



## EVALUATION OF FOOT CREAMS FORMULATION ON HUMAN SKIN – A NOVEL APPROACH

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Article Received on  
12 July 2017,

Revised on 02 August 2017,  
Accepted on 23 August 2017,

DOI: 10.20959/wjpps20179-9924

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### ABSTRACT

The skin on our feet is naturally dry, because in feet there is no oil gland like rest of the body. The foot skin can become dry for a number of reasons, but there are ways to prevent it, such as keeping our feet moisturized and avoiding rubbing or scratching the skin. In general cracked heels are noticed in the elderly aged female when compared to the young age girls. Similarly these problems are very much pronounced in elderly female than male. Foot cracks open the entry path of bacteria to the body, and it may lead to promote the foot ulceration, microbial attach and lead to amputation also. The present study aims to measure the hydration property and hydration lock property of foot cream measured with help of carneometer. In addition

to that, the present study deals about the wound healing properties of new developed formula. This article covers the detailed quantification of anti-microbial and anti-fungal screening and it will helpful to generate the optimum formula for the end user with respect to moisture benefit and healing property of foot cream. In the case of tested leading bench mark initially increase up to 17 unit and reach the 12.6 unit after 12 hours. This result indicates the alarm of next application of cream. Study results revealed daily two times application of foot cream maintain the skin moisture and prevent from the skin damage issues. Based on primary study results indicates that the option 2 sample was better when compared to option 1 and tested bench mark sample. Antibacterial and antifungal activity of samples and bench mark found to be highly significant when compared to the standard. The study reveals that the wound healing activity of both sample and standard found to be highly significant ( $p < 0.001$ ) when compared to control. However the in-house samples are having the slightly leading edge when compared to the bench mark samples.

**KEYWORDS:** Foot cream, heal cream, carneometer, dry skin, anti-fungal, anti microbial, wound healing.

## INTRODUCTION

The skin on our feet is naturally dry, unlike the skin on the rest of the body. The skin on our feet has no oil glands, so it relies on hundreds of thousands of sweat glands to keep our feet moisturized.<sup>[1,2]</sup> Dry feet can range in severity from mild, temporary dry skin to severe dry skin that causes additional problems. Skin can become dry for a number of reasons, but there are ways to prevent it, such as keeping our feet moisturized and avoiding rubbing or scratching the skin. In general cracked heels are noticed in the elderly aged female when compared to the young age girls. Similarly this problem very much pronounced in elderly female than male. Foot cracks open the entry path of bacteria to body, and it may lead to promote the foot ulceration, microbial attach and lead to amputation also. The stratum corneum is the outermost layer of the epidermis and it consisting the dead cells. It is act as barriers to protect underlying tissue from infection, dehydration, chemicals/mechanical stress. This thickness varied throughout the body and it ranged between 10 and 40  $\mu\text{m}$ .<sup>[3,4,5]</sup> Proper moisturizing ingredient provides the moisture care to the foot, however the unique method also need to check the hydration behavior of foot. In earlier days the hydration power indirectly correlated with the total fatty matter of the formula, however it will mislead the formulator in many times. Moisturizer/hydration pattern depends upon the other proportion also, now a day's many unique raw materials available in the market, it will not impact on the total fatty matter and directly correlated to the hydration property and moisture lock. We have developed the unique formula of foot cream to give the extra hydration to the foot and it has the higher the hydration lock property. The present study aims to measure the hydration property and hydration lock of footcream property and it measured with help of carneometer. There are several techniques that have been used as skin moisture measuring devices. Suh *et al.*<sup>[3]</sup> developed the unique method to measure the stratum corneum water content. Carneometer measurement based on the electric conductance principle, it measures the conductance behavior of the skin. Conductance directly correlated to the skin moisture levels. We have developed the unique formula for the healing the foot and compare the efficacy with market leading bench mark samples. The present study aims to develop the unique foot cream to retain the moisture level up-to 6 hours and compare the efficacy to leading bench mark samples. Check the moisture/hydration power due to application of heel cream and also correlate the total fatty matter content and moisture measurement in carneometer. In addition

to that, the present study deals about the wound healing properties of new developed formula. This article also covers the detailed quantification of anti-microbial and anti-fungal screening and it will helpful to generate the optimum formula for the end user with respect to moisture benefit and healing property of foot cream.

## MATERIALS AND METHODS

Oil in water type cream base was prepared and detailed formulation details present in table 1.

**Table 1: Formulation details of in house.**

S. No.	Option 1	Option 2
1	Cream base	Cream base
2	Perfume	Perfume
3	Preservative	Preservative
4	DL Panthenol	DL Panthenol
5	Allantoin	Allantoin
6	Salicylic acid	Salicylic acid
7	-----	Unique RM - 1
8	-----	Unique RM - 1
9	Plant actives	Plant actives

### *Moisture measurement through the carneometer CM825*

The measurement is based on capacitance measurement of a dielectric medium. The Corneometer<sup>®</sup> CM 825 measures the change in the dielectric constant due to skin surface hydration changing the capacitance of a precision capacitor. The measurement can detects even slight changes in the hydration level. Measurement is based on the completely different dielectric constant of water and other substances. The measuring capacitor shows changes of capacitance according to the moisture content of the tested samples. A glass of lamina separates the metallic tracks in the probe head from the skin in order to prevent current conduction in the sample. An electric field between the tracks with alternating attraction develops. One track builds up surplus electrons (minus charge) and another side builds up the lack of electrons (plus charge). The scatter-field penetrates the very first layer of the skin during the measurement and the capacitance is determined.

### *Preparation of the room*

For all the measurements of skin parameters it is important to keep constant ambient conditions. Temperature and relative humidity should be maintained constant and it is vital for the comparison of long-term measurements. The optimal room conditions are 23-25 °C and 40 -60 % relative humidity. We allowed the test person to take rest for around 10 to 20

minutes, so that their blood circulation can regain a normal level after possible physical exercise. The area to be measured should not be covered with cloth during acclimatization time.

### ***Interpretation of the results***

Following values are valid for healthy skin and normal room conditions (25 deg C and 40 to 60 % RH) and will help you to determine the skin type. Arbitrary units varied between 0 and 130 and the standard values are provided below.

<b>Arbitrary units</b>	<b>Skin types</b>
<b>Less than 30</b>	<b>Very dry skin</b>
<b>30 to 45</b>	<b>Dry skin</b>
<b>&gt; 45</b>	<b>Sufficiently moisturized</b>

### ***Anti-microbial and anti-fungal screening***

Anti microbial and anti-fungal activity of study materials was tested in ‘*National College of Pharmacy*’, Shimoga, India. The cylinder plate assay of drug potency is based on the measurement of the diameter of zones of microbial growth inhibition surrounding the cylinder containing various dilutions of test compounds. The antimicrobial activity of standard drugs, topical cream formulations and base used, were carried out by the cup plate method. The zone of inhibition was measured by anti biotic zone reader.<sup>[6,7,8,9]</sup>

### ***Wound healing activity***

Animals are divided into two groups, one act as control and remaining one act as a treatment. Hair at the back of the animal was clipped with scissors and circular area of 300 – 500 sq.mm. The skin was excised to its full thickness with scalpel and scissor under light ether anesthesia. Next day the initial wound area was traced and later the respective formulations were applied as mentioned below for 8 days. Wound contraction was measured by tracing the wound margin on tracing paper and the area assessed using a graph paper on day 2,4,6 and day 8.<sup>[9,10,11,12]</sup>

### ***Statistical analysis***

Treated group results were compared with the control group. The results were analyzed statistically using Student's t-test to identify the differences between the treated and control.

## RESULTS AND DISCUSSION

Physico chemical parameters of heel care cream developed and bench mark sample analyzed and the analytical value summarized in table 3. Among the cream the option 2 has the higher total fatty matter content when compared to benchmark and option 1 sample. Nangbes *et al.*<sup>[13]</sup> found the higher TFM content of cosmetic products deliver the better moisture to the skin and prevent from the dryness. There is no significant difference in other parameters across the bench mark samples and in-house developed options.

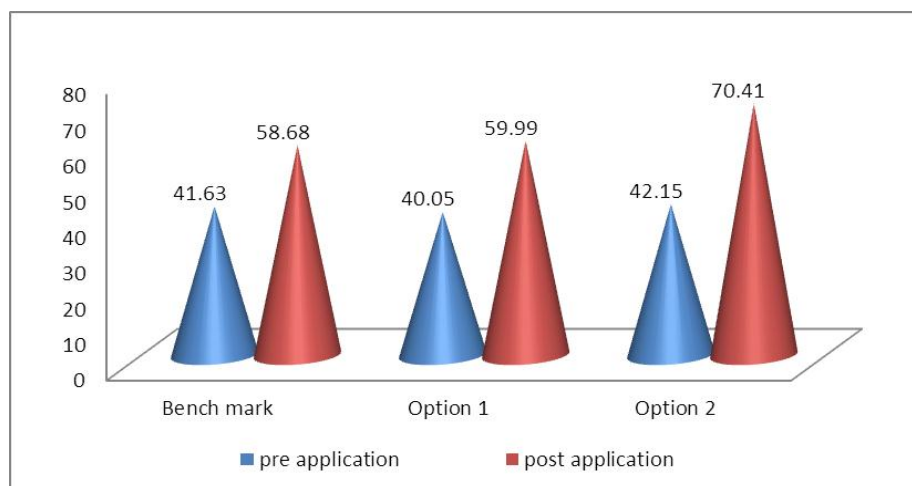
**Table 3: Physico-chemical properties of tested food creams.**

S.No	Parameters	Bench mark	Option 1	Option 2
1	Description	White colour cream	White colour cream	White colour cream
2	pH	4.56	4.72	4.71
3	Viscosity in (cps)	75000	76000	75500
4	Density @ 25°C	0.945	0.935	0.955
5	Total fatty mater (%)	23.5%	27.5 (%)	32.0 (%)
6	Total Aerobic Bacterial count (CFU/gm)	<10	<10	<10
7	Total yeast and mould (CFU/gm)	<10	<10	<10

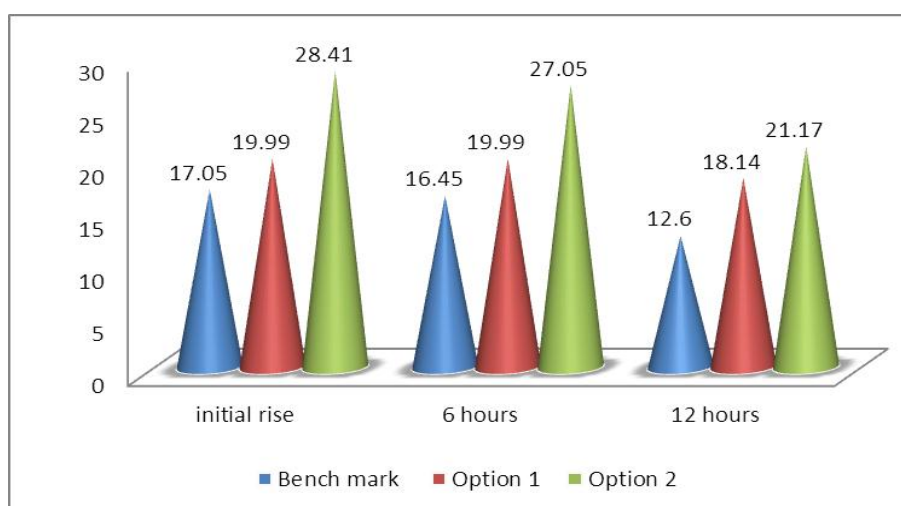
### Carneometer analysis

Study results clearly indicate that the skin was sufficiently moisturized after application of foot heel cream. Initially the skin arbitrary units were found to be lesser than 45 while after application of foot cream arbitrary units increased higher side; which means that the skin had been sufficiently moisturized. Around 17.05 arbitrary units ( $\Delta M$ ) increased due to application of bench mark samples. However the in-house prepared option 2 samples shows the higher increase of arbitrary unit and the increased value is 28.41. Option 1 sample increase the arbitrary unit ( $\Delta M$ ) around 19.99. Among the sample tested the Option 2 showed the higher moisturizing benefits when compared to bench mark and Option 1 samples. Moisture retention / moisture lock study also carried out with help of carneometer. Readings are carried out with same respondent after 6 hours and 12 hours of cream applications and the results are furnished in Figure 2.  $\Delta M$  value gradually decreased with increase the time of application, *i.e.* in six hours slightly the moisture value decreased in directly reflect the  $\Delta M$  value. However the drastic reduction noticed in after 12 hours, it means that the skin is needed to be moisturized. Option 2 samples initially shows around 28 units ( $\Delta M$ ) raise due to the application and gradually decreased and reach the 21  $\Delta M$  unit level after 12 hours. In the case bench mark initially rise up to 17 unit and reach the 12.6 unit after 12 hours. This result indicates the alarm of next application of cream. Study results revealed that daily two times

application of foot cream maintains the skin moisture and prevent skin from the damage issues. Based on primary study results indicates that the option 2 sample was better when compared to option 1 and bench mark sample, therefore the option 2 was carried out for the microbiological screening and other studies. Hema Sharma Datta *et al.*<sup>[14]</sup> also observed that the total fatty matter content directly correlated with the moisture benefit of the skin.



**Figure 1: Carneometer arbitrary value of before and after application of foot cream.**



**Figure 2: Increase moisture ( $\Delta M$ ) carneometer arbitrary value of different foot creams.**

### Microbiological screening test

The anti-microbial activity of developed foot cream compared with bench mark cream by cup plate method.<sup>[9]</sup> Results of anti-microbial activity of the foot cream formulation observed equivalent results against the bench mark samples and the results are summarized in table 4. The study reveals that the antibacterial and antifungal activity of both samples and standard found to be highly significant when compared to standard.

**Table 4: Anti-microbial study of foot cream formulation.**

Microorganism	Concentration	Standard	Bench mark	Option 2
<b>Gram Positive Bacteria</b>				
<i>Bacillus Subtilis</i>	200µg/disc	32±0.972	23± 0.23	25± 0.2363
<i>Bacillus cereus</i>	200µg/disc	32±0.65	25±0.56	25±0.56
<b>Gram Negative bacteria</b>				
<i>Shigella shiga</i>	200µg/disc	32±0.56	26±0.25	24± 0.41
<i>Esceria coli</i>	200µg/disc	34±0.12	25± 0.36	22.± 0.45
<b>Fungi</b>				
<i>Aspergillus fumigattus</i>	200µg/disc	32±0.22	24± 0.36	23± 0.26
<i>Candida albicans</i>	200µg/disc	32±0.43	30± 0.52	32± 0.18

### Wound healing study of foot cream formulations

Processes involved in wound healing are epithelialization, contraction with connective tissue deposition. Epithelialization is the process where keratinocytes migrate from the lower skin layers and divide. Option 2 treated wounds were found to heal much faster as indicated by improved rates of epithelialization and wound contraction, also confirmed by histopathological examinations. Also, the tensile strength of drug-treated wounds was increased significantly. Statistical analysis was done using ANOVA method followed by student's t-test method. The study reveals that the wound healing activity of both sample and standard found to be highly significant ( $P < 0.001$ ) when compared to control. However the in-house samples are having the slightly leading edge when compared to the bench mark samples.

**Table 5: Effect of foot cream on percentage of wound area contraction/healing.**

Treatment details	1 <sup>st</sup> day	2 <sup>nd</sup> day	4 <sup>th</sup> day	8 <sup>th</sup> day	21 <sup>st</sup> day
Control	29.09	41.74	49.30	59.49	93.24
Bench mark	32.84*	56.88*	68.78*	96.71*	--
Option 2	37.16*	67.85*	74.96*	94.33*	--

\*-statistically significant at  $P < 0.001$  level.

### CONCLUSION

In the case of bench mark initially increase up to 17 unit and reach the 12.6 ( $\Delta M$ ) unit after application of 12 hours. This result indicates the alarm of next application of cream and study results revealed that daily two times application of foot cream maintain the skin moisture and prevent from the skin damage issues. Based on primary study results indicates that the option 2 sample was better when compared to option 1 and bench mark sample. Antibacterial and antifungal activity of samples and bench mark found to be highly significant when compared



to standard. The study results reveals that the wound healing activity of both sample and standard found to be highly significant ( $P < 0.001$ ) when compared to control. However the in-house samples are having the slightly leading edge when compared to the bench mark samples.

### ACKNOWLEDGEMENT

The researchers thank the Mr. Mohit Malhotra, CEO; Mr. Vivek Dhir – Head of Marketing and Mr. Jude Linhares – Head of operation for their constant encouragement and support for the study.

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