Beneficial Effects of the Regular Use of Exfoliating Beads

Summary:

Exfoliating beads have a long history in cosmetics, but we are unaware of previous studies on the effect of their regular use. A clinical study with 10 subjects shows that regular exfoliation leads to a reduction in the cell turnover time of the stratum corneum (SC) by about 15 % (significant at the 95 % level). Standard models of skin function interpret increased cell turnover time as increased desquamation. The regularly exfoliated skin also had a significantly increased uptake of dansyl chloride dye. Higher stain uptake accompanying the increase in desquamation suggests that regular exfoliation promotes addition of new cells to the SC. The study acclimatized the test panel to the exfoliant treatment for two weeks prior to the measurements to minimize the chance that results could be attributed to a shift in treatment procedures.

Introduction:

Desquamation is the natural process of old, dead cells falling off the surface of our skin. It is estimated that each of us sheds as many as a billion cells each day.[1,2] Desquamation has been postulated to evolve in order to remove the cells damaged by airborne toxins and eliminate waste from inside the body, such as excess iron.[2] Exfoliation hastens the desquamation process and exposes skin cells with a brighter appearance and a tighter feel. Chemicals can be used to reduce the cohesion between the cells and promote sloughing, but the physical action of exfoliating beads may be a safer way to achieve the same result. Exfoliating beads have a long history in cosmetic applications, but we are unaware of previous studies to substantiate their effectiveness. One may expect that an individual application of scrubbing

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beads promotes desquamation, but we wanted to discover if their regular use leads to definite, quantifiable changes in the skin.

To better understand exfoliation we need an appreciation of the basic physiology of the epidermis, the outer layer of the skin. The cells that desquamate come from the outermost layer of cells, the stratum corneum (SC). The cells of this layer are no longer living and are often described as protein bricks in a waxy mortar. The number of layers of cells in the SC varies substantially depending on the part of the body, with a maximum number of layers on the heel and a minimum on the genitals.[3] Typically the face and arms have 10 to 20 layers. Most studies indicate that the number of layers does not change with age or vary between men and women.[4] The cells of the SC have lost their nuclei and are filled primarily with the structural protein keratin and small amounts of melanin pigments that absorb light and degraded protein fragments that retain moisture, the NMF or natural moisturizing factors. The mortar is made of sheets of lipids that make the skin water repellant. These hydrophobic molecules cause water to bead up and run off our skin when we shower. Protein links, the desmosomes, run through the intercellular lamellar lipid layer to bind the cells together. Multiple enzymes assist in the degradation of these links before the cells desquamate. Low humidity hinders the degradation of the desmosomes and leads to flaky skin.

Below the SC is the vital epidermis, or Malpighi layer, which is made up of living cells. At the innermost side one layer of cells divides. As these cells progress up through the vital epidermis they undergo a progression of changes before entering the SC. Desquamation can be seen as the final step in the maturation of a skin cell.

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The best way to measure desquamation is not obvious. Surface cells can easily be observed by pulling a strip of adhesive tape off your finger. Your unaided eye sees an impression of the fingerprint, but a low powered microscope reveals that the print is actually lines of small scaly cells stuck to the tape. This technique verifies that cells have been removed, but it is not the consequence of the natural process of desquamation. To find the rate of natural desquamation cylindrical chambers with a radius and height of about 1 cm have been glued to the skin on various parts of the body to collect the desquamating cells over 48 hours.[1] A much simpler test is to stain the skin with a dansyl chloride dye and monitor its presence by its UV fluorescence.[5] Following the dyeing process with skin biopsies showed that with sufficient application time the dansyl chloride stains the whole SC layer but does not enter the vital epidermis.[5] After applying the stain the level of florescence decreased linearly during the next one to three weeks, and biopsies show a reduction in the number of stained layers in the SC proportional to the decrease in the optical signal.[6] The duration from the initial staining to the loss of detectable fluorescence is called the SC turnover time. The turnover time for different parts of the body correlated well with the number of cells collected per unit area by either natural or forced exfoliation.[4] Because of its simplicity to monitor, the SC turnover time has become the most commonly measured indicator of desquamation rate. One study reported turnover times for different parts of the body varying from 8.5 days for the forehead to 17.2 days for the lower arm with12.6 days for the upper arm,[7] although there is substantial variation among the results reported from different labs.[8]

Both natural and synthetic exfoliating beads are used in cosmetic applications. Beads from natural sources are more susceptible to bacterial contamination. Synthetic beads are often made of polyethylene or oxidized polyethylene with a wide selection of particle sizes and surface properties. Depending on the application, the average diameters range from about 150 to 600 μm.

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Test Methodology:

For this study we selected Asensa SC 232 which is a hard, high density oxidized polyethylene bead recommended for body/facial scrubs that has an average particle diameter of 325 µm. Figure 1 shows an electron micrograph illustrating the irregular shapes and slightly rounded edges of the particles. For this study beads were formulated at the 10 % level in a moderately abrasive hand/body cleanser as follows:

Formulation for Body Scrub Gel with Asensa® SC 232 Oxidized Polyethylene Beads

No.	Phase	INCI Name	% by Weight
1	A	Water (Aqua)	24.00
2	A	Disodium EDTA	0.05
3	A	Acrylates Copolymer	10.00
4	A	Sodium Laureth Sulfate	25.00
5	A	Ammonium Laureth Sulfate	15.00
6	B	Sodium Hydroxide	3.12
7	C	Cocamidopropyl Betaine	8.00
8	C	Fragrance	0.05
9	C	Polysorbate 20 (and) PEG-40 Castor Oil	3.60
10	D	Methylisothiazolinone	0.05
11	E	Oxidized Polyethylene	10.00
12	F	Citric Acid	0.07

Instructions:

Phase A Combine Phase A. Heat to 65°C.
Phase B Use phase B to adjust pH of batch to 6.5.
Phase C Heat phase C to 60°C and mix until uniform. Add to batch. Cool batch to 30°C.
Phase D Add phase D ingredient to batch with mixing.

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Phase E	Add phase E ingredient to batch with mixing.
Phase G	Use phase G to adjust pH to 6.6.

A second formulation, identical in all respects except it contained no scrubbing beads, was prepared as one control. No treatment was used as a second control. Both formulations were coded to mask their identity.

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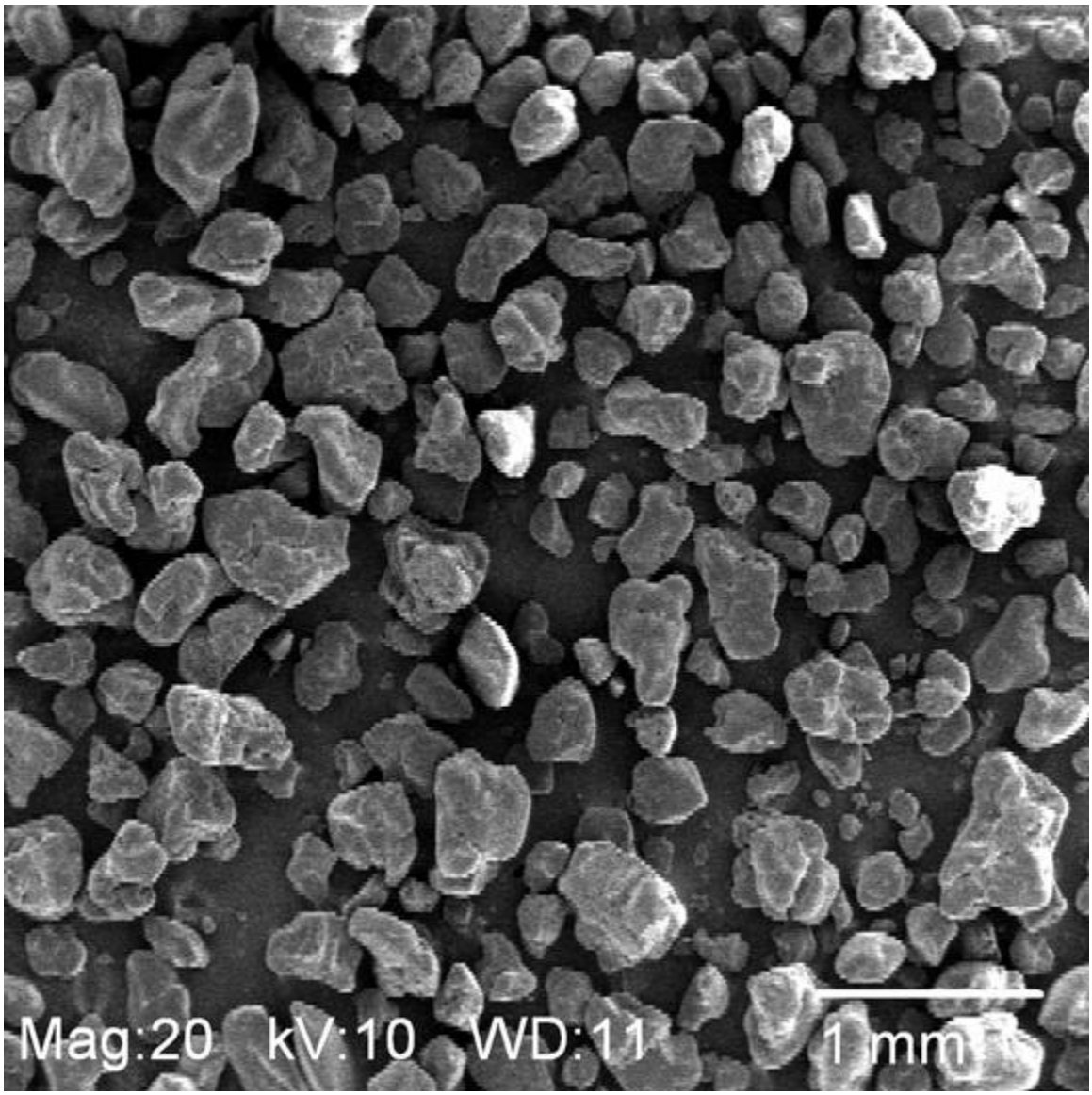

Figure 1. Scanning electron micrograph of Asensa® SC 232 Oxidized Polyethylene exfoliating beads

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To find out if routine use of such a cleanser affects desquamation, we contracted with an independent testing clinic to test the products. The study was conducted in accordance with the intent and purpose of Good Clinical Practice regulations described in the CFR Title 21, Parts 50, 56 and 312 and/or the Declaration of Helsinki. A pool of 11 Caucasian women between the ages of 28 and 68 were enrolled in the study. Ten subjects with an average age of 49 completed the study. All panelists were interviewed and examined to determine that they had no skin conditions which could interfere with the study. Three squares of one inch length were marked on the upper outer arms of each subject. The center square on each arm was selected as a no treatment control area. Two of the remaining four sites were randomly assigned to the Asensa SC 232 scrub and the formulation with no beads. The other two sites were used in other studies.

Since we wanted to mimic regular use of exfoliating products, the women were taught how to apply the scrub to its assigned site twice daily for a two week period of acclimatization. They were instructed to avoid washing their arms or swimming for four hours after applications, to refrain from using scrubs, loofah sponges or wash cloths on their arms and to use no moisturizers, sunscreens or other toiletries on their arms. One subject was removed from the study when she developed a rash. The rash covered both control and treatment sites and was suspected to be caused by the soap specified by the test clinic to be used during the trial. After two weeks of use, on a Monday morning, the six sites of the remaining 10 subjects were stained with dansyl chloride for five hours and examined under a long wave UV lamp to verify that each site was uniformly and fully stained. Each site was evaluated by a trained clinical technician on a score of 0 to 3 in measurement units of 0.5 where

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0.0 = no stain (except for fine hairs or follicles)

0.5 = barely perceptible evidence of stain

1.0 = partial or light stain

2.0 = moderate stain covering all of the contact areas

3.0 = intense, fully stained test area

A minimum score of 2.0 was required for every site for continuation in the study. Each subject came daily to the clinic where the intensity of the fluorescence of each site was evaluated and the appropriate treatment was then applied by the clinical technician. The procedure continued until all sites were a scored 0. No measurements were made on Saturday or Sunday. No subject showed any unfavorable reaction to any of the treatments.

Results:

The average number of treatments until SC turnover for scrub with Asensa® SC 232 beads (7.9), formulations with no beads (9.5), and no treatment (9.1) are compared in Figure 2. The standard error for each average is included on the plot. Since no treatments were applied on weekends, the number of treatments is indicative of, but smaller than, the days for SC turnover. While the treatment with beads gave a faster turnover, average values do not indicate if the differences are significant. The significance is determined by paired t-tests between sites. Their verdict is that the reduction in turnover with the inclusion of the beads is significant at the 95% level and there is no discernable difference between no treatment and the formulation with no beads. Since turnover time is inversely related to desquamation rate, the reduced number of treatments with exfoliating beads indicates that regular exfoliation increases desquamation.

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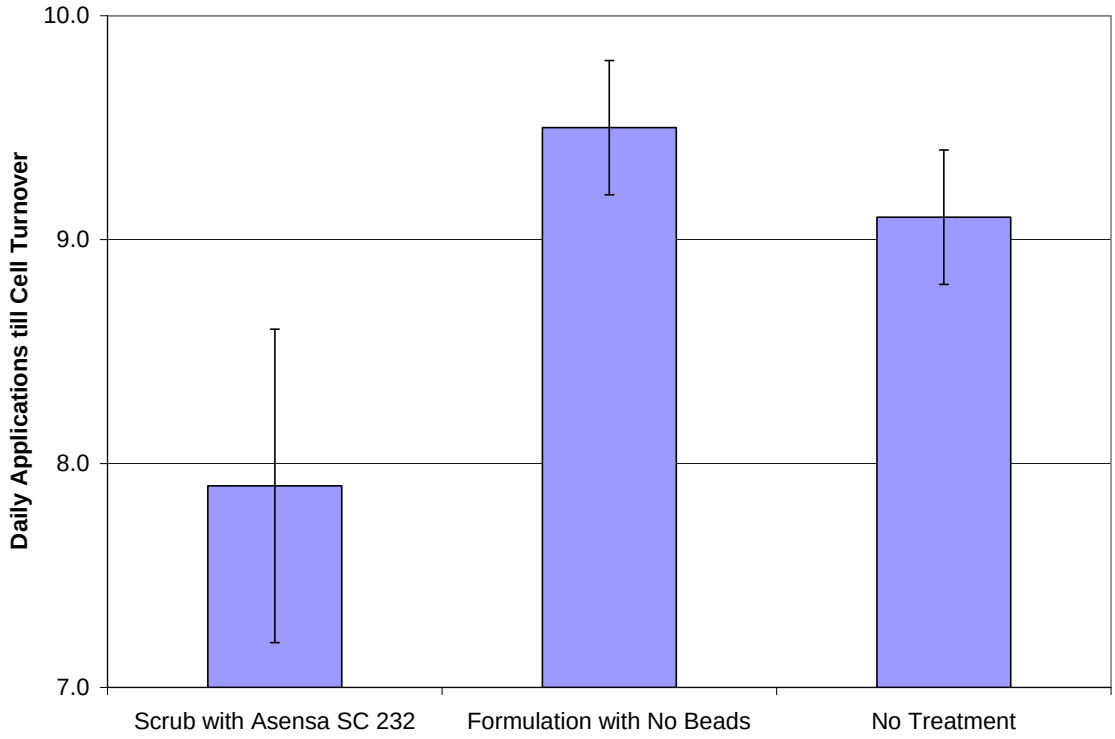

Figure 2. The number of daily applications before cell turnover

Before the measurement period the skin was acclimatized to its treatment condition so we expect the number of cell layers in the SC to be constant. The constant number requires that new cells enter the SC at the same rate they are lost by desquamation. If treatment increases desquamation, then either the SC is thinner or more new cells enter the layer. If the SC were thinner, one would expect a less intense initial stain from the reduced number of layers of cells, although the difference might be too small to be detected by the relatively crude visual scoring system. The average initial stain scores for the scrub

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treatment with beads and its corresponding no-treatment control are 2.20 and 2.00 with a pooled standard error of 0.06. These values are statistically different at the 95 % level. Although an experienced technician grading is probably not as precise as instrumental assessment in this situation, we interpret the 10 % higher score to indicate that exfoliation has certainly not made the SC thinner. Combining the observations that the desquamation rate is increasing and the SC is not getting thinner indicates that regular exfoliation stimulates the rate that new cells join the SC. There is no significant difference between the level of stain for the formulation with no beads and its adjacent control area.

Because the fluorescence signal is proportional to the portion of cells that have not yet turned over, we examine the increase in cell turnover during the study. These subjects were evaluated by a technician-assessed numerical score, rather than fluorescence intensity. While it is clear that a change on one scale corresponds to a change on the other in the same direction, we do not know if the two changes are directly proportional. We evaluate the possibility by assuming that they are. Then the ratio of the current score to its initial value corresponds to the fraction of cells that have not yet been shed. The average values of one minus the ratio for treatments with the SC 232 scrub, the formulation with no beads, and no treatment are plotted in Figure 3. We see that much of the data for any treatment is fit by a straight line as we would expect if the observer assigned score is directly proportional to optical measurement. The plot suggests that the regular use of exfoliating beads produce a uniform, faster turnover. The similarity of the two controls indicates that the effect cannot be attributed to other ingredients of the formulation.

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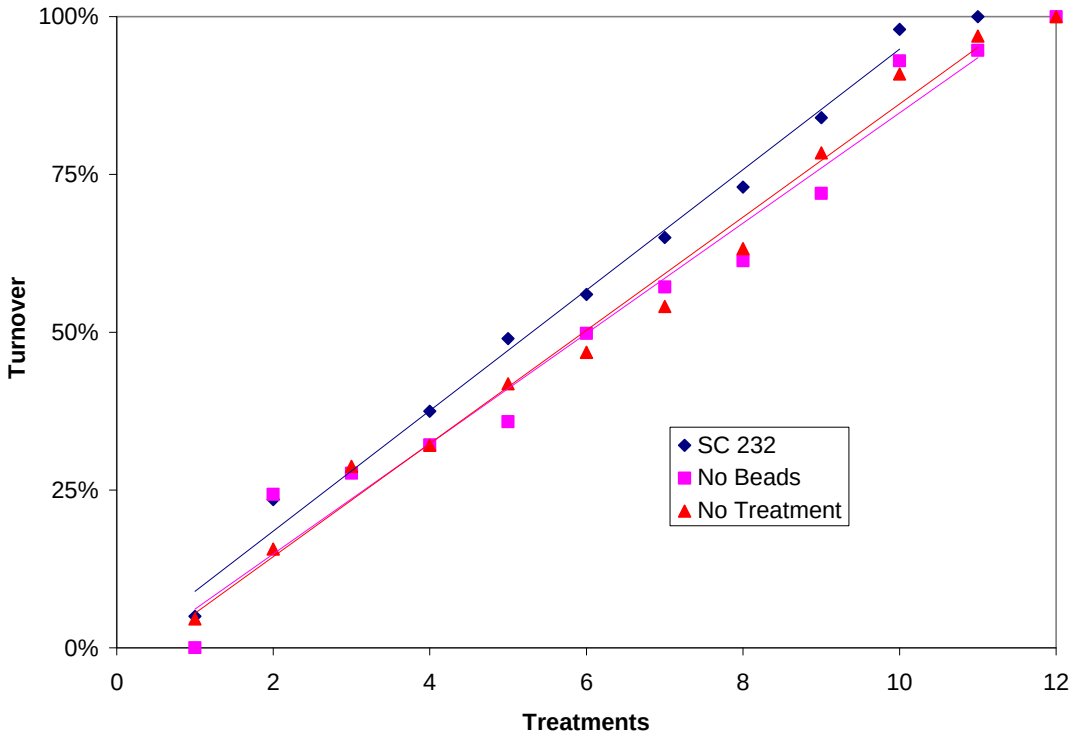

Figure 3. The reduction in the ratio of current to initial fluorescence scores with number of treatments

Conclusions:

Regular exfoliation produces quantifiable differences in the skin. This study shows a faster turnover of the SC and a higher diagnostic stain uptake with the regular use of an exfoliating scrub. The faster SC turnover time indicates increased desquamation. Faster turnover also brings about more rapid elimination of both airborne and internal toxins with the discarded skin cells. Higher stain uptake

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accompanying the increase in desquamation implies that regular exfoliation also promotes addition of new cells to the SC.

Footnotes

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