), linear viscoelastic region (LVR), and critical strain and stress at the point where G' and G'' cross over. All tests were conducted in triplicate.

2.6. Tribology

Tribological properties of the cream emulsions were evaluated using a Discovery Hybrid Rheometer fitted with three balls on plate tribology geometry (TA Instrument, USA). Prior to the measurements, the Peltier plate was covered with silicone tape (AWD Medical, USA) cut into squares, which was then covered with surgical tape (3M Transpore, Australia). The friction tests were performed at a temperature of 32°C and a force of 4.5N in order to replicate the conditions of applying cosmetic creams to human skin. The angular velocity ranging from 0.1 to 100 rad/s was applied with an acquisition rate of 5 points per decade. All tests were conducted in triplicate.

2.7. Statistical analysis

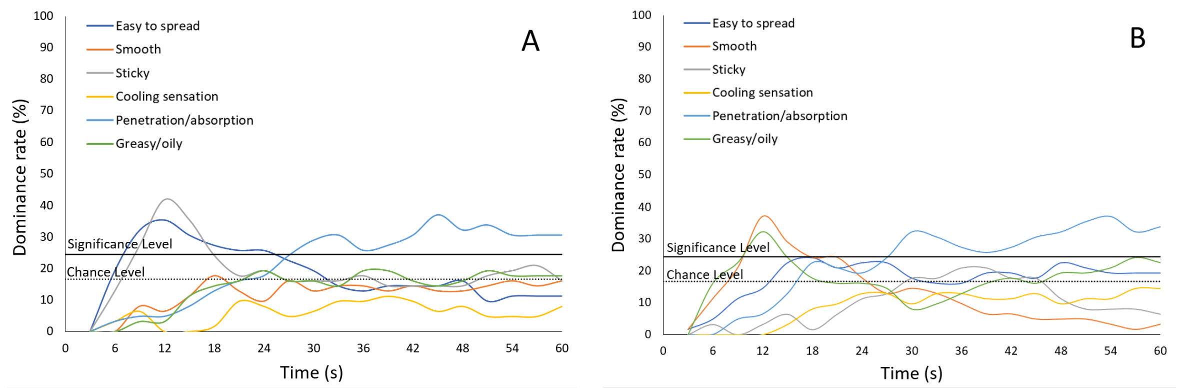
The studies were conducted three times, and the results were presented as the average value ± standard deviation. An analysis of variance (ANOVA) with Tukey's pairwise comparison test was conducted to identify significant differences ($P<0.05$) in the textural features of each cream sample. The statistical analyses were conducted using Minitab® 16 software (Minitab Inc., Chicago).

3. Result and discussion

3.1. Sensory evaluation using temporal dominance of sensation (TDS)

When consumers utilize topical products, the sensation experienced on the skin is crucial both during and after application. In this study, the TDS was employed to evaluate the sensory properties of skin creams during application. The attributes listed in Table II were chosen to accurately depict the sensory qualities of the creams throughout the evaluation process. The temporal profile of all skin cream samples was mainly characterized by five sensory attributes: *spreadability, stickiness, smoothness, greasiness/oiliness, and penetration/absorption* (Figure 1). At the onset of evaluation, four features were predominantly observed across most samples, except for cream B, which exhibited *smoothness* and *greasiness* as the predominant characteristics. The attribute of *spreadability* was significantly greater for cream A and B, indicating that these samples had a thicker consistency. These results align with the viscosity and adhesiveness statistics presented in Figure 2 and Table III, respectively. Furthermore, cream B exhibited the lowest viscosity and low adhesiveness (3.92 N/s), indicating a thinner consistency, consistent with prior findings by Boinbaser et al. (2015).

The initial sensation of products on the skin is heavily influenced by their rheological properties. The product spreads well upon application, except for cream B (Figure 1), which forms a lubricating film between the finger and the skin, reducing spreadability (Guest et al., 2013). After 25 seconds of application, *penetration/absorption* becomes the dominant sensation for all skin cream samples. During application, the creams' *absorption* into the skin increases, coinciding with a rise in the *greasy/oily* sensation. This reduction in lubrication between the finger and forearm makes the product more difficult to spread. Cyriac et al. (2022) suggest that insufficient lubrication of natural skin is caused by cream absorption. These processes explain why the attribute of *spreadability* is dominant at the beginning of application and decreases towards the end.



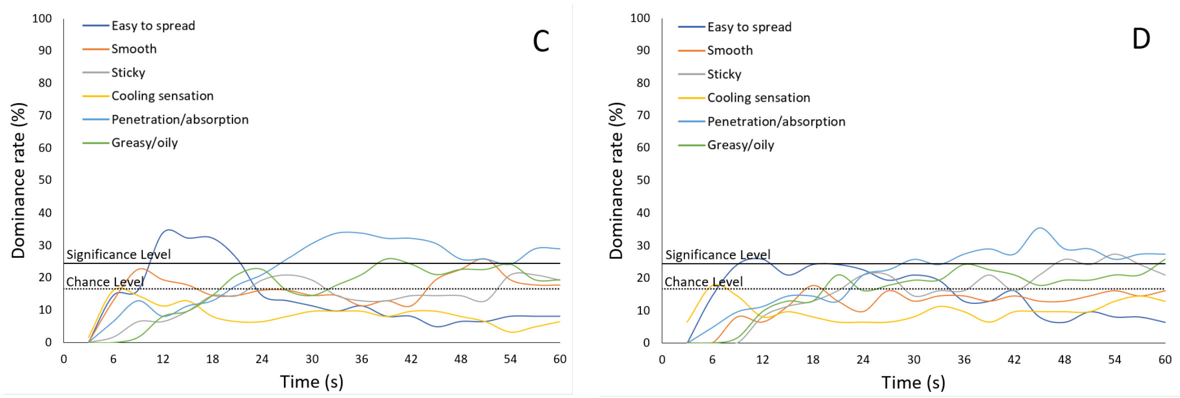


Figure 1. TDS curves for different skin cream samples

The dominant sensation for cream B was *smooth* and *greasy/oily*, likely due to the presence of petrolatum, glycerin, or mineral oil (Table I). As previously described by Guest et al. (2013), these ingredients contribute to a decreased friction coefficient and are typically perceived as initially greasy, correlating with an initial reduction in the friction coefficient (Figure 4). These sensations gradually decreased at 12 seconds and disappeared completely after 20 seconds. Ultimately, *penetration/absorption* became a dominant sensation perceived by the panelists.

During a 12-second rubbing period, cream A exhibited the highest dominance rate (40%) of stickiness (Figure 1A), likely due to its components. Cream A contains white beeswax (Table I), which has high hydrophobicity and moisture resistance, providing plasticity and increasing skin adhesiveness (Kurek-Górecka & Olczyk, 2022). In contrast, the sticky sensation dominated near the end of rubbing for the cream D sample (Figure 1D), possibly due to the high amount of glycerol. Previous studies have indicated that glycerin’s thick texture can leave a sticky residue on the skin after other formulation components have evaporated or been absorbed into the skin (Lodén & Wessman, 2001).

Finally, cream C was distinguished by its characteristics of being easily spreadable (within 10-20 seconds), capable of penetrating and being absorbed (after 25 seconds), having a greasy or oily texture (37-40 seconds), and feeling smooth (about 50 seconds). The perception of smoothness was observed when the thickness of the product's film decreased (Figure 1C), due to components like glyceryl stearate, dimethicone, and glycerine, which function as surfactants or emulsifiers (Ali et al., 2022). Consistent with the prior investigation by Boinbaser et al. (2015), this perception was linked to the components that persist on the surface of the product's film left on the skin following application and rubbing.

3.2. Texture Profile Analysis

Instrumental texture analysis was conducted to assess the mechanical properties that influence consumer perception. This study quantifies important textural characteristics, including firmness, adhesiveness, and spreadability, by inserting and removing a probe from the sample (Cyriac et al., 2022). Table III summarizes the textural characteristics of all cream samples utilized in this research. Cream A exhibited the maximum level of hardness (4.83 N), whereas Cream C and B demonstrated intermediate levels, and Cream D displayed the lowest level. This could be explained by the presence of white beeswax in cream A composition (Table I). The hardness attribute is specifically related to the application of the product, which mostly involves extracting the emulsion from the packing. The value falls within the hardness range reported in earlier investigations on cream emulsion containing beeswax (1.47 – 6.74 N) (Lukic et al., 2012).

Table III. The textural parameters of cream samples

Parameters	Cream A	Cream B	Cream C	Cream D
Hardness (N)	4.83 ± 0.20^{a}	2.55 ± 0.08^{c}	3.83 ± 0.05^{b}	1.67 ± 0.14^{cd}
Adhesiveness (N/s) (negative value)	6.85 ± 0.29^{a}	3.92 ± 0.04^{c}	5.14 ± 0.57^{b}	2.29 ± 0.17^{d}
Cohesiveness	0.74 ± 0.07^{a}	0.72 ± 0.02^{a}	0.76 ± 0.08^{a}	0.79 ± 0.01^{a}
Spreadability (N.s)	4.04 ± 0.04^{a}	3.02 ± 0.03^{b}	4.28 ± 0.48^{a}	2.71 ± 0.06^{c}
Viscosity at 1000/s (Pa.s)	0.026 ± 0.005^{c}	0.250 ± 0.010^{a}	0.012 ± 0.006^{d}	0.049 ± 0.049^{b}
G' (Pa)	3920 ± 121.36	7761.67 ± 1752.56	10510.33 ± 599.76	2158.33 ± 1308.76

G" (Pa)	1781.33 ± 264.39	4874.33 ± 1097.66	3164.67 ± 313.31	520.53 ± 87.79

Values are expressed in means ± SD from three replications. Samples with different letters between columns for each parameter show significant difference according to Tukey's pairwise comparison ($p<0.05$).

The adhesiveness is determined by the interaction between the product and the skin surface (sensory) or the probe (instrumental), whereas the cohesiveness is determined by the cream's internal structure. The cream D sample exhibited the lowest adhesiveness value of 2.29 N/s and the highest cohesiveness value of 0.79, suggesting it is the easiest to apply compared to other creams that have been analysed, as it has the least amount of interaction with the skin. In contrast, cream A high adhesiveness (6.85 N/s) indicates it is challenging to distribute evenly when applied. No uninterrupted layer will protect the barrier after applying the cream to the skin. This result is in line with the friction measurement, Figure 4, which shows an increased friction coefficient with higher sliding speeds.

The spreadability of gels, creams, ointments, and lotions is determined by a mixture of rheological factors, including viscosity and viscoelasticity. The stiffness, strength, and relative contributions of elastic and viscous behaviour are key factors that significantly influence the spreading qualities (Kwak et al., 2015). It can be inferred from Table III that cream A and C exhibit high spreadability values (4.04 and 4.28 N.s, respectively), indicating less stickiness. These findings align with TDS results (Figures 1A and 1C), which highlighted the dominance of easy-to-spread attributes at the beginning of the application. Overall, this analysis critically examines the textural properties of creams, linking them to composition and practical application, supported by statistical analysis and comparison with existing literature.

3.3. Rheology

The rheological properties, referring to the flow characteristics, are critical physical qualities of cream. The parameters provide valuable information about the creams' colloidal structure and physical stability (Medina-Torres et al., 2014). Rheological characteristics determine a cream's ability to be applied and spread smoothly on the skin. Ali et al. (2022) suggest that skin creams should possess low viscosity at high shear conditions for easy application while exhibiting high viscosity under low shear conditions to prevent leakage from the container. In this study, the flow characteristics of all cream samples displayed a consistent pattern of zero-shear viscosity and shear-thinning viscosity. This flow behaviour is attributed to the network structure's ability to withstand structural breakdown below critical stress, followed by shear-induced structural breakdown and rearrangement (Barnes, 2004).

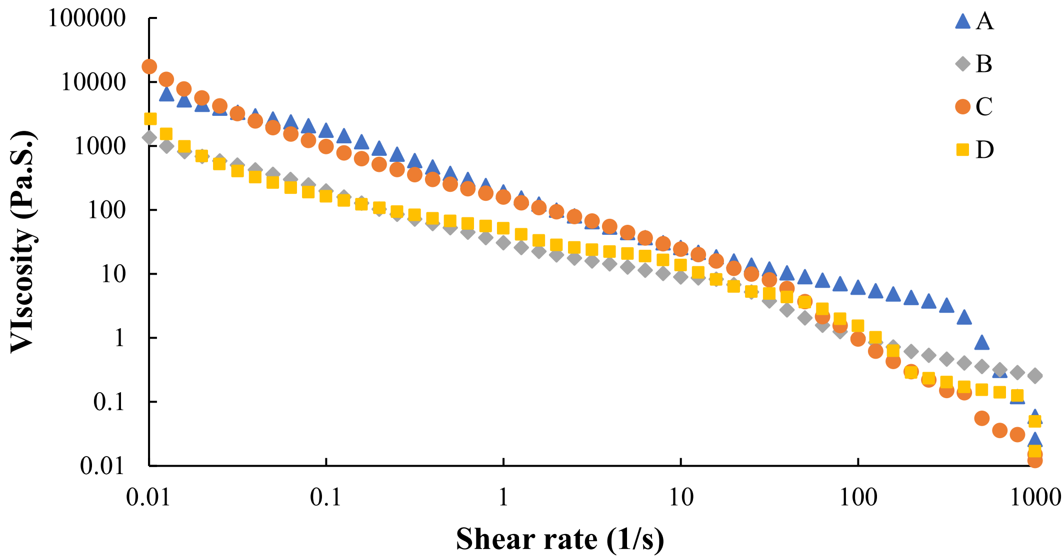


Figure 2. The apparent viscosity of cream samples

Shear-thinning behaviour is a crucial property for creams, as it significantly affects spreadability on the human skin. The decrease in viscosity of all creams under shear can be explained by alterations in the microstructure and alignment of polymer chain segments in components like paraffin and beeswax (Kwak et al., 2015). Cream A and C exhibited high viscosity at low shear rates because of the cross-linked gel network structure formed by beeswax and paraffin. As the shear rate increased, the interactions between polymer chain segments and side chains weakened, leading to deformation and destruction of the microgel structure (Islam et al., 2004). Conversely, cream B and D exhibited low viscosity at higher shear rates due to the presence of oily constituents and thickening agents/humectants, resulting in weaker entanglements and chemical bonding responsible for the material's microstructure (Kwak et al., 2015).

The viscosity measurements in Table III were recorded at a shear rate of 1000/s, corresponding to the skin's spreading process (Barnes, 2004). At this specific shear rate, creams undergo structural loss followed by disintegration, as seen by a significant fall in viscosity. Cream B exhibited the highest viscosity with a value of 0.250 Pa.s (Table III), whereas other samples, particularly cream A and C, displayed lower viscosity levels. Compounds found exclusively in cream B samples, such as Petrolatum, identified as a purified semi-solid mixture of hydrocarbons (van Heugten et al., 2018), likely contribute to their high viscosity.

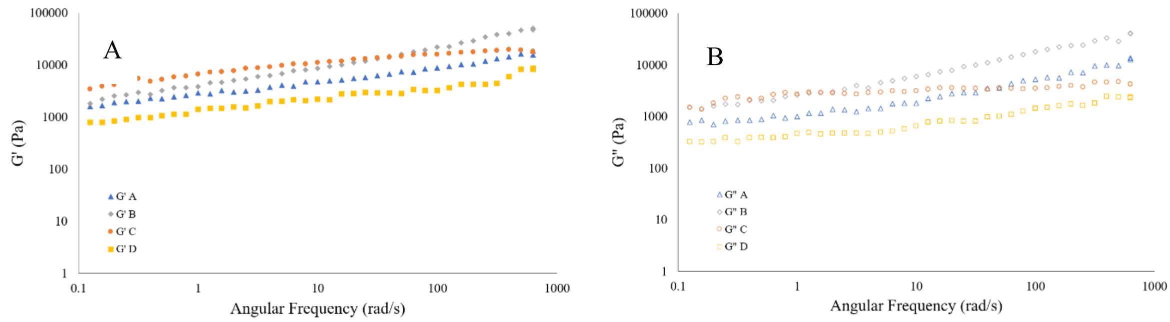


Figure 3. Storage modulus, G’ (A) and loss modulus, G” (B) as a function of Angular Frequency of various cream samples

Figures 3A and 3B display the storage modulus (G') and loss modulus (G") of cream samples, respectively, as a function of the angular frequency of various cream samples. Both storage and loss modulus display a qualitatively similar pattern across the whole range of angular frequencies examined. They either increase or remain nearly constant with an increase in angular frequency. Furthermore, the storage modulus (Figure 3A) consistently exceeds the loss modulus (Figure 3B), indicating that the linear viscoelastic properties of the creams are primarily governed by their elastic characteristics, suggesting a gel-like structure. The interactions of components such as paraffin, beeswax, and glyceryl polymethacrylate can be linked to phenomena such as crosslinking, entanglement, and aggregation (Kwak et al., 2015). As shown in Figure 3, cream D exhibits the thinner appearance compared to other creams, possibly due to

3.4. Tribology

The typical velocity at which individuals perform touch-feel evaluations falls within the range of 10 to 50 mm/s (Brummer & Godersky, 1999). When applying a cream for the first time, the thickness of the film that forms between the skin and finger significantly affects friction. The cream's viscosity determines how slippery the product feels (Ali et al., 2022). Once applied, the water and other volatile components from the cream evaporate, allowing the product's impact on the skin to become noticeable.

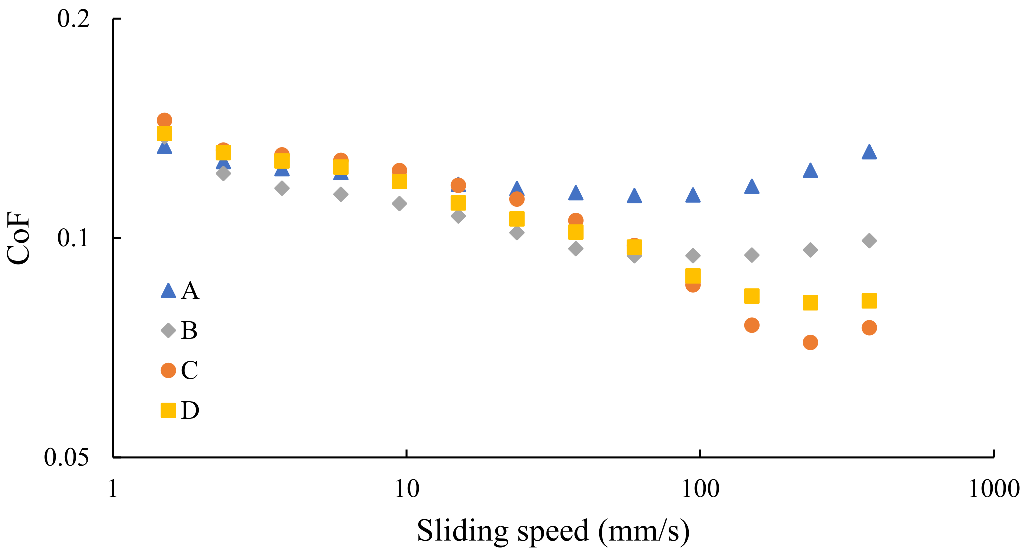


Figure 4. The lubrication properties of cream samples

Figure 4 demonstrates that in all cream samples, friction decreases initially upon the application due to the spreading of the creams. Cream A and B exhibit slightly lower friction at low sliding speeds, which progressively increases at higher sliding speeds. The findings indicate that both samples provide lubrication, reducing the coefficient of friction (CoF) during the early rubbing stage. As shown in Table I, cream A contains stearyl alcohol, acting as a co-emulsifier or thickener, while the Petrolatum in cream B provides lubricating properties. The reduced friction observed with cream B over a longer period indicates that consumers may perceive it as "greasy" (Figure 1B) due to creating a thicker lubricating layer between the probe and the silicone tape.

Each cream transitioned from low to high friction caused by an increased contact area between the probe and the silicone tape. As the film thickness decreased over time, the friction coefficient increased. Cream C displayed the lowest friction at higher speeds, followed by cream D, B, and A. The variations in friction coefficient are likely due to increased skin hydration, which the products achieve by preventing water loss through the skin. Glyceryl polymethacrylate, a film-forming agent found in cream C, provides a layer that reduces friction during rubbing (Boinbaser et al., 2015). Meanwhile, the liquid paraffin and white soft paraffin found in cream D contribute to lowering the friction at a higher speed due to its lubricant properties. Additionally, the product's composition changes as ingredients are absorbed into the skin or moved from the initial application location. The results indicate a significant disparity in the coefficient of friction (CoF) among various skin creams, which may be attributed to distinct moisturizing constituents, chemical compositions, and the time-dependent evaporation of water from the formulations.

4. Conclusion

The ease of applying semisolid creams to the human skin surface is crucial for customer acceptance. Evaluating a cream's texture profile involves assessing factors such as firmness, extrudability, first skin contact sensation, spreadability, adhesiveness, residual greasiness, and texture changes during application. This study employed the Temporal Dominance Sensation (TDS) approach to investigate the dynamics of the sensory characteristics of skin creams throughout the application. These dynamics can be explained by processes such as changes in rheological properties, tribology, and TPA (Texture Profile Analysis). Key findings included the initial stickiness of creams containing Beeswax (cream A), while cream A and C were noted for their ease of spreading, attributed to film-forming agents, emulsifiers, and humectants. Cream B was characterised by its smooth and greasy texture, linked to its high oil content, providing lubrication (low friction) at low sliding speeds. However, only cream D exhibited a prominent sticky sensation at the end of rubbing, likely due to a high concentration of glycerol, which also affects spreadability. The sensory and instrumental analysis results demonstrate that TDS effectively assesses the changing sensory characteristics of skin creams during application. Future research should focus on optimising the integration of TDS in industrial analysis by testing its application on various cosmetic products.

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Conflict of interest

The authors declare that there are no conflicts of interest.

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