A quantitative descriptive analysis comparing sensory profiles of nipple creams

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Abstract

Background: Topical lanolin is commonly used on the nipples of breastfeeding women to increase moisturisation and maintain the skin barrier. There are various grades of lanolin which differ in colour, taste and smell, depending on the level of refinement. This study aims to evaluate key sensory attributes of different lanolin nipple creams.

Methods: Five lanolin nipple care products along with two lanolin raw materials underwent quantitative descriptive analysis by a trained independent testing panel (n=8). Samples were assessed on various parameters including appearance, aroma, oral characteristics, rub-in and after-feel characteristics. A two factor ANOVA (mixed model) and Tukey Kramer HSD multiple comparison test were used to identify significant differences between samples (5%, p=0.05).

Results: None of the samples had a perceivable aroma. A highly purified anhydrous (HPA) lanolin scored the lightest shade of yellow (rated 2) on an in-house standard colour chart based on the Gardner scale (scale: 1-66). No significant difference was noted in oral characteristics, greasiness, perceived absorbency, perceived moisturisation level after product use, skin residue or slipperiness. Differences were noted in the neat characteristics of the samples and spreadability, drag, waxiness and stickiness during product use ($p=<0.05$).

Conclusions: Nipple creams should be pleasant to use, neutral in smell and taste and non-slippery in texture to prevent interference with breastfeeding. The sensory data presented here indicates that all the lanolin products included in this study met these criteria, however, the ultra-refined, highly purified lanolin was lightest in colour, significantly less sticky, the least greasy and the most spreadable compared to other topical lanolin nipple care products evaluated.

Keywords: Sensory Science; Lanolin; Cosmetic; Purity; Texture

Introduction

Lanolin is derived from wool wax and is a key ingredient in modern day skin creams and ointments (Schlossman & McCarthy, 1979). Its use for cosmetic and pharmaceutical applications requires the removal of impurities such as pesticide residues and detergents left over from the wool wax processing via a multi-stage refining sequence. Variability in the refinement methods used can influence the purity level and final properties of the lanolin end-product (Clark, 1999; Schlossman & McCarthy, 1979). Simplistically, the higher the level of refinement, the more contaminants will be removed. Super-refinement impacts colour of the lanolin material (although sometimes lanolin may be artificially lightened through a bleaching step) and reduces the amount of odour compounds (Clark, 1999). The refinement process can be costly and time consuming, therefore the conditions and level of refinement can be optimised depending on the final application of the ingredient; in addition to cosmetic and pharmaceutical applications, there are even lower grades of lanolin used for industrial purposes (Schlossman & McCarthy, 1979).

A lanolin grade that complies to the United States (USP) and European Pharmacopoeia (Ph. Eur.) has set maximum permitted levels for impurities, making it particularly useful for applications such as nipple care in breastfeeding mothers, where it is used to aid comfort and breastfeeding success. As it is not removed before nursing, purity of the material is critical to ensure that the nipple cream is safe and is accepted by the infant. It is not always clear what grade of lanolin is used for nipple care products, with many simply stating that they are ‘medical grade’; a statement which does not correlate directly with the pharmacopoeia standards.

In this study, a quantitative sensory descriptive analysis of five lanolin nipple creams (Finished Products, FP) was carried out according to the American Society for Testing and Materials (ASTM) E1490 Standard. Two lanolin Raw Materials (RM), one cosmetic grade and one pharmaceutical grade, were evaluated alongside the nipple care products to determine the effects that the refinement process has on lanolin sensory characteristics.

Sensory analysis is widely used in the food and cosmetics industry (Almeida et al., 2008; Aust et al., 1987; Parente et al., 2005; Wortel & Wiechers, 2000), and when provided by a trained descriptive panel, can fill the gap between clinical and consumer data and can be used to predict or interpret the latter (Almeida et al., 2008).

Materials and Methods

Table 1. Sample Selection

Sample Name	INCI	Grade	Product Type	Sample ID
HPA® Lanolin (Lansinoh Laboratories Inc., VA, USA)	100% Lanolin	Highly Purified Anhydrous Lanolin/Ultra-Pure	FP	Sample 1
Purelan™ (Medela AG, Baar, CH)	100% Lanolin	'medical grade'	FP	Sample 2
Multi-Mam Lanolin (BioClin BV, Delft, NL)	100% Lanolin	'medical grade'	FP	Sample 3
Ardo Care Lanolin (Ardo Medical AG, Unterägeri, CH)	100% Lanolin	'medical grade'	FP	Sample 4
Maternity Lanolin Nipple Cream (Boots, Nottingham, UK)	Lanolin, tocopherol	'medical grade'	FP	Sample 5
Pharmalan™ PH EU-SO-(RB) (Croda, Goole, UK)	100% Lanolin	Ph. Eur. Grade	RM	Sample 6
Corona 8-SO-(RB) (Croda, Goole, UK)	100% Lanolin	Cosmetic Grade	RM	Sample 7

Sample Assessment

Sensory profiling was conducted at a specialised home and personal care test facility (Sensory Dimensions Ltd, Nottingham, UK). Trained sensory panellists were recruited from an in-house Qualitative Descriptive Analysis (QDA) panel. In total, n=8 panellists successfully completed testing; 100% women aged between 18 to 65 years.

Development of the Descriptive Lexicon: Prior to formal sample review, panellists generated descriptive vocabulary that covered the appearance, aroma, oral characteristics, rub-in and after-feel characteristics of the samples. For each attribute, the procedure, definition and scale were agreed.

Sample preparation: Each sample was evaluated in duplicate and samples were blinded. Samples were prepared no more than 30 minutes before testing in a temperature-controlled room (22 °C). Each test sample was accurately weighed to 0.2 g (representative of a typical consumer dose), per panellist per replicate.

Sample evaluation: The panellists were required to attend rating sessions on consecutive days. Panellists attended a total of five rating sessions and assessed no more than five samples per visit to minimise sensory fatigue. Samples were assessed according to a sequential monadic and balanced design.

For modalities and attributes that required evaluation of the product in neat form, samples were assessed in 1 oz white pots. The colour of each sample was assessed using an in-house standard colour chart based on the Gardner scale, ranging from 1 – 66, with each number corresponding to a shade of white-yellow-brown. Panellists were then able to select which number best matched the colour of the test sample. For modalities and attributes that required the samples to be applied to the skin panellists were instructed to apply the sample to the inside of their forearm at the centre of a 2 inch (51 mm) circle. Panellists were then required to follow specific assessment protocols for each attribute. After each sample, the panellists were required to wash their forearms with fragrance free soap and pat dry the area using a

towel. A 10 minute break was then enforced between samples to allow the skin to equilibrate back to room temperate and standard pH.

Data Analysis

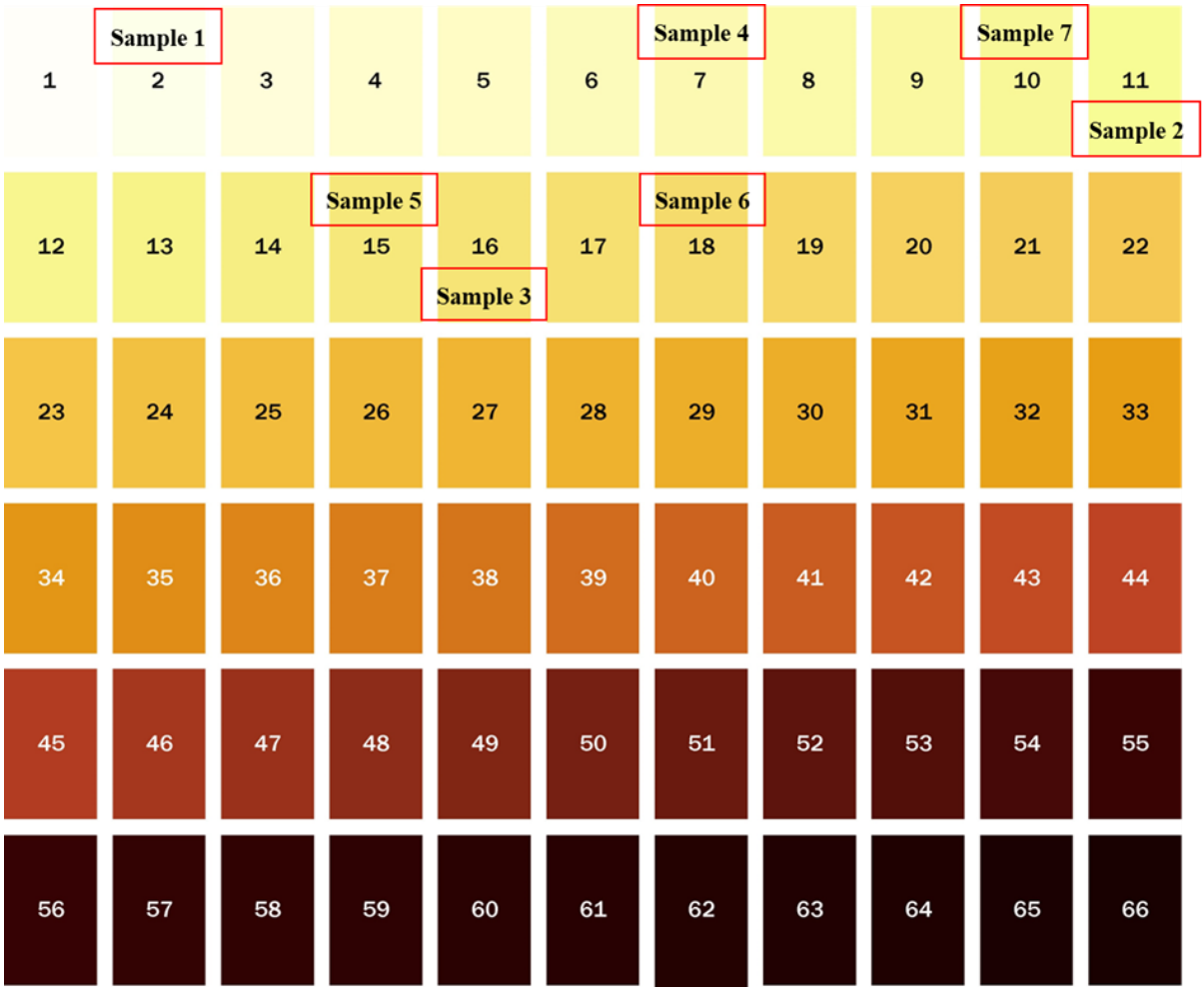
Data was collected via RedJade (Curion Insights, USA), an online data collection software and analysed using XLStat.

Data was analysed using Analysis of Variance (ANOVA) (assessor, sample as factors) to investigate whether there were any significant differences across the sample set/which attributes discriminated between the sample set, followed by Tukey's HSD multiple comparison post-hoc test, to understand which samples (if any) were significantly different to one another (significance at 5% level).

A total of 10 samples were assessed across two phases of the project, including 3 non-lanolin samples. This article focuses on a subset of lanolin only samples (n=7) however it was necessary to apply the statistical analysis across the complete dataset of 10 samples. Due to the nature of the study design three non-lanolin samples were included as part of the lexicon generation and so contributed to the scale context, therefore their inclusion ensures the statistical analysis is robust.

Results

Figure 1. Colour Chart Ratings



Colour Assessment

Lanolin samples were evaluated visually against an in-house standard white-yellow-brown colour chart. All samples were reasonably light in colour, with nothing scoring higher than 18 on a scale of 1-66. Sample 1 (HPA Lanolin) was the lightest in colour with a rating of 2, while the other lanolin FP scored between 7-16, indicating they were darker in colour and more similar to the lanolin RM (samples 6 & 7) which scored 18 and 10 respectively.

Table 2. Summary of Sample Differences (mean scores, ANOVA and post-hoc results to 5% significance level for each of the attributes assessed)

	Finished Product										Raw Material					
	Sample 1		Sample 2		Sample 3		Sample 4		Sample 5		Sample 6		Sample 7		HSD	Prob
Fragrance Intensity (NEAT)	0.9	a	0.5	a	0.4	a	1.0	a	1.2	a	0.3	a	0.3	a	3.4	0.674
Depth of Colour (NEAT)	5.1	e	38.4	abcd	58.8	a	20.0	cde	49.2	abc	54.8	ab	26.9	bcde	30.6	<0.001
Opacity (NEAT)	31.3	bc	61.3	ab	72.6	a	58.3	ab	66.6	ab	85.2	a	54.9	ab	40.9	<0.001
Smoothness (NEAT)	88.6	a	74.6	abc	78.4	ab	68.9	abc	75.6	ab	62.4	bc	71.9	abc	23.2	0.000
Shininess (NEAT)	82.2	ab	67.9	bc	58.4	c	69.9	abc	71.4	abc	62.0	bc	76.1	abc	22.8	<0.001
Spreadability (RUB-IN)	70.5	abc	66.3	bc	64.7	bc	66.3	bc	67.1	bc	32.0	d	50.2	cd	22.6	<0.001
Drag (RUB-IN)	17.3	bcd	28.4	abc	21.4	bcd	21.0	bcd	22.8	bcd	52.4	a	32.3	abc	27.1	<0.001
Greasiness (RUB-IN)*	45.9	abc	65.4	a	65.8	a	57.9	ab	64.8	a	74.1	a	54.3	ab	32.8	<0.001
Waxiness (RUB-IN)	16.9	b	28.9	b	25.3	b	21.9	b	21.1	b	62.3	a	30.1	b	28.1	<0.001
Stickiness (RUB-IN)	17.0	cde	29.6	bcd	36.3	bc	45.0	ab	41.6	ab	63.9	a	48.3	ab	23.8	<0.001
Absorbency (RUB-IN)*	34.5	abc	14.3	c	19.0	bc	18.1	bc	16.7	bc	17.8	bc	27.8	bc	28.3	<0.001
Flavour Intensity (ORAL)	0.5	a	1.8	a	8.2	a	3.3	a	6.4	a	1.0	a	0.7	a	13.2	0.604
Petroleum Jelly-Like Flavour (ORAL)	9.1	a	12.5	a	18.5	a	9.9	a	15.1	a	10.6	a	6.6	a	21.1	0.586
Greasy Mouth-Feel (ORAL)	36.3	a	39.9	a	39.5	a	46.9	a	50.2	a	49.1	a	35.3	a	35.7	0.704
Moisturising (AFTER-FEEL)	62.6	a	52.9	a	54.2	a	63.2	a	61.3	a	52.8	a	55.2	a	32.5	0.564
Slipperiness (AFTER-FEEL)*	39.7	b	43.4	b	39.5	b	43.4	b	48.3	b	41.9	b	40.4	b	32.8	<0.001
Residue (AFTER-FEEL)*	56.8	ab	65.5	ab	74.5	a	66.4	ab	67.2	ab	72.3	a	66.8	ab	32.1	0.024

*p=<0.05 across all 10 samples (non-lanolin samples excluded). No significant differences found between lanolin samples.

Aroma and Oral Characteristics

There were no statistically significant differences between the samples in terms of their fragrance intensity (p=0.674). All samples scored less than 3 (scale: 0 = no aroma to 100 = strong aroma) and therefore had no perceivable fragrance. There were also no significant differences in flavour intensity (p=0.604), petroleum jelly-like flavour (p=0.586) and greasy mouth-feel (p=0.704) when samples were evaluated orally.

Neat, Rub-In and After-Feel Characteristics

Variability was seen between the lanolin samples in terms of their neat characteristics. Differences were noted on the measures of depth of colour, opacity, smoothness and shininess. Sample 1 (HPA Lanolin) was rated the lowest for colour depth (scale: 0 = not deep in colour to 100 = very deep in colour) and opacity (scale: 0 = not opaque to 100 = very opaque). Sample 1 was also rated highest for smoothness and shininess when evaluated neat.

When scored for rub-in characteristics, spreadability ratings ranged from 32.0-70.5 (scale: 0 = not easy to spread and 100 = very easy to spread), with a higher score indicating the material was more spreadable. Sample 1 (HPA Lanolin) had the highest rating for spreadability and was significantly more spreadable than lanolin RM sample 6. No significant difference was noted for greasiness of the lanolin samples, but differences were observed for stickiness with sample 1 being rated lowest for both attributes. Sample 1 was rated significantly less sticky than samples 4-7. Sample 1 was also rated as the fastest absorbing test sample. Sample 6 had the highest amount of drag, scoring 52.4 (scale: 0 = no drag and 100 = a lot of drag), all other samples were rated 32.3 or less for drag. Sample 6 was also the waxiest in nature, scoring 62.3 (scale: 0 = not waxy to 100 = very waxy).

When scoring after-feel characteristics, no significant differences between lanolin samples were noted for moisturising ($p=0.564$), slipperiness or skin residue. All samples were rated relatively low for slipperiness, with values ranging from 39.5 for sample 3 to 48.3 for sample 5 (scale: 0 = not slippery and 100 = very slippery). Sample 6 and sample 3 were noted as leaving a high amount of residue on the skin, scoring 72.3 and 74.5 respectively (scale: 0 = no residue to 100 = high amount of residue).

Discussion

When comparing ratings for the sensory attributes of these samples, method and level of refinement must be considered. Samples 2-5 all state that they are a medical grade of lanolin, indicating that they have undergone a high level of refinement, although compliance with a particular monograph is not stated. In contrast, HPA Lanolin (Sample 1), is a specific grade of highly purified anhydrous lanolin known to undergo a proprietary, low temperature chromatographic adsorption refining process unique to this product, which results in a material that exceeds monograph compliance.

This difference in refinement method did not lead to any notable differences in aroma or flavour; both methods of physical distillation of raw wool grease to remove chemical impurities also remove compounds that cause malodour, and decreases the levels of

undesirable by-products of oxidation, which can cause wool grease to become rancid (Clark, 1999). However, the deeper yellow colour observed for the medical grade FPs and lanolin RMs tested in this study is characteristic of the high temperature distillation process which is the standard method applied to lanolin to remove impurities (Clark, 1999). This method of purification may require further bleaching or chemical modification to achieve an acceptable colour. The low temperature processing of sample 1 will have contributed to the paler and more transparent final product.

Lanolin nipple creams are intended to soothe sore and cracked nipples so that mothers can ultimately breastfeed for longer. Therefore, in addition to purity, the sensory characteristics of nipple creams are important and an odourless, tasteless, spreadable, non-greasy, non-slippery formula are all appealing attributes. A material that is neutral in taste and smell is essential to prevent infant rejection or any interference with the breastfeeding process. Similarly, a nipple cream which scores low for slipperiness is desirable, to minimise the risk of the infant 'slipping off' the nipple, negatively impacting latch and attachment (Butler & Upstone, 2016). A smooth, spreadable formula maximises comfort when applying creams to nipples which may be sore or cracked, so extremely painful to touch. Other characteristics relate more to a positive consumer experience; nipple creams are often applied frequently throughout the day, so a non-greasy formulation is generally desirable (Xu et al., 2017).

Conclusion

Nipple creams should be a pleasant texture for mothers to use and neutral in smell and taste to avoid infant rejection. The data presented here indicates that all the lanolin samples evaluated are appropriate for their intended use, however, there are detectable differences in a number of key sensory characteristics for different lanolin materials, possibly relating to the level and method of refinement used to achieve a pure final product. In particular, the HPA Lanolin was lightest in colour, significantly less sticky, the least greasy and the most spreadable compared to other topical lanolin nipple care products evaluated.

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Conflict of Interest Statement

Data collection for this study was conducted by Sensory Dimensions. Authors are affiliated with Lansinoh Laboratories.

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