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Comparative Analysis of Moisturising Creams from Vegetable Oils and Paraffin Oil

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Abstract: Coconut and palm kernel oils were extracted from the kernels of the fruits by the hot extraction method using hexane as solvent. The oils obtained were characterized and used to formulate moisturizing creams using a developed formulary. These creams were analyzed and their stabilities determined. The creams were then compared with a cream formulated with paraffin oil (cosmetic grade) that had similarly been analyzed. All the three creams were then compared with a popular moisturizing cream in the Nigerian market, using parameters like pH, conductivity, total acid value, parcentage of free fatty acid and saponification value at normal and elevated temperatures. The results obtained were generally similar in all cases with the exception of that obtained for palm kernel oil cream. All the values indicate that the coconut oil based product was as stable as the paraffin oil based products.

Key words: Vegetable oils, paraffin oil, moisturizing creams, comparative stability, conductivity, hexane

INTRODUCTION

Dry skin is a problem in the tropical countries of the world and in particular on the African continent. This condition is aggravated by the use of detergents and the hot alternating wet and dry climate. Any formulation that can help relieve this condition will have a wide market acceptance. Of all the beneficial properties claimed for cosmetic creams moisturizing is probably the most widely used. The term stems from the discovery that water is the only material that will plasticize the outer dead layers of the epidermis to give the more desired attribute referred to as soft and smooth skin. If water is lost more rapidly than it is received from the lower layers of the epidermis, the skin becomes dehydrated and loses its flexibility. Blank has shown that oil alone will not restore this flexibility. It is therefore necessary to present the oil to the skin in form of an emulsion which includes oil and water.

There are two basic types of dry skin. The first is due to prolonged exposure to low humidity and air movement which modifies the normal hydration gradient of the stratum corneum. The second is due to processes such as aging, continual degreasing and so on (Reiger, 1989). The approach to restoring water to dry skin has taken three different routes, occlusion, humectancy and restoration of deficient materials to the skin. This process may be used alone or they may be combined. The usual solution to the problem of dry skin is the use of petroleum-based formulations. This choice is guided by the belief that it confers occlusivity, emollience and humectancy on the skin. Locally however, various vegetable oils, herbs and fruits are applied for the moisturizing, protection and healing of problematic skins. With the advent of technological advances and the discovery that skin pH is in the acidic range (Jacobi and Heinrich, 1954). With the recent trend towards environmentally friendly substances and more biodegradable options, the use of vegetable oil based formulations seem to be a more physiologically encouraging option. The support for this choice is in the fact that vegetable oils are acidic in nature, easily biodegradable and skin lipid compatible than paraffin oil. They can also act as humectant, emollient and occlusive material, helping to restore skin moisture balance. It is the objective of this study therefore; to show that it is possible to prepare vegetable oil based moisturizing creams whose stabilities would be comparable to paraffin oil-based emulsions.

MATERIALS AND METHODS

Extraction of coconut and palm kernel oils: Pre-weighed kernel of palm kernel (*Elaeis guineensis*) and coconut (*Cocos nucifera*) were extracted with hexane by the hot extraction method with soxhlet extractor for 16 h. The oils were then recovered by distilling off the solvent. The last trace of the solvent was removed by vacuum distillation. Percentage by weight of the oils extracted were calculated based on the weight of the raw seeds.

Characterisation of oils and other raw materials: The oils and other raw materials used in the formulation of the

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Table 1: The creams were formulated using the following developed formulary

Material	By weight (%)
Stearic acid	4.0
Paraffin wax/Beeswax	4.0
Lanolin	4.0
Paraffin oil/Vegetable oil	10.5
Cetyl alcohol	1.2
Glycerol	1.5
Triethanolamine	0.4
Methyl-p-hydroxy benzoate	0.1
Propyl-p- hydroxy benzoate	0.1
And-Tocopherol	0.4
Deionized water	73.4
Color	*QS
Perfume oil	*QS

* = Quantity sufficient

moisturizing creams were characterized by determining their color, pH, specific gravity, viscosity, total acid no, percentage of free fatty acid, saponification value using standard analytical procedures (Paqut and Hautfenne, 1987).

Formulation of oil in water moisturizing creams: The creams were formulated using the following developed formulary as shown in Table 1. The same raw materials were used for the product formulation with the exception that paraffin wax was used with paraffin oil based cream and beeswax with the vegetable oil based creams. The materials were then grouped into aqueous and lipid phases.

Aqueous phase: To the deionised water in a stainless steel container, other water-soluble materials like glycerol, methyl-p-hydroxy benzoate and triethanolamine were added and the solution heated until it attained a temperature of about 70°C.

Lipid phase: To the vegetable oils or paraffin oil in a stainless steel container. Other oil soluble materials like beeswax/paraffin wax, lanolin, cetyl alcohol, stearic acid, propyl-p-hydroxybenzoate and and tocopherol were added. The temperature of the solution was then brought to about 70°C.

Production: The aqueous phase was slowly added to the lipid phase while stirring with the aid of a mechanical stirrer. The temperature of the emulsion formed was kept at 70°C for about 15 min until saponification was complete. The emulsion was then allowed to cool gradually while stirring until it had reduced to 35°C. The perfume already dispersed in a portion of the glycerol was then added to the emulsion. The emulsion was again stirred until homogeneity was achieved. The emulsion was covered and left for 12 h after which it was mixed again at a higher speed to improve homogenization. The emulsion was then poured into a suitable plastic container with a screw cap for storage and analysis.

Control analysis: The three emulsions produced and the purchased moisturizing cream were subjected to cosmetic control analysis and stability tests. These tests include pH, conductivity, microscopic examination, cyclical temperature variation tests, determination total acid value, percentage of free fatty acid, saponification value and mechanical tests using the methods of Sherman (1971).

Statistical comparison of emulsions: The emulsions were compared based on the analysis of the cyclical temperature variation tests results with the experiment laid out in a completely randomized block design. Analysis of variance was then used to test the variation of all the parameters measured among all the treatments. The Least Significant Difference (LSD) procedure was then used to rank the treatment in order of significance.

RESULTS AND DISCUSSION

Percentage yield of the hexane extracted oils were 38.20% for palm kernel and 63.95% for coconut oil. The results of the physicochemical analysis of the oils and some of the raw materials are shown in Table 2. The oils used in this study were obviously free from degradation as shown from the percantage free fatty acids and peroxide values (Table 2). It can be inferred from the viscosities (Table 2) that coconut oil will produce more stable emulsions as increase in viscosity of oil results in increased stability of emulsions because of the viscosity of the dispersed phase (Royal Society of Chemistry, 1999). This inference is confirmed by the results of the cyclical variation tests (Table 3). The iodine values of the vegetable oils were quite low (Table 2) showing that the oils contained saturated molecules and hence will not be easily degraded through auto-oxidation. Saponification values of oils were quite high (Table 2) indicating the soap forming abilities of the oils. Coconut oil had a higher value than palm kernel oil. This indicates that coconut oil contains more esters and free fatty acids than palm kernel oil. It is therefore more likely to produce more soap in the system on reaction with triethanolamine. This soap will then stabilize the emulsion system.

Table 3 contains the results of physicochemical analysis of the cosmetic emulsions while Table 4 contains the temperature variation tests results. Conductivity values for the emulsion and dye-uptake test together with microscopic examination all point to the fact that the emulsions were all of the oil in water type as only oil in water emulsions would conduct electric (Bercher, 1983)

Table 2: Physicochemical analysis of oils and some raw materials

Parameters	Paraffin oil	Coconut oil	Palm kernel oil	Stearic acid	Beeswax	Lanolin
Colour	Colourless	Pale yellow	Yellow	White	Off white	Yellow
Odour	Bland	Sweet	Sweet	None	Honey like	Woolly
State	Liquid	Liquid	Liquid	Solid	Solid	Semisolid
H_2O Solubility	Insoluble	P miscible	P miscible	Insoluble	Insoluble	S miscible
SG at 28°C	0.8548	0.8810	0.8720	-	-	-
R I at 40°C	1.476	1.454	1.449	-	-	-
Viscosity (cs)	10.12±0.02	50.34±0.04	49.82±0.01	-	-	-
Mpt. in°C	-	-	-	39-60	62-70	40-44
pH	7.97±0.01	4.00±0.06	5.00±0.07	-	-	-
TAV (mg KOH g^{-1})	-	1.66±0.02	0.66±0.02	610±0.2	24.52±0.03	5.86±0.20
FFA (%)	-	0.84	0.34	309.4	12.35	2.95
SV (mg KOH g^{-1})	-	274.34±0.02	249.96±0.06	238.00±0.15	28.00±0.07	88.48±0.02
EV (mg KOH g^{-1})	-	272.68±0.01	249.30±0.05	372.00±0.04	3.48±0.05	82.62±0.18
PV (mg Eq Kg^{-1})	ND	ND	ND	ND	ND	ND
IV (mgI_2/100 g)	-	3.5×10^{-5}	1.37×10^{-5}	-	-	-

SG = Specific Gravity, RI = Refractive Index, Mpt = Melting point, TAV = Total Acid Value, EV = Ester Value, PV = Peroxide value, P miscible = Partly miscible, S miscible = Slightly miscible, Results are mean±SD of three determinations

Table 3: Physicochemical analysis of the emulsions

Parameters	Paraffin oil emulsion	Coconut oil emulsion	Palm kernel oil emulsion	VMC
Colour	White	Off white	Pale yellow	Pink
PH	6.8±0.06	6.37±0.02	7.19±0.01	7.10±0.07
Conductivity (ms cm^{-1})	0.12±0.02	0.19±0.01	0.13±0.01	0.01±0.01
Microscopic examination	Even sized globules	Even sized globules	Uneven globules	Even sized globules
Dye uptake using water soluble dye	Takes up dye	Takes up dye	Takes up dye	Takes up dye
Emulsion type	Oil in water	Oil in water	Oil in water	Oil in water
Total acid value (mgKOH g^{-1})	26.36±0.01	48.43±0.03	46.59±0.01	34.33±0.02
Free fatty acid (%)	13.28±0.01	24.39±0.01	23.46±0.07	17.29±0.01
Saponification value (mg KOH g^{-1})	123.20±0.04	138.88±0.09	155.63±0.02	84.00±0.08
Centrifugation (5000 rpm for 1h)	Stable emulsion	Stable emulsion	Emulsion separates into layers	Stable emulsion
Cyclical temp variation (25-45 soluble dye°C)	Stable emulsion	Stable emulsion	Emulsion separates into distinct layers	Stable emulsion
pH after cyclical variation	7.00±0.04	6.50±0.01	6.20±0.01	7.35±0.04

VMC = Popular Moisturising Cream bought from a Nigerian market used as control, Cyclical temperature variation was carried out 24 h for 3 cycles and then the pH of the emulsion was taken, Results are mean±SD of three determinations

Table 4: Results of control analysis at various temperatures

Emulsions	Appearance	pH	Conductivity (ms cm^{-1})	Total acid value (mg KOH g^{-1})	Saponification value (mg KOH g^{-1})	Centrifugation (5000 rpm for 30 min)
Paraffin (4°C)	No change	6.79±0.02	0.14±0.01	26.27±0.01	126.48±0.02	Stable
Paraffin (37°C)	Bubble formation	6.87±0.01	0.14±0.01	23.12±0.09	128.24±0.01	Stable
Paraffin (45°C)	Bubble formation	7.09±0.07	0.13±0.01	22.82±0.01	124.80±0.07	Stable
Coconut (4°C)	No change	6.22±0.01	0.10±0.02	48.10±0.08	138.80±0.04	Stable
Coconut (37°C)	Mild bubble formation	6.46±0.03	0.17±0.02	45.50±0.01	132.16±0.05	Stable
Coconut (45°C)	Bubble formation	6.53±0.05	0.17±0.01	43.20±0.02	130.20±0.02	Stable
Palm kernel (4°C)	Bubble formation	6.50±0.02	0.10±0.01	46.65±0.08	153.36±0.01	Emulsion breaks down
Palm kernel (37°C)	Heavy bubble formation	7.65±0.02	0.13±0.01	41.37±0.09	151.12±0.01	Emulsion breaks down
Palm kernel (45°C)	Phase separation occurs	8.10±0.04	0.08±0.00	37.58±0.09	146.60±0.04	Emulsion breaks down
VMC (4°C)	No change	7.00±0.00	0.01±0.00	34.20±0.07	83.80±0.04	Stable
VMC (37°C)	Mild bubble formation	7.20±0.04	0.02±0.00	33.50±0.03	80.00±0.00	Stable
VMC (45°C)	Bubble formation	7.50±0.05	0.05±0.01	27.00±0.00	78.20±0.08	Stable

Results are mean±SD of three determinations

and soluble dyes would only dissolve in water continuous emulsions. The values obtained for the purchased moisturizing cream suggest a multiple emulsion of the type W/O/W as the value was very low and emulsion in spite of this could mix with soluble dye.

pH of the emulsions were all close to neutral point. Only coconut emulsion had a pH in the acid range, showing that it will be more skin compatible as the pH was closer to 5.5 which is the pH of the mantle of the skin (Reiger, 1989). Microscopic examination of the creams revealed that they had even sized globules an indication of proper homogenization leading to stability with the exception of palm kernel cream that had uneven sized globules which is a sign that it was likely to break down more easily than the others as coalescence was more likely in this instance than in the other cases (Jass, 1967).

The creams produced however were aesthetically pleasing as a result of their smooth surfaces, feel, rub in effect and sheen. When analysis of variance was used to test the variation in total acid, saponification value, Percentage of free fatty acid, pH and conductivity among all the treatments (coconut, palm kernel and paraffin oil emulsions), pH, total acid and percentage free fatty acid of the emulsions did not show any significant difference at different temperatures at 5% probability level.

There were significant differences of 27.4 and 35.7 at 5% probability level for the saponification value for both treatment and temperature, respectively. The least significant difference found using the student's t-distribution at 5% probability level was 7.7 and 8.9 for treatment and temperature, respectively.

The conductivity value has a significant difference only on the treatment, and the LSD value was 0.04. The null hypothesis was therefore accepted for the temperature effect, since it has no significant difference on conductivity of the emulsions.

The interpretation of this statistical data shows that the paraffin oil and coconut oil emulsions were better and more stable creams than the palm kernel oil emulsion. Variations in temperature had virtually no effect on paraffin and coconut oil emulsions but caused the palm kernel oil emulsions to break down into distinct phases. With cyclical temperature variations (Table 3), there was a sharp drop in the pH of the palm kernel emulsion confirming phase separation.

It could be inferred that the cream might possibly cause skin irritations in users affecting skin pH (Wickett and Trobaugh, 1990). The pH values for coconut oil emulsions however remained within reasonable limits showing emulsion stability. The coconut oil emulsions were able to withstand greater temperature variations even more than paraffin oil emulsions.

CONCLUSION

It is better to use coconut oil to make cosmetic emulsions as it was not only better than palm kernel oil emulsions, it was more stable and as stable as paraffin oil emulsions and more biodegradable and also from a renewable natural product.

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