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FORMULATING

Foot Care Products

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FORMULATING FOOT CARE PRODUCTS

In this class, we will cover:

1. Introduction to foot care products.
2. Formulating products for the feet.
3. Formulation examples.
4. Herbal Foot Soak.
5. Refreshing Foot Scrub.
6. Anti-callus Foot Lotion.
7. Softening Foot Cream.

INTRODUCTION TO FOOT CARE PRODUCTS

Our feet are in constant contact with the ground, which can cause practically lifelong wear and tear on the soles of the feet. Hours of friction due to walking, plus the warm and humid environment in the shoes, can cause a vast array of skin damage – from cosmetic (dry skin, calluses) to medical (fungal infections).

SKIN ON THE FEET

Skin on the feet is a lot like skin on the rest of our bodies – it has the same structure and a very similar function. However, there are some differences between foot skin and the skin on other parts of the body. Apart from some differences in the structure of the epidermis, the biggest difference is that skin thickens.

The outermost epidermis layers on the sole normally harden up soon after children start walking. On average foot skin is 1.5mm thick, with heels having the thickest skin. Adult skin on the heels can be up to 5mm thick, which is approximately 20 times thicker than on other body parts.

Constant mechanical stress of carrying our body weight can cause hyperkeratosis as a protective response[1]. This means that due to mechanical stress, skin cells from the dermis and epidermis levels differentiate at a faster pace, thus creating a thicker stratum corneum (the outermost layer of the skin, composed of corneocytes). Hyperkeratosis can be seen as calluses and corns on the feet. These skin issues are more common in older people, but can easily develop on young feet, too.

Interesting fact: Skin on the feet (as well as on the palms of the hands) has no hair follicles, which means it does not grow any body hair.

FORMULATING PRODUCTS FOR THE FEET

Several product types can be used in foot care – bath soaks/ salts, scrubs, creams, masks and butters.

Most cosmetic products for foot care usually target dry, hyperkeratotic skin, as well as calluses and cracked heels. In order to soften hard skin and hydrate extremely dry skin, different ingredient types can be used:

Keratolytic agents. Ingredients like salicylic acid, alpha hydroxy acids (AHAs) and allantoin can soften keratin in the epidermis and thus soften the skin of the soles. To find out more about AHAs and BHAs, including how to formulate with them, please check out Formulating with AHAs and BHAs in the Natural Cosmetic Formulation Club.

Humectants. Ingredients like glycerin, sorbitol or xylitol attract water and thus hydrate dehydrated foot skin.

Above: Anti-callus foot lotion with urea

Urea. Probably one of the most commonly used ingredients to soften hard and dry skin of the feet and hands. It functions as a wound healer and keratolytic, as well as a humectant. It can be tricky to use as it is rather unstable in water solutions, degrading into ammonia and carbon dioxide. Ammonia raises the pH, which increases the degradation of urea, plus it can cause pH-dependent preservatives to become inactive. Carbon dioxide causes bubbles in the product and increases the pressure inside the packaging, which can lead to the container to burst. For these reasons, urea in cosmetic formulations needs to be stabilized. Normally, it is combined with a buffer system to prevent pH shifts, and to 'lock' the pH at 6.2, where urea is most stable. Other acids, like salicylic and lactic can also help to stabilize urea. Decreasing water activity by using other solvents, eg glycols, will slow down urea degradation as well.

Above: Refreshing foot scrub

Emulsions formulated for feet are typically very light and easy to absorb. For this reason they usually use lower oil phases and do not contain occlusive ingredients. Oils rich in polyunsaturated fatty acids can also provide beneficial lipids to the epidermal cells.

To create a non-greasy, powdery feel after application, foot care products often contain ingredients that improve slip, eg talc. Natural alternatives to talc can be silica microspheres, but starch can also be used (eg cornstarch, arrowroot powder, tapioca starch, etc). The dry ingredients also function as sweat absorbers, so they offer an additional benefit in a product.

Since feet often spend a lot of time in socks and shoes, they are prone to developing unpleasant odors due to sweating. To reduce sweating, antiperspirant ingredients like aluminum salts are commonly used. To neutralize malodor, different deodorizing ingredients can be used, such as triethyl citrate, zinc ricinoleate, or essential oils to mask the foot odor.

To find out more about deodorants, including formulating your own natural deodorants, please check out Formulating Advanced Natural Deodorants in the Natural Cosmetic Formulation Club.

Products aimed at tired legs usually use essential oils with cooling, uplifting and astringent properties, eg peppermint, rosemary or eucalyptus. Horse chestnut extract (INCI: Aesculus Hippocastanum Extract) can improve blood circulation in veins in the legs and thus decrease swelling.

FORMULATION EXAMPLES

A note on making emulsions: Some of the formulas below are emulsions. Different methods can be used to heat and combine the water phase and oil phase of an emulsion. You can choose to heat the phases in a double boiler/bain-marie or on a hotplate (for example a magnetic hotplate stirrer). You can also choose to use the 'heat and hold' method. The heat and hold method involves heating both containers to 70°C and holding them there for 20 minutes. To account for water evaporation during heating, weigh the water phase container before heating and take a note of the weight. After the 20 minutes have passed, weigh the container again to see how much water has evaporated. Add the appropriate amount of purified/deionized water to compensate for any water lost during heating. Alternatively, you can cover the container with plastic wrap to prevent evaporation, heat to the required temperature and use immediately.

We discuss the pros and cons of these different methods in detail in our Diploma in Natural Skincare Formulation

ADJUSTING pH

You can test the pH of your skincare products with either pH strips or a pH meter. A pH meter will give more precise measurements.

Most commonly the pH is lowered with a citric acid solution (usually a 50% solution) and increased with a sodium hydroxide solution (usually a 10% solution).

WARNING!

Sodium hydroxide (NaOH) is extremely caustic. This means it is very corrosive and may cause damage if it comes into contact with organic tissue, such as skin, eyes or the mucous membranes of people or animals. The damage can include chemical burns and blindness. **Sodium hydroxide should never be inhaled or consumed – it can be fatal if swallowed.**

Dissolving sodium hydroxide in water is a highly exothermic process – it releases a large amount of energy in the form of heat. This causes sodium hydroxide solution to heat up to almost boiling point. The resulting heat can cause heat burns or damage to materials that are heat sensitive. High temperatures cause caustic fumes to rise from the container, which can be harmful when inhaled. It is necessary to prepare sodium hydroxide solution in a well-ventilated area. **Always add NaOH to the water and not the other way around.**

It is important to **wear protective clothing and equipment** when working with sodium hydroxide. Wear thick and long gloves to protect your hands, eye protection to prevent any damage to the eye and a mask or respirator can also be worn. Protective clothing needs to include long sleeves, long pants and closed-toe shoes, so no skin is exposed.

10% sodium hydroxide solution can be prepared by mixing 10 grams of NaOH in 90 grams of purified water. This solution can be stored in a glass bottle for later use. A 50% citric acid solution is prepared by mixing 50g of citric acid with 50g of purified (deionized) water.

For more information on adjusting pH please refer to our article How to test and adjust the pH of natural skincare products (and why you should)

To find out more about how to develop your pH lab skills, please check out the pH Masterclass in the Natural Cosmetic Formulation Club.

HERBAL FOOT SOAK

This is a simple dry product used to make a hydrating foot soak. To use, add approximately 3 tablespoons of the powder in 4 liters of warm water. Soak the feet for 10-30 minutes, then dry and apply a moisturizing cream. Use the foot soak once a week.

PRODUCT DEVELOPMENT QUESTIONS

Product type
Spa-style foot soak.

Are you formulating to meet a particular standard or certification?
We are mainly using naturally derived ingredients. Most are COSMOS/Ecocert-permitted ingredients. Urea and allantoin are synthetically produced but nature-identical.

Who is your target audience?
People of all ages.

What problems are you solving? What skin type is it for?
For all skin types. To help cleanse, soften and smooth the skin on the feet.

What is the purpose/function of your product?
The product is to be used either before a pedicure or as a standalone foot treatment. It will soften and smooth the skin, and cleanse and refresh the feet. It will also promote relaxation and help reduce stress.

What properties and qualities do you want your product to have?
This product contains mostly salt therefore the appearance will be white crystals, which dissolve when added to water. It will have an invigorating smell of herbal essential oils.

What type of packaging will your product go in?
Clear jar.

Which salt are you using (if any) and why?
Epsom salt – in a foot bath soak it relieves stress and calms the skin. It contains magnesium, which can be beneficial to treat minor aches and tired muscles.

Dead Sea salt – in foot bath soaks it relieves stress and calms the skin. It contains more trace elements than regular sea salt such as magnesium, calcium, sulfur, bromide, iodine, sodium, zinc and potassium, which all help to rehydrate and restore the skin.

Which other powdered ingredients (if any) are you using and why?
Allantoin and urea. Both will help to soften the skin with their keratolytic properties.

Which essential oils/fragrance oils are you using and why?
Peppermint essential oil to alleviate aches and pains, and to reduce stress and anxiety. It has a refreshing and invigorating aroma.

Which dried botanicals/botanical powders are you using (if any) and why?
Peppermint, lavender and calendula – mainly for aesthetic purposes, but also for the scent.

Which other ingredients specific to this product type are you using and why?
None.

FORMULA

Phase	INCI name	Trade name	Function	w/w%
A	Magnesium Sulfate	Epsom salt	Stress relief	44.0
A	Maris Sal (Dead Sea Salt)	Dead Sea salt	Skin hydrator/restorer	30.0
A	Sodium Bicarbonate	Baking soda	Odor neutralizer	10.0
A	Urea	Urea	Keratolytic, humectant	10.0
A	Allantoin	Allantoin	Keratolytic, skin softening	2.0
B	Lavandula Angustifolia (Lavender) Flower Oil	Lavender essential oil	Fragrance	0.5
B	Mentha Piperita (Peppermint) Oil	Peppermint essential oil	Fragrance	0.3
B	Eucalyptus Globulus (Eucalyptus) Leaf Oil	Eucalyptus essential oil	Fragrance	0.2
B	Mentha Piperita (Peppermint) Leaf	Dried peppermint leaves	Aesthetic	1.0
B	Lavandula Angustifolia (Lavender) Flower	Dried lavender flowers	Aesthetic	1.0
B	Calendula Officinalis Flower	Dried calendula petals	Aesthetic	1.0

INSTRUCTIONS

1. Weigh out each ingredient in turn and add to the main mixture in the order listed. Stir with a spatula or manual whisk between each addition until thoroughly mixed.
2. Transfer to your packaging of choice.

PRODUCT SPECIFICATIONS

Appearance: Mixture of combined salts, powders and dried botanicals.

Odor: Sharp, herbal, minty.

Color: White, with colored bits.

pH: N/A.

REFRESHING FOOT SCRUB

This product is a water-based gel that contains ground pumice for exfoliation. It is best when used after a foot soak – the skin is then softer and exfoliation will be more effective. To use, apply the scrub on the soles of your feet, massage gently, then wash off. Follow with a generous layer of hydrating and nourishing cream. Use two to three times per month.

PRODUCT DEVELOPMENT QUESTIONS

Product type
Foot scrub to be used two to three times per month.

Are you formulating to meet a particular standard or certification?
Yes, COSMOS.

Who is your target audience?
People of all ages.

What problems are you solving? What skin type is it for?
For all skin types, especially dry and rough skin. To help smooth and soften the skin on the feet.

What is the purpose/function of your product?
The product is to be used either before a foot soak or as a standalone foot treatment. It will soften and smooth the skin, and refresh the feet. It will also prevent dry skin build-up on the soles.

What properties and qualities do you want your product to have?
It is a gel-based scrub, so it will look semi-transparent, with a green tint due to the chlorophyll in the product. It will have a fresh, energizing, herbal scent.

What type of packaging will your product go in?
Clear jar. A squeeze tube could also be used.

Which thickeners/suspending agents are you using and why?
Xanthan gum as it is easily available and is very successful at suspending exfoliant particles. Konjac gum to counter the slimy skin feel of xanthan gum.

Which exfoliating ingredients are you using and why?
Ground pumice – it is a natural exfoliator that will not dissolve in water and is strong enough to exfoliate any hard, dry skin of the feet.

Which humectants are you using and why?
Glycerin – to offer some moisturization while using the scrub.

Which active ingredients and/or essential oils are you using and why?
Rosemary, cypress and pine needle essential oil for a refreshing scent.

Which other ingredients specific to this product type are you using and why?
Caprylyl/capryl glucoside to solubilize the essential oils in the water. We are also using liquid chlorophyll to achieve a natural green color that goes well with the herbal-fresh scent of the product.

FORMULA

Phase	INCI name	Trade name	Function	w/w%
A	Aqua	Purified water (deionized)	Solvent	71.7
A1	Amorphophallus Konjac Root Extract	Konjac gum	Thickener	0.6
A1	Xanthan Gum	Xanthan gum	Thickener	0.6
A1	Glycerin	Glycerin	Humectant	5.0
B	Caprylyl/Capryl Glucoside	Caprylyl/capryl glucoside	Solubilizer	10.0
B	Rosmarinus Officinalis (Rosemary) Leaf Oil	Rosemary essential oil	Fragrance	0.6
B	Cupressus Sempervirens (Cypress) Leaf Oil	Cypress essential oil	Fragrance	0.3
B	Pinus Sylvestris (Pine Needle) Leaf Oil	Pine needle essential oil	Fragrance	0.3
C	Pumice	Ground pumice	Exfoliant	10.0
C	CI 75810/Chlorophyllin-Copper Complex	Liquid chlorophyll	Colorant	0.1
C	Dehydroacetic Acid, Benzyl Alcohol	Geogard 221	Preservative	0.8

INSTRUCTIONS

1. Combine A1 to form a slurry.
2. Add phase A1 ingredients to the water (phase A), and mix until gel starts to form. If lumps appear, use a stick blend to break the lumps apart.
3. Combine phase B ingredients and then mix into phase A.
4. Add phase C ingredients to phases A+B. Stir until mixed in.
5. Adjust the pH to 5.0.

PRODUCT SPECIFICATIONS

Appearance: Medium thick gel with exfoliant particles.

Odor: Sharp, herbal, minty.

Color: Green, semi-transparent, with white particles.

pH: 5.0.

ANTI-CALLUS FOOT LOTION

This foot lotion features urea that will help to soften dry skin on the heels and prevent calluses from forming. Since urea is an unstable ingredient, the formula contains lactic acid and sodium lactate – a buffer that will help to prevent pH drift. It also contains a small amount of salicylic acid which functions as a keratolytic and urea stabilizer. For a refreshing and deodorizing action, peppermint essential oil is included.

The lotion can be applied to clean feet every day. Due to the low stability of urea, it is best to use the lotion within one to two months of making it.

PRODUCT DEVELOPMENT QUESTIONS

Product type
Foot lotion – an emulsion to be used daily.

Are you formulating to meet a particular standard or certification?
We are mainly using naturally derived ingredients. Urea and allantoin are synthetically produced.

Who is your target audience?
People of all ages.

What problems are you solving? What skin type is it for?
For all skin types, especially dry and rough skin. To soften the skin of the feet and to prevent dry skin build-up and callus formation.

What is the purpose/function of your product?
The product is best used every day on the feet. It will soften rough and dry skin.

What properties and qualities do you want your product to have?
It is a white emulsion with a strong minty scent.

What type of packaging will your product go in?
Bottle with a lotion pump.

Which emulsifiers are you using and why?
Olivem 1000 as it is easily available and easy to work with. It also has a high pH and electrolyte tolerance which is a useful trait in this formula.

Which stabilizers/thickeners are you using and why?
Xanthan gum as it is easily available and cetyl alcohol which will also function as an emollient.

Which emollients are you using and why?
Sunflower oil for its high linoleic fatty acid content and fractionated coconut oil for its light, non-greasy skin feel.

Which humectants are you using and why?
Glycerin, to offer some moisturization. Propanediol, in which to dissolve salicylic acid (since it has low water solubility). It can be replaced by propylene glycol or naturally derived pentylene glycol.

Which active ingredients and/or essential oils are you using and why?
Urea, as the main keratolytic and skin softening active ingredient; lactic acid and sodium lactate as a buffer system for pH stabilization; salicylic acid for keratolytic properties and urea stabilization; and peppermint essential oil for a cooling effect and fresh scent.

Which other ingredients specific to this product type are you using and why?
Naticide as the preservative, since it has a broad pH range where it remains active. Other preservatives can also be used, as long as they are active at pH 6.0 and above.

If using Geogard 221, use 1% Geogard 221 and 5% pentylene glycol (a natural preservative booster) to ensure proper preservation. Remove 5% water, so the formula still equals 100%.

FORMULA

Phase	INCI name	Trade name	Function	w/w%
A	Aqua	Purified water (deionized)	Solvent	20.9
A	Lactic Acid, Aqua	Lactic acid (80% solution)	pH stabilizer	0.5
A	Sodium Lactate	Sodium lactate	pH stabilizer	10.0
A1	Propanediol	Propanediol	Solvent/humectant	20.0
A1	Salicylic Acid	Salicylic acid	Exfoliant, stabilizer	0.2
A2	Glycerin	Glycerin	Humectant	2.0
A2	Xanthan Gum	Xanthan gum	Thickener	0.7
B	Cetearyl Olivate (and) Sorbitan Olivate	Olivem 1000	Emulsifier	5.0
B	Helianthus Annuus (Sunflower) Seed Oil	Sunflower oil	Emollient	3.0
B	Caprylic/Capric Triglyceride	Fractionated coconut oil	Emollient	3.0
B	Cetyl Alcohol	Cetyl alcohol	Emollient/thickener	3.0
C	Aqua	Purified water (deionized)	Solvent	20.0
C	Urea	Urea	Keratolytic	10.0
D	Naticide	Parfum	Preservative	1.0
D	Mentha Piperita (Peppermint) Oil	Peppermint essential oil	Fragrance	0.6
D	Tocopherol	Vitamin E (95% mixed tocopherols)	Antioxidant	0.1

INSTRUCTIONS

1. Combine phase A1 ingredients, heat to 50°C.
2. Combine phase A2 ingredients to a slurry.
3. Mix phase A1 into A, then add A2 and mix until the gum hydrates.
4. Combine phase B ingredients.
5. Heat phase A and phase B separately to 70°C.
6. Combine phases A and B, emulsify using a stick blender or a homogenizer.
7. Cool down the emulsion to 50°C.
8. Combine phase C ingredients, mix until urea dissolves.
9. Add phase C to A+B, emulsify again using a stick blender or a homogenizer.
10. Add phase D. Stir well.
11. Adjust the pH to 6.2 using lactic acid (to decrease the pH) or sodium lactate (to increase the pH).

PRODUCT SPECIFICATIONS

Appearance: Medium to low viscosity white emulsion.

Odor: Sharp, herbal, minty.

Color: White.

pH: 6.2.

SOFTENING FOOT CREAM

This foot cream uses lactic acid to soften, exfoliate and hydrate the skin on the feet. For a refreshing scent, wintergreen and spearmint essential oil is included. Because lactic acid is an AHA (alpha hydroxy acid) it increases the skin's sensitivity to sun. For this reason, the cream should only be used on the soles of the feet. If you are using it on the top of your feet, only use it during months when your feet are not exposed to sun. The cream can be used two to three times per week. On extremely dry and thick skin of the feet, it can be used every day. Wash your hands after applying the cream.

PRODUCT DEVELOPMENT QUESTIONS

Product type
Foot cream – an emulsion to be used two to three times per week.

Are you formulating to meet a particular standard or certification?
We are mainly using naturally derived ingredients.

Who is your target audience?
People of all ages.

What problems are you solving? What skin type is it for?
For all skin types, especially dry and rough skin. It exfoliates rough skin and hydrates dry skin.

What is the purpose/function of your product?
The product is used two to three times per week to soften the skin on the feet.

What properties and qualities do you want your product to have?
It is a blue-green emulsion with a strong herbal scent.

What type of packaging will your product go in?
Clear jar.

Which emulsifiers are you using and why?
Montanov 68 as it has a high pH tolerance, which is useful in this cream as it contains AHAs.

Which stabilizers/thickeners are you using and why?
Xanthan gum as it is easily available; and cetyl alcohol which will also function as an emollient.

Which emollients are you using and why?
Evening primrose oil for its high linoleic and Gamma linolenic acid (GLA) fatty acid content; and squalane and fractionated coconut oil for their light, non-greasy skin feel.

Which humectants are you using and why?
Glycerin, to offer some moisturization.

Which active ingredients and/or essential oils are you using and why?
Lactic acid as the main chemical exfoliant and skin softening active ingredient; panthenol to promote skin regeneration; wintergreen and spearmint essential oil for a refreshing and invigorating scent; and German chamomile essential oil for its scent as well as blue color.

Which other ingredients specific to this product type are you using and why?
None.

FORMULA

Phase	INCI name	Trade name	Function	w/w%
A	Aqua	Purified water (deionized)	Solvent	51.2
A	Lactic Acid, Aqua	Lactic acid (80% solution)	Exfoliant	8.0
A	Sodium Hydroxide, Aqua	Sodium hydroxide (25% solution)	pH adjuster	6.0
A1	Glycerin	Glycerin	Humectant	2.0
A1	Xanthan Gum	Xanthan gum	Thickener, stabilizer	0.7
B	Cetearyl Alcohol (and) Cetearyl Glucoside	Montanov 68/Vegetal/Sugarmulse	Emulsifier	6.0
B	Caprylic/Capric Triglyceride	Fractionated coconut oil	Emollient	9.0
B	Squalane	Squalane	Emollient	4.0
B	Oenothera Biennis (Evening Primrose) Oil	Evening primrose oil	Emollient	4.0
B	Cetyl Alcohol	Cetyl alcohol	Thickener, stabilizer	4.0
C	Panthenol	Panthenol	Active ingredient	3.0
C	Benzyl Alcohol, Salicylic Acid, Glycerin, Sorbic Acid	Preservative ECO/Geogard ECT	Preservative	1.0
C	Gaultheria Procumbens (Wintergreen) Leaf Oil	Wintergreen essential oil	Fragrance	0.6
C	Mentha Piperita (Peppermint) Oil	Spearmint essential oil	Fragrance	0.2
C	Chamomilla Recutita (Matricaria) Flower Oil	Chamomile (blue) essential oil	Fragrance/colorant	0.2
C	Tocopherol	Vitamin E (95% mixed tocopherols)	Antioxidant	0.1

INSTRUCTIONS

1. Combine phase A1 to create a slurry.
2. Combine phase A, add A1 and mix until the gum hydrates.
3. Combine phase B.
4. Heat phase A and phase B to 70°C.
5. Remove the containers from the heat and add phase B to phase A.
6. Mix with a stick blender to create an homogeneous emulsion.
7. Put the emulsion in a cold water bath and cool to 40°C whilst stirring.
8. Once it cools down, add phase C ingredients and mix thoroughly.
9. Measure and adjust the pH to 3.6-4.0. This pH ensure the optimal functioning of lactic acid.

PRODUCT SPECIFICATIONS

Appearance: Medium viscosity emulsion.

Odor: Sharp, herbal, minty.

Color: Light blue.

pH: 3.6-4.0.

SUMMARY

In this class we explained how to formulate products for foot care. We also gave formulation examples for four different products: a foot soak, foot scrub, foot cream and foot lotion.

REFERENCES

1. Rubin, Louis. 1949. 'Hyperkeratosis in response to mechanical irritation', in *Journal of Investigative Dermatology* 13, no. 6: 313-315.

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