Sensory testing of spreadability; investigation of the rheological conditions operative during application of topical preparations

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A method was developed which related sensory impressions of spreadability of ointments and creams to instrumental rheological analysis. The method may be used in routine industrial control procedures, and as a spreadability screening test for laboratory use prior to field trials in innovative work.

The mean temperature of the skin of the inner surfaces of the forearms of a test panel was approximately 34°. Instrumental rheograms for a series of test materials were determined at 34° using a Ferranti Shirley viscometer; two methods, modifications of that due to Wood (1968), were employed. Panel members were asked to compare test samples with Newtonian silicone oils by spreading them on the skin, and to select the Newtonian material most similar to the test sample. The intersection of the rheograms of the test sample and the selected Newtonian oil indicated the approximate rheological conditions during spreading on the skin.

A Master Curve of the approximate rheological conditions operative during spreading was determined for a series of lipophilic materials ranging from stiff semisolids to mobile fluids. Rates of shear varied approximately from 400 to 2500 s^{-1}, shear stresses varied approximately from 40 to 6000 $Nm.^{-2}$

The panel members assessed the test samples using Ordinal, Preference and Ratio scaling procedures (Torgerson, 1965). Logarithmic and double logarithmic plots of mean panel score against apparent viscosity or shear stress (at the rate of shear indicated by the Master Curve) were linear with one exception.

The Preference test data, in conjunction with the Master Curve, were employed to determine the rheological conditions which yielded maximum consumer acceptance of the spreadability of a product. The preferred region of the Master Curve was bounded approximately by 400 to 700 s^{-1} and 200 to 700 Nm^{-2}.

The panel was asked to spread Newtonian silicone oils of known viscosity between marks 10 cm apart on the skin of the forearm. An estimate was made of the number of strokes per unit time. The relative viscosity, V cm s^{-1}, between the skin surfaces was thus determined approximately. The rate of shear, $\dot{\gamma}$ s^{-1}, during spreading of each oil was determined by reference to the Master Curve. Using the equation for plane laminar flow between parallel plates

$$\dot{\gamma} = V/d$$

where d is the plate separation in cm, the approximate thickness of the oil film on the skin was calculated. The data indicated a *dynamic* relation between $\dot{\gamma}$, V and d, which may explain former difficulties and variation in results obtained in the evaluation of the shear conditions operative during spreading of topical applications (Langenbucher & Lange, 1970).

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The effect of constituents in white soft paraffin on the efficacy of corticosteroid ointments in the vasoconstrictor test

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The vasoconstrictor test developed by McKenzie & Stoughton, is widely accepted as one of the most useful methods for assessing the activity of a topical corticosteroid. Recently, modifications have been introduced to the test in order to examine the effect of formulation on the response of the steroid. The test now enables numerous formulation effects to be evaluated which would previously have required large-scale, and therefore costly, clinical trials. Four white soft paraffin bases (A, B, C and D) each meeting the B.P. specifications were prepared with differing proportions of constituents so that the degree of waxiness increased in the order A < B < C < D. These bases were then used to prepare placebo ointments containing 5% propylene glycol and active ointments containing 0·025% fluocinolone acetonide (Synalar) dissolved in 5% propylene glycol. In spite of the similarity of the preparations the responses varied considerably in the vasoconstrictor test. Fig. 1 shows the variation in response among the fluocinolone acetonide ointments. It can be seen that the overall response in the test increases in order A < B ≃ C < D. The responses of the placebo preparations are shown in Fig. 2. These differ appreciably at the first reading increasing in the order A < B < D < C and then fall to much lower levels during the next 1½ h.

It is suggested that these results are due to the degree of occlusion that such preparations present to the skin. For some time ointments have been thought to be such effective corticosteroid formulations because they induce a degree of occlusion to the treated site and so increase the penetration of the drug through the skin in the same way as an occlusive plastic film. Conceivably the placebo response is really a whitening of the skin due to the increased hydration of the tissues under the application site. The fact that this response seems to dissipate quickly once the ointment has been removed tends to support this assumption.

The different responses of the active ointments can also be reasonably explained in similar terms. Those bases which cause a high degree of hydration of the skin can be expected to favour better penetration of the drug. Consequently the most waxy bases C and D deliver more steroid to the skin and therefore they are the most effective.

The experiment shows clearly how an alteration in the nature of the formulation can appreciably change the effectiveness of the preparation.

Figure 1. Responses of Different Ointment Bases, Containing 0.025% Fluocinolone Acetonide, at Different Time Intervals.

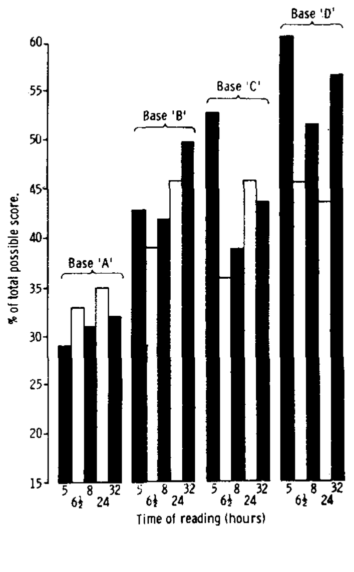
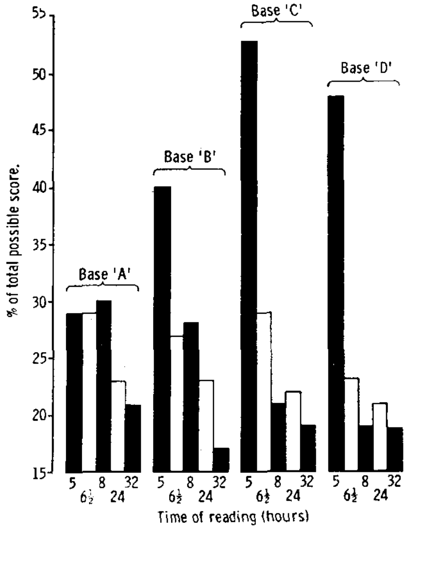


Figure 2. Responses of Different Ointment Bases at Different Time Intervals.



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