INFANT'S SKIN AND CARE NEEDS WITH SPECIAL CONSIDERATION TO FORMULATION ADDITIVES

SIRI SINDHURA DK, VIKAS JAIN*
Department of Pharmaceutics, JSS College of Pharmacy, JSS Academy of Higher Education and Research, Mysore, Karnataka, India. Email: vikasjain@jssuni.edu.in

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ABSTRACT

Infancy is the time of adaptation from intrauterine life to the rather dry and cold, environment. Infant skin is more sensitive due to the immature immune system, hence, effortlessly prone to complications. Children from different age groups face diverse skin problems such as cradle cap, infant eczema, diaper rash, prickly heat, and many more. During early infancy, the products such as mild cleansers and lotions are used, and later, massage oils, creams, lotions, soaps, bubble bath, and other products are utilized for another few years, as a part of routine care. The preterm infants are more prone to skin damage and percutaneous toxicity from topically applied products. The ingredients incorporated in infant care products require special attention while choosing a product for them. Topical application of any such product requires thorough screening for potentially harmful ingredients before its exposure to the infant’s skin. Products used for infants should be safe and restricted of fragrance, coloring agents, parabens, plant oils, extracts, and other obnoxious ingredients. The literature is flooded with the list of safer excipients that can be utilized for the development of skin care products for infants and children.

Keywords: Dermatitis, Formulation additives, Dry skin, Skin structure, Skin barrier.

INTRODUCTION

Infant skin is considered most delicate among all skin types [1]. The neonatal period states for the 1st month after birth. A newborn baby is born with a protective covering which is wrinkly in nature, called vernix [2]. It naturally peels off during the 1st week after birth. The anatomical features such as the presence of thin dermis, decreased cohesion between dermis and epidermis renders it more vulnerable to certain obnoxious stimuli and make it susceptible to certain common skin disorders such as Eczema, cradle cap, heat rash, diaper dermatitis, and other forms of dermatitis [3].

Baby’s skin has special skin care needs to protect from common disorders. The formulations chosen for the baby skin require specific consideration [4]. Neonatal skin has peculiar absorption characteristics, with high permeability to topical agents. In the early neonatal period, there is a marked topical drug absorption and high skin water loss because of incomplete development of the stratum corneum [5,6]. On safety, this article discusses the baby skin structural features, the common skin disorders seen in babies, and skin care needs of a baby including the formulation excipients that are commonly recommended and avoided [7].

SKIN FEATURES OF AN INFANT

Functional and structural skin maturation is a dynamic process, which starts at the moment of delivery and ends in the 1st year of life. In full-term newborns, this process begins immediately after birth, while in preterm newborns by 2–3 weeks after birth, the skin is comparable to a full-term newborn’s skin [8].

The skin comprises a multi-layered epidermis from ectoderm with an underlying dermis derived from mesoderm [9]. The skin further develops through the embryonic and fetal stage [10]. The epidermis also includes the basal layer and the superficial periderm [11]. Vernix caseosa is a protective hydrophobic layer that guards the fetal skin against intrauterine maceration. It is composed of water (80.5%), proteins, sebum lipids, and antimicrobial peptides with biomechanical and water-binding properties [12].

DIFSERENCES BETWEEN AN ADULT AND BABY’S SKIN

Infant skin is often regarded as ideal skin, and adults normally seek its features [13]. Higher skin hydration, a lower skin pH, relates to a reduced heat loss after birth. Pre-mature babies have an immature epidermal barrier and lack the protective coating of vernix caseosa; therefore, greater risk of having a lower body temperature [14]. Infant skin has a higher rate of water absorption and desorption compared to adults [15]. Newborns have a large surface area in relation to volume and a high thermal conductance with an increased risk of heat loss. They have less melanocytes, which results in less photo-protection of their skin, resulting in abnormal collagen and elastin levels [16]. Sebum levels in the 1st week of life are high, which subsequently decrease [17]. The natural moisturizing factor is lower in infants compared to adults, but the level of NMF is reported to be higher in the first 2 weeks of life [18-20].

COMMON SKIN DISORDERS SEEN IN BABIES

Diaper dermatitis
A rash that occurs in the parts within the diaper in infants aged around 9–12 months is usually termed as diaper dermatitis. Around 7–35% of the infant population suffer from diaper dermatitis [21].

Increased wetness in the diaper area results in increased susceptibility of baby’s skin to physical, chemical damage, and some enzymatic mechanisms. Excess hydration causes the urease enzyme that is found in the stools to liberate ammonia, a mild irritant, which increases the pH and cause irritation to the skin [21]. Other enzymes such as lipases, proteases come in contact with the skin; they can also break down the skin barrier. The bile salts present in the feces boost the activity of enzymes, adding to the effect [22].

A fungus, Candida albicans can also contribute to augment diaper dermatitis. Other microbes have been secluded less often, as they occur as a result of secondary infections [23].

The treatment available in the market does comprise diaper rash creams which contain zinc oxide as their active ingredient as it dries the area,
Avoided
Coconut oil
Olive oil
Recommended
Liquid paraffin
Clove bud, leaf, and stem oil
All
Peppermint oil
Eucalyptus oil
Anise/aniseed oil
All
Clarified butter (ghee)
Cornstarch (natural and organic)
None
Peanut oil
Fennel oil
Chamomile oil
Mustard oil

Specifically considering seasonal variations. It is known that an infant's skin is categorized into - dry skin, oily skin, and combination skin. When it comes to seasonal variations, care and product considerations are given utmost importance [45,46].

**Infant's skin care needs**

An infant's skin is categorized into - dry skin, oily skin, and combination skin. Each skin type has special daily care needs specifically considering seasonal variations. It is known that an infant's skin is different from adult skin. When it comes to seasonal variations, to protect their skin from various ailments, also in general day-to-day care and product considerations are given utmost importance [45,46].

**Daily skin care**

The process of bathing dries out the infant's skin because it saps out the natural. Bathing time should be kept minimal, and the temperature of the water should remain optimum. In general, perfume and detergent-free soap is recommended [47].

To maintain the proper level of moisturization, moisturizing at regular intervals while there is still some moisture left on the skin from the bath helps to lock the water on the skin [48]. Use of emollients can be helpful to restore skin elasticity, sustain skin homeostasis, and control TEWL, while a regular emollient application from birth can be considered an effective approach for atopic dermatitis prevention in neonates [49].

| Excipients | Recommended | Avoided |
|------------|-------------|---------|
| **Fixed oils** | Coconut oil | Mustard oil |
| | Sesame oil | Clarified butter (ghee) |
| | Almond oil | Olive oil |
| | Sunflower oil | Peanut oil |
| | Castor oil | |
| | Grape seed oil | |
| | Safflower seed oil | |
| | Soybean oil | |
| | Corn oil | |
| | Jojoba oil | |
| | Shea | |
| | Cranberry seed oil | |
| | Peach kernel | |
| | Cherry kernel | |
| | Kiwi seed oil | |
| | Moringa oil | |
| | Broccoli seed oil | |
| **Essential Oils** | Chamomile oil | Anise/aniseed oil |
| | Dill oil | Clove bud, leaf, and stem oil |
| | Lavender oil | Eucalyptus oil |
| | Tea tree oil | Fennel oil |
| | Avocado oil | Lemongrass oil |
| | Calendula oil | Peppermint oil |
| | Mandarin oil (sweet orange) | Yang-ylang oil |
| | Rose Otto (steam distilled rose oil) | Rosemary oil |
| **Mineral oils** | Liquid paraffin | Balsam Peru oil |

| Excipients | Recommended | Avoided |
|------------|-------------|---------|
| **Bulking agents** | Cornstarch (natural and organic) | Talc |
| | Tapioca starch | |
| | Oat starch | |
| | Sodium bicarbonate | |
| | Bentonite | |
| | Kaolin | |
| **Antibacterial** | Zinc oxide | |
| **Antioxidant** | Tocopheryl Acetate | |
| **Fragrance** | None | All |
| **Dyes** | None | All |
Changing lifestyles cause babies in need of disposable diapers and wipes which are convenient for parents. Airing out the diaper area is very important to prevent moisture accumulation. Constant use of diapers may cause redness, leading to diaper dermatitis in most cases [50]. Baby products contain mild cleansers and protect the natural balance of baby’s skin. Skin care products made for babies should have lower levels of chemicals, fragrance, and dyes [51].

### Summer care

The heat alleviates the perspiration, which leads to skin infections in infants [52]. Sweat contains sodium chloride in it causing rashes and itching [53,54]. Cradle cap can be a sign of fungal infection, and certain antifungal preparations on baby’s head can be used. Application of oil is avoided if dermatitis or heat rash is seen along with cradle cap [55]. Heat rash is commonly observed during summer. Prickly heat powders with zinc oxide are widely used [56]. If sweating is heavy and fungal infection is seen, the best way to manage would be using dusting powders [57,58].

### Winter care

Winter can seem very harsh on infant’s sensitive skin. During winter, their skin tends to become dry forming wrinkles [59,60]. Applying any baby massage oil all over the baby’s scalp and massaging gently can remove dandruff from the scalp caused due to winters [61]. Safe, low-dose, and hydrocortisone can be used for heat rashes due to over-clothing [62]. Any signs of eczema, ointments can be used as moisturizers after baths. For good results, oils are massaged at regular intervals, which increases the penetration of oil into the skin [63,64].

### Formulation Essentials for Infant’s Skin Care Products

The market is filled with various baby care products such as baby oils, shampoos, soaps, and creams. To choose the right product for your baby skin is a challenge, as they have to meet certain criteria such as being mild and non-toxic. However, not all the ingredients that are present in baby products are harmful. Therefore, the excipients considered harmful should be avoided in baby products. This section discusses the excipients that are usually recommended to use and should be avoided in infant’s products.

#### Baby oils

Baby oils are mineral or natural oil or combination of these categories used for applying on baby skin or scalp to moisturize. Massaging baby oils is to strengthen the muscles and relax them. Oil massage of newborns has been practiced for generations. However, oils may vary from potentially beneficial, for example, sunflower seed oil, and to potentially toxic, for example, mustard oil (Table 1). Among all oils,

### Excipients

| Category          | Recommended                              | Avoided                                      |
|-------------------|------------------------------------------|----------------------------------------------|
| Surfactants       | Sodium Trideceth Sulfate                 | Sodium lauryl sulfate                        |
|                   | Cocamidopropyl betaine                   | Sodium laureth sulfate                       |
|                   | Disodium cocamphodiacetate               | Ammonium laureth sulfate.                    |
|                   | Coco-glucoside                           | Carboxylates                                 |
|                   | Decyl glucoside                          | Quaternary ammonium salts                    |
|                   | Lauryl glucoside                         | Amine oxides                                 |
|                   | Sucrose Laurate                          | Sulfoxides                                   |
|                   | Glyceryl oleate                          | Ethoxylates                                  |
|                   | Sodium lauroamphoacetate                 | Poloxamers                                   |
| Conditioning Agent| Polyquaternium-10                        | Dimethicone                                  |
|                   | Guar Hydroxy-propyl trimonium Chloride    | Silicones                                    |
|                   | Butylene Glycol                          |                                              |
|                   | Capryloyl glycine                        |                                              |
|                   | PCA Glyceryl oleate                      |                                              |
| Foamer            | Disodium oleamide                        | Parabens: Methyl paraben, propyl paraben etc.|
|                   | Xanthan gum                              | Formaldehyde donors                          |
| Thickener         | PEG-80                                   |                                              |
|                   | Xanthan gum                              |                                              |
| Preservatives     | Sodium Benzoate                          |                                              |
|                   | Glucose oxidase and lactoperoxidase      |                                              |
|                   | Phenoxyethanol                           |                                              |
|                   | Potassium sorbate                        |                                              |
| Humectant         | Glycerine                                | Propylene glycol                             |
|                   | Calcium gluconate                        |                                              |
| Chemical Fragrances| None                                     |                                              |
|                   | None                                     |                                              |
| Synthetic Colors  | Acetaldehyde, Benzophenone, BHA, Benzyl Salicylate, Benzyl Benzoate, Butoxyethanol, Butylphenyl methylpropional, Chloromethane (methyl chloride), Dichloromethane (methylene chloride), DEP Eugenyl methyl ether (Methyleneugenol), Formaldehyde, MEA, DEA, TEA–ethanolamines, Oxybenzone (BP-3), Methanol, Synthetic Musks (Tonalide, Galaxolide, Musk Ketone, Musk Xylene) etc. |
| Other Excipients  | Glucose (natural exfoliate)              |                                              |
|                   | Citric Acid (pH stabilizer)              |                                              |
|                   | Sodium Hydroxide (relaxer)               |                                              |
|                   | Allyl caproate (emollient)               |                                              |
|                   | Triethyl citrate (masking)               |                                              |
|                   | FD&amp; Red No. 6/D&amp;C Green No. 6.   |                                              |
|                   | Isopropyl alcohol (solvent)              |                                              |

BHA: Butylated hydroxyanisole, DEP: Diethyl phthalate
coconut oil and sunflower oil have been most widely used for infant massage [65,66]. Sunflower oil protects the integrity of stratum corneum and improves hydration [67]. Olive oil can promote atopic dermatitis and aggravate existing dermatitis [70].

Ahmed et al. 2007 suggested that those who received an oil massage, the most commonly-used product was mustard oil, which was applied to 73 (88%) of the 83 babies massaged; other products mentioned were coconut oil in eight (9.6%) cases, and olive oil, and proprietary baby lotion in one each. In this study, the "mean oxygen saturation" was enhanced in babies massaged with sunflower oil [68].

In general, vegetable oils that are high in linoleic acid are gentler on baby skin. Linoleic acid is an essential fatty acid that helps to protect the barrier of skin, for example, Sunflower oil and grape seed oil. Vegetable oils high in oleic acid may be harsher on your baby’s skin, for example, olive oil. Perfume-free baby mineral oils are another option if your baby has dry, broken skin. Mineral oil is derived from petroleum [69,70]. Petroleum-based skin softeners (emollients) are effective and safe for treating skin problems such as dermatitis and eczema (Table 1).

Table 4: The excipients recommended and to be avoided in the formulation of creams and lotions [72-74,93]

| Excipients | Recommended | Avoided |
|------------|-------------|---------|
| **Emulsifiers** | Cetyl palmitate | Propylene glycol (1,2-propanediol, methyl ethyl glycol, 1,2-propylene glycol), 2-bromo-2 nitropropane-1,3- diol |
| Sorbitan Palmitate | Triethanolamine |
| Ricinus Communis Seed Oil | Steareth-20 |
| Mineral Oil | | |
| Capric Triglyceride | | |
| Sorbitan Oleate | | |
| Petrolatum | | |
| Decyl Oleate | | |
| Ascorbyl Palmitate | | |
| Stearic acid | | |
| Beeswax | | |
| Polysorbate 60 | | |
| **Humectant** | Glycerine | | |
| **Alcohols** | Cetyl Alcohol | Isopropyl alcohol |
| Glycerol Alcohol | Ethyl alcohol |
| Steareth-20 | Benzyl alcohol |
| **Emollient** | Glyceryl Stearate | | |
| PEG-40 Stearate | Cyclohexanol |
| Caprylyl Glycol | | |
| Glycerol caprylate | | |
| Caprylyl alcohol | | |
| Lecithin | | |
| **Preservative** | Phenoxethanol | Parabens |
| Sodium benzoate | Formaldehyde donors |
| Sorbic acid | Phthalates: (Di (2-ethylhexyl) phthalate (DEHP), dioctyl phthalate (DOP), and bis (2-ethylhexyl) phthalate (BEHP)). Methylisothiazolinone and methylchloroisothiazolinone |
| **Other** | Citric acid (pH stabilizing agent) | Ethylhexylglycerin (conditioning agent) |
| **Excipients** | Dimethicone (conditioning agent) | Potassium lactate (conditioning agent) |
| Bentonite (emulsion stabilizer) | | |
| Toocopheryl acetate (skin conditioning) | | |
| Zinc oxide (diaper rash) | | |
| **Chemical** | None | Linalool |
| **Fragrances** | None | Hexyl cinnamal |
| **Dyes** | None | All |

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### Table 5: The excipients recommended and to be avoided in the formulation of a bubble bath. [72-74,97]

| Excipients | Recommended | Avoided |
|------------|-------------|---------|
| **Surfactants** | | |
| Sodium lauryl glycol carboxylate | Sodium lauryl sulfate |
| Sodium cocoyl alkyl Esters | Sodium laureth sulfate |
| Decyl glucoside | Carboxylates |
| Laurylglucoside | Quaternary ammonium salts |
| Disodium cocoamphodiacetate | Amine oxides |
| Disodium-coco glucoside sulfosuccinate | Sulfoxides |
| Glyceryl Oleate | Ethoxylates |
| Coco- glucoside | Poloxamers |
| Sodium Lauramphoacetate | |
| Betaine | |
| Sorbitan Laurate | |
| Sodium cocoyl Isethionate | |
| Sodium-coco sulfate | |
| **Foamer** | Disodium oleamide | |
| **Humectant** | Glycerine | Propylene glycol |
| | Gluconolactone | |
| **Emollient** | Capryl glycol | Cyclopentasiloxane |
| | Capryl glycol | |
| | Glyceryl caprylate | |
| **Preservatives** | Sodium benzoate | Parabens |
| | Phenoxethanol | Formaldehyde donors |
| | | Phthalates |
| **Other Excipients** | Citric acid (pH stabilizing agent) | Ethylhexyl glycerine (conditioning agent) |
| | Acetic acid (pH modifier) | |

### Table 6: The excipients recommended and to be avoided in the formulation of baby soap [72-74,98]

| Excipients | Recommended | Avoided |
|------------|-------------|---------|
| **Fats/oils** | | |
| Saponified olive oil | Propylene glycol |
| Saponified coconut oil [99] | |
| Saponified palm oil | Sodium lauryl sulfate |
| Cocoa butter | Ammonium laureth sulfate |
| Sodium palmate | |
| | Carboxylates |
| | Quaternary ammonium salts |
| | Amine oxides |
| | Ethoxylates |
| | Poloxamers |
| **Alkali** | Potassium hydroxide | |
| | Sodium chloride | |
| **Humectants** | Glycerine | |
| | Propylene glycol | |
| **Surfactant** | Sodium myristoyl sarcosinate | Sodium lauryl sulfate |
| | Sodium lauramphoacetate | Ammonium laureth sulfate |
| | Cocamphoacetate | |
| | Palm acid | Carboxylates |
| | Polyglycerol 2-oleyl ether | Quaternary ammonium salts |
| | Glutamate | Amine oxides |
| | Glucosides | Sulfoxides |
| | | Ethoxylates |
| | | Poloxamers |
| **Preservatives** | Sorbates | Parabens |
| | Phenoxethanol | Formaldehyde donors |
| | Sodium benzoate [100] | Phthalates |

These barrier creams are effective around the nose and mouth. They usually also contain moisturizers, soothing active ingredients, and non-ionic emulsifiers [93].

Ingredients used for formulating baby creams and lotions should be mild and non-irritating. They should moisturize the skin and give an emollient action (Table 4). The pH of the cream/lotion should be maintained around pH 6.5 and should be scrutinized for dermal and ocular safety, including clinical assessment for dermal irritation, dermal sensitization potential, and ocular irritation (Table 4).

### Bubble bath

A bubble bath is a filled bathtub with a layer of surfactant foam on the surface of the water and consequently the surfactant product used to produce the foam. Less commonly, aerated or carbonated baths are called bubble baths. Mixtures of surfactants, foam stabilizers, emollients, humectants are the main constituents of bubble bath formulation. The surfactants used in bubble baths should be mild. It should not contain any chemical fragrances [97] (Table 5).

### Baby soap

Baby soap is the salt of fatty acid, which is used for cleansing the baby and should leave the baby skin moisturized [98]. It should cleanse the dirt and oils properly from the skin it should contain ingredients that should be non-irritating, scent and dye free. The fatty acids used for the baby soap are usually obtained from natural oils such as saponified olive oil and coconut oil (Table 6).

### CONCLUSION

The delicate skin of infants can be considered as the biggest challenge for formulation scientist because the diversity associated with different skin types again poses a significant constraint for selecting safer formulation ingredients. Although this review incorporates a better insight into care as well as formulation needs, the ingredients incorporated in infant care products requires thorough screening for their safety. Products used for infant’s care should be safe and free of fragrance, coloring agents, synthetic preservatives, and any unexplored natural and synthetic material. Although it is an era of herbal cosmetics, the herbal ingredients should not be accepted blindly, as formulation additives.
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