THE COLOR DURABILITY OF "CHOCOLATE PEARLS" BY BALLERINA PEARL CO.

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Treated-color brown Tahitian cultured pearls, known in the trade as "Chocolate Pearls," have become increasingly prevalent in the market. As a result, it is important that the durability of the color treatment is well understood. Seven Chocolate Pearls supplied by Ballerina Pearl Co. and 12 untreated Tahitian cultured pearls (for comparison) were exposed to conditions of consumer care and wear—heat, household chemicals, daylight, and some typical cosmetics—to determine their effects on the color. The results were similar for both groups: They did not change color when exposed to daylight, cosmetics, and some chemicals; subtle changes were noticed after exposure to heat; and more significant changes were observed when the samples were exposed to chemically reactive household cleaning solutions.

The Ballerina Pearl Co. produces attractive brown pearls from off-color "black" Tahitian cultured pearls using a bleaching process (Wang et al., 2006); these are now known in the trade as "Chocolate Pearls" (see, e.g., Sanchez, 2004; Zachovay, 2005).

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The increasing availability of such "chocolate" cultured pearls in the marketplace likewise creates a need for better understanding of any durability issues involving their treated color. Under normal wearing conditions, these treated cultured pearls could be subjected to situations such as unintentional exposure to heat in a domestic kitchen, contact with typical household chemicals, and prolonged exposure to daylight; most will be exposed to common cosmetics. All of these situations could affect the color of Chocolate Pearls, just as they can affect untreated pearls (e.g., Nassau, 1984; Nassau and Hanson, 1985; Martin, 1987; Overton and Elen, 2004; CIBJO, 2007). Through a series of carefully controlled exposure experiments involving heat, standard household chemicals, daylight, and certain cosmetics, we examined the durability of the color of several Ballerina Chocolate Pearls as compared to their untreated Tahitian counterparts.

MATERIALS AND METHODS

We studied seven treated Tahitian "chocolate" cultured pearls provided by Ballerina Pearl Co. (figure 1). They ranged from 8.44 to 12.57 ct (10.50–12.53 mm; see table 1). The colors were dark orangy brown, orangy brown, and pinkish brown, according to the GIA pearl grading color reference charts (Gemological Institute of America, 2000), as determined by experienced gemologists. All had high luster.

For comparison, we also examined 12 untreated "black" Tahitian cultured pearls ranging from 6.42 to

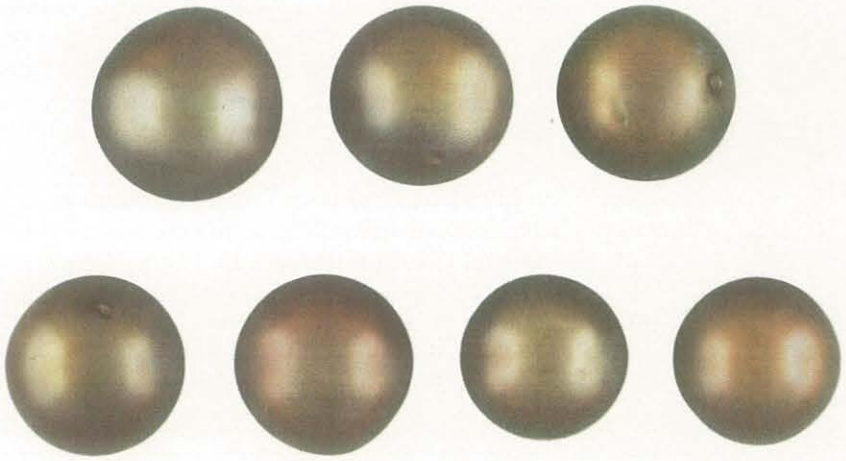

Figure 1. These seven Tahitian cultured Chocolate Pearls (10.50–12.53 mm), treated by Ballerina Pearl Co. using a proprietary bleaching method, were studied to evaluate their durability to various conditions of consumer wear. The samples are in order (CCP-1 to CCP-7) from left to right, top to bottom. Composite photo by Suchada Kittayachaiwattana.

30.62 ct (9.81–25.94 mm in longest dimension; again, see table 1). The dominant colors were gray, brown, and black with green, pink, and purple modifiers (see table 1), again based on the GIA color reference charts (e.g., figure 2). One sample showed orient and one showed green and rosé overtones. All but one of the untreated Tahitian cultured pearls had good to very good luster.

We identified two broad types of durability concerns: (1) jewelry manufacturing or repair processes, and (2) daily use by consumers. Pearls are well known to be fragile gems, so informed jewelers are careful not to expose them to adverse conditions during setting and repair and to clean them using only mild soap and water, never with ultrasonic or steam cleaners. In addition, pearl nacre consists mainly of the mineral aragonite with organic materials, which are very soft (Mohs hardness = 2.5–3.5; Sinkankas, 1972). Most household scrubbing cleansers contain particles of quartz (hardness = 7) or marble (hardness = 3) or other materials that will inevitably damage pearl nacre, whether or not the pearl has been treated. Thus, we focused our study on durability issues involved with the nonabrasive interaction between the jewelry of an average consumer and that consumer's daily activities. The following experiments were performed using a group of potentially adverse conditions designed with these everyday interactions in mind (table 2).

The reader is cautioned that not all pearls marketed as Chocolate Pearls have been treated in the same manner as the Ballerina product (see, e.g., Hänni,

TABLE 1. Characteristics of the seven "chocolate" cultured pearls from Ballerina Pearl Co. and 12 natural-color Tahitian cultured pearls used for the various durability tests.

Sample	Weight (ct)	Measurements (mm)	Color	Luster
"Chocolate" Cultured Pearls				
CCP-1	12.57	11.97–12.53	Pinkish brown	High
CCP-2	11.78	11.76–11.84	Pinkish brown	High
CCP-3	10.20	11.27–11.43	Dark orangy brown	High
CCP-4	10.56	11.35–11.42	Orangy brown	High
CCP-5	9.85	11.17–11.55	Pinkish brown	High
CCP-6	8.44	10.50–10.60	Dark orangy brown	High
CCP-7	8.52	10.58–10.67	Pinkish brown	High
Natural-Color Tahitian Cultured Pearls				
PE-1	6.53	9.29–11.37	Dark greenish gray	Good
PE-2	6.69	9.42–12.01	Dark green-gray	Very good
PE-3	10.96	11.50–11.99	Gray with green and rosé overtones	Good
PE-4	7.32	9.94–10.93	Dark gray	Very good
PE-5	8.83	10.65–12.84	Gray with orient	Very good
PE-6	9.40	10.76–14.40	Pinkish brown and greenish gray with orient	Good
PE-12	27.64	14.54–18.78	Dark gray	Good
PE-13	13.28	11.87–14.25	Purplish gray	Good
PE-14	12.38	11.15–15.57	Dark greenish gray	Very good
PE-15	11.49	11.51–13.38	Greenish black	Good
PE-16	6.42	9.69–9.81	Dark green-gray	Good
PE-17	30.62	14.35–25.94	Gray	Fair

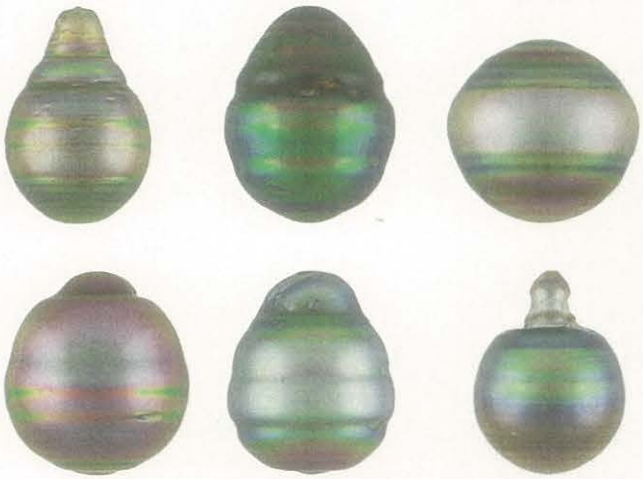

Figure 2. These six untreated "black" Tahitian cultured pearls are part of the sample group tested using similar methods to serve as a reference for any color changes observed in the treated Chocolate Pearls. Again the samples are in order (PE-1 to PE-6) from left to right, top to bottom. Composite photo by Wuyi Wang (not scaled to size).

2006); therefore, some may react differently to the tests conducted in this study. It should also be noted that these experiments were performed with a small number of undrilled samples and for limited durations (up to 40 hours), so they may not predict the long-term durability of the treatment in all cases. Likewise, we tested specific products within a category, not the range of products that are available in each category (e.g., only one ammonia solution and one each perfume, hair spray, and facial cream). We examined the results visually with the unaided eye as well as with a gemological microscope using 10–70× magnification throughout the course of the tests.

Controlled Heating. To examine the effects of accidental exposure to heat in the kitchen (e.g., placement of a ring near a hot burner or electric frying pan), we performed controlled heating experiments using a Lindberg/Blue M Moldatherm box furnace. We heated two treated Chocolate Pearls and two untreated Tahitian samples at 90°C (194°F) and 150°C (302°F), respectively, in air for 0.5, 1.5, and 2.5 hours (treated samples) and 2 and 2.75 hours (untreated). Target temperatures were reached prior to placing the samples in the oven. Temperature variations at each targeted temperature were within 10°C.

Prolonged Exposure to Common Household Chemicals. Because pearls set in a ring or bracelet have a good possibility of being exposed to household cleaners and other products when worn by the consumer, we tested five common chemicals: rubbing alcohol (isopropyl), acetone (reagent grade, commonly used as fingernail polish remover), ammonia (5–10% ammonium hydroxide solution), and two kinds of bleach—undiluted liquid Clorox (5.25% sodium hypochlorite solution) and undiluted liquid Clorox 2 (chlorine-free or "color safe" version; 5–25% sodium perborate tetrahydrate). One treated and one untreated sample were immersed in each solution for various periods of time to evaluate the effects of exposure (again, see table 2). We used a clear polyethylene bottle to facilitate observation and assessed the samples visually every five minutes during the first hour and every hour for the following four hours. For the isopropyl alcohol and acetone tests, we immersed the Chocolate Pearls for five hours and the untreated pearls for 18 hours. For the Clorox test, we immersed both samples for only 50 minutes (due to observation of rapid surface damage). For the ammonia and Clorox 2 solutions, we immersed the samples for a total of 18 hours in each. If any change in color or texture was observed prior to the planned end of the immersion time, we stopped the experiment and documented the changes. Otherwise, experiments were run to completion and documented immediately thereafter.

Effects of Daylight. To evaluate the effects of exposure to daylight, we placed two "chocolate" cultured pearls and two untreated Tahitian samples in direct sunlight on a window sill at room temperature in Bangkok (13°27′ N) in March 2008, for a period of five days with a total sunlight exposure time of 40 hours.

Contact with Cosmetics. For this test, we used typical cosmetics: YSL Paris perfume by Yves Saint Laurent, TRESemmé European Tres Two Extra Hold hair spray, and L'Oréal Transformance face cream. We immersed one treated and one untreated sample in the perfume for 2.5 hours and a second untreated and second treated sample in the hair spray for 3.5 hours. After these tests were completed, and no changes were observed with either the unaided eye or a gemological microscope, we thoroughly cleaned all four samples and immersed them in the face cream for 26 hours.

TABLE 2. Durability testing of Ballerina treated "chocolate" cultured pearls and of untreated Tahitian cultured pearls for comparison.

Testing method	Conditions	"Chocolate" cultured pearls			Untreated Tahitian cultured pearls		
		Sample(s)	Duration (hours)	Results	Sample(s)	Duration (hours)	Results
Controlled heating	90°C	CCP-1 & CCP-2	0.5, 1.5, 2.5	Color appeared slightly lighter with increasing heating duration (fig. 3)	PE-5 & PE-6	2.75	Very subtle color fading noted in one of two pearls tested
	150°C		0.5, 1.5, 2.5	Color appeared slightly lighter with increasing heating duration (fig. 3)		2	Showed slightly lighter tones with much of the greenish overtone becoming browner (fig. 4)
Bleach (Clorox)	Immersed in 5.25% sodium hypochlorite (bottled, undiluted chlorine bleach)	CCP-5	0.83	After 30 min., slight color fading observed; after 50 min., whitish spots and etched, flaky texture observed on the surface with white discoloration rings concentrated near natural indentations (figs. 5 and 6)	PE-15	0.83	After 30 min., slight color fading observed; after 50 min., whitish spots and etched, flaky texture observed on the surface with white discoloration rings concentrated near natural indentations
Acetone	Immersed in reagent grade acetone	CCP-7	5	No visible changes	PE-13 & PE-17	18	After 4 hours, the hue became noticeably darker and the stone appeared browner (fig. 7)
Isopropyl alcohol	Immersed in standard rubbing alcohol	CCP-6	5	No visible changes	PE-12	18	No visible changes
Ammonia	Immersed in 5–10% ammonium hydroxide	CCP-6	18	No change after 2 hours; after 18 hours, significant color fading noted and distinct irregular zones of light and dark color observed (figs. 8 and 9)	PE-14	18	No change after 2 hours; after 18 hours, some color fading and distinct irregular zones of light and dark color observed
"Color safe" bleach (Clorox 2)	Immersed in 5–25% sodium perborate tetrahydrate (bottled, undiluted chlorine-free bleach)	CCP-7	18	No change after 2 hours; after 18 hours, slight color fading noted and faint mottled whitish appearance (fig. 8)	PE-16	18	No change after 2 hours; after 18 hours, slight color change noted (darker tone in general), but no obvious damage observed
Daylight	Exposed to direct sunlight	CCP-3 & CCP-4	40	No visible changes	PE-3 & PE-4	40	No visible changes
Cosmetics	Immersed in perfume	CCP-1	2.5	No visible changes	PE-1	2.5	No visible changes
	Immersed in hair spray	CCP-2	3.5	No visible changes	PE-2	3.5	No visible changes
	Immersed in face cream	CCP-1 & CCP-2	26	No visible changes	PE-1 & PE-2	26	No visible changes

RESULTS

Exposure to Heat. Heating the Chocolate Pearls at 90°C and 150°C produced similar results. The pinkish brown color appeared slightly lighter in tone (figure 3), but we detected no variation in hue. The reference untreated samples showed little reaction at 90°C, but at 150°C they also appeared to have slightly lighter tones with much of the greenish overtone becoming browner (figure 4).

Exposure to Household Chemicals. Exposure of the samples to various chemical solvents produced dramatically different results. After immersion in concentrated Clorox chlorine bleach for 30 minutes, sample CCP-5 became slightly lighter in tone (figure 5B). After 50 minutes, noticeable whitish spots developed on its surface and an etched, flaky texture (figure 5C) was apparent. Discoloration was especially prominent around natural indentations on the surface, as white, ring-like patterns (figure 6). The untreated Tahitian sample had a similar reaction. In contrast, the Chocolate Pearls immersed in acetone (CCP-7) and isopropyl alcohol (CCP-6) showed no significant changes after five hours. While untreated

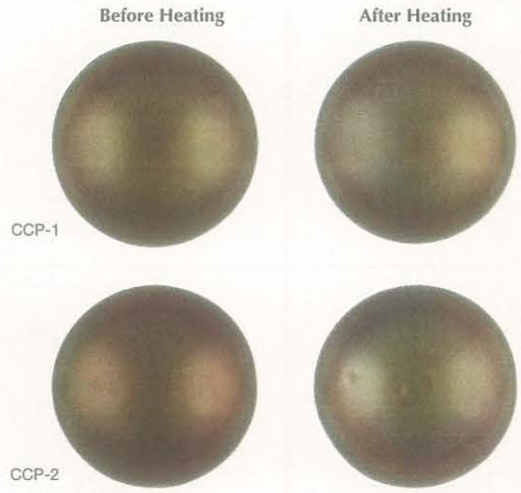

Figure 3. The pinkish brown color of these samples (CCP-1 and CCP-2) appeared lighter after heating at either 90°C or 150°C, but no variation in hue was detected. Top: CCP-1 before heating (left) and after heating at 90°C for 2.5 hours (right). Bottom: CCP-2 before heating (left) and after heating at 150°C for 2.5 hours (right). Photos by Wuyi Wang.

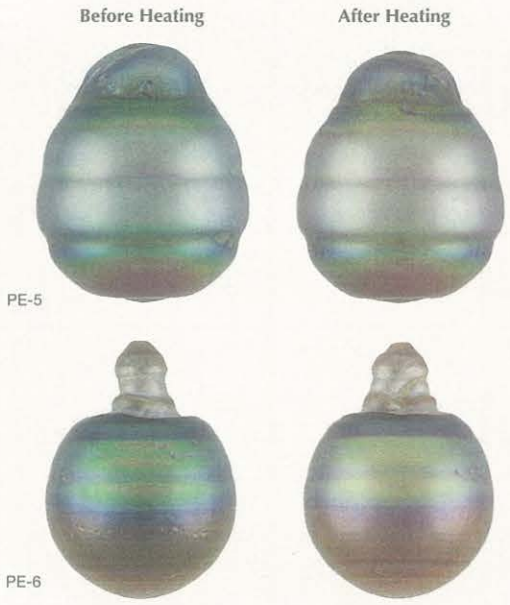

Figure 4. The untreated Tahitian cultured pearls (PE-5 and PE-6) showed little reaction at 90°C, but at 150°C they also developed slightly lighter tones with much of the greenish overtone becoming browner in color. Left: before heating; right: after heating at 150°C for 2 hours. Photos by Wuyi Wang.

sample PE-12 also did not react to isopropyl alcohol (after a total of 18 hours of immersion), acetone caused untreated samples PE-13 and PE-17 to become noticeably darker with a more brownish hue (see, e.g., figure 7), starting after four hours of immersion.

The apparently unaffected Chocolate Pearl samples, CCP-6 and CCP-7, were then cleaned in water and immersed in concentrated ammonia and "color safe" Clorox 2 bleach, respectively. After two hours of exposure, neither sample showed any changes; after 18 hours, however, both showed color fading. The sample exposed to Clorox 2 bleach became lighter in color with faint, irregular whitish patches (figure 8). In contrast, large sections of the surface of the treated sample exposed to ammonia became discolored, with distinct light regions mixed with remnant zones of darker color (figures 8 and 9). The degree of color fading caused by ammonia over an 18-hour period was substantially more than that

Figure 5. After immersion in concentrated Clorox chlorine bleach for 30 minutes, sample CCP-5 (A, before immersion) showed slight changes in color appearance (B), with noticeable changes apparent after immersion for 50 minutes (C). Photos by Robison McMurtry.

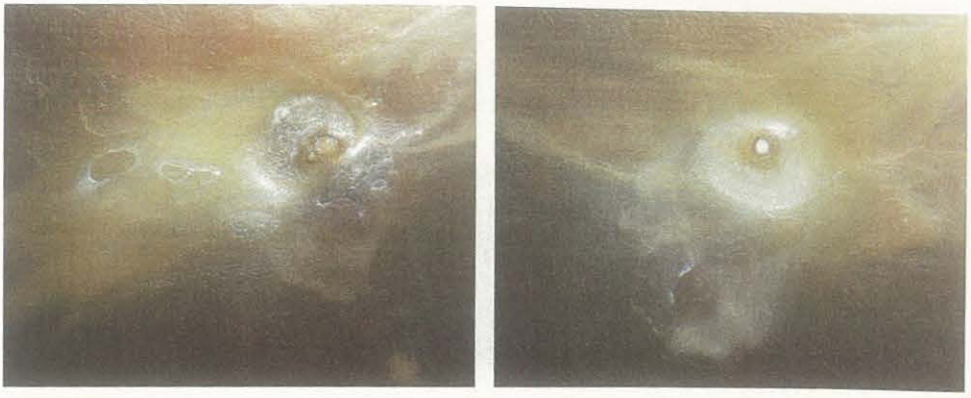

Figure 6. On areas of the surface where natural indentations were present, immersion in concentrated Clorox bleach for 50 minutes produced prominent discoloration—seen as white, ring-like patterns around the indentations (here, on sample CCP-5). Photomicrographs by A. H. Shen; fields of view 5.2 mm (left) and 3.1 mm (right).

observed from both types of bleach; however, the damage produced by the chlorine bleach occurred in a much shorter time period (less than one hour). Similar reactions were seen in the untreated Tahitian samples.

Exposure to Daylight. Prolonged daylight exposure appeared to have little, if any, effect on the color of the Chocolate Pearls or the untreated samples. After 40 hours of cumulative exposure to direct near-equatorial sunlight, no noticeable change in tone, hue, or saturation was observed.

Exposure to Cosmetics. In the course of daily wear by a consumer, cosmetics are the chemicals with which pearls are most likely to come into contact. After extended exposure to perfume, hair spray, and face cream, both the color and luster of the Chocolate Pearls tested remained unchanged. Likewise, the untreated samples also showed no changes. Although it is commonly stated that consumers should avoid having pearls come into contact with cosmetics, we found no detrimental effects when the pearls in this experiment were exposed to cosmetics. It should be noted, however, that we used relatively short exposure times compared to a lifetime of wearing pearl jewelry.

DISCUSSION

From our data, it appears that the Ballerina Chocolate Pearls are no less durable than their untreated Tahitian counterparts. Neither should be subjected to high temperatures or exposed to a strong cleaner such as chlorine bleach or concentrated ammonia for any extended period of time. "Color safe" bleach can also cause damage with prolonged exposure. Although milder solvents such as acetone and isopropyl alcohol did not appear to cause noticeable damage to the Chocolate Pearls under the test conditions, the untreated Tahitian sample began to change color in acetone after four hours of immersion. Therefore, prolonged exposure to acetone is inadvisable in either the treated or untreated material.

Again, it should be noted that these experiments were performed with a small number of undrilled samples and for limited durations. Drilled samples would have allowed access to the interior, so the samples might have experienced different reactions. Likewise, we tested specific products

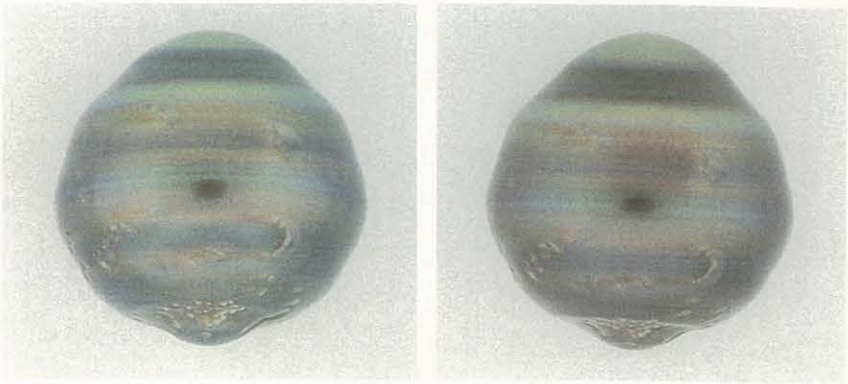

Figure 7. Unlike Ballerina Chocolate Pearl CCP-7, untreated sample PE-13 (left, before immersion) became noticeably darker and browner when placed in acetone for four hours (right, after immersion). Photos by C. D. Mengason.

Figure 8. Samples CCP-6 and CCP-7 both showed color fading after 18 hours of immersion in concentrated ammonia and "color safe" Clorox 2 bleach, respectively. Top: CCP-6 before immersion in ammonia (left) and after immersion for 18 hours (right). Bottom: CCP-7 before immersion in Clorox 2 bleach (left) and after immersion for 18 hours. Photos by Robison McMurtry.

within a category, but not the range of products available in that category. Therefore, the results of these experiments may not predict the long-term durability of the treatment in all cases.

Figure 9. Large sections of the pearl surface exposed to ammonia (CCP-6) for 18 hours became discolored, with distinct light regions mixed with remnant zones of darker color. Photomicrograph by A. H. Shen; field of view 2.6 mm.

CONCLUSIONS

The recent popularity of Chocolate Pearls requires that we better understand their durability under typical conditions of consumer wear, especially in the household. Our experiments revealed that, in most situations tested, the durability of the color of Ballerina "chocolate" cultured pearls is comparable to that of untreated Tahitian cultured pearls. When exposed to daylight and cosmetics such as perfume, hair spray, and a facial cream, our samples showed no noticeable changes in color. Only relatively prolonged exposure to heat, ammonia, or bleach caused significant alterations to the surface texture and color of the treated and untreated cultured pearls. The wearer should also be reminded that, because of the relative softness of pearls, abrasive household cleansers (many of which consist of particulate ingredients harder than pearl nacre) represent another danger (not tested here because of known behavior) in the average household.

Although it seems unlikely that most pearl jewelry would be exposed to temperatures as high as 90°C or to harsh chemicals for extended periods of time, such exposure does happen and it is important to understand its effect on this organic gem and inform the consumer accordingly. All cultured pearls are fragile and susceptible to damage by physical contact with harsh chemicals and heat or the application of cosmetics; therefore, the consumer would be well advised to remove pearl jewelry when these possibilities exist. By exercising caution, a consumer can greatly reduce the cumulative effects that such exposure may have.

It is important to note again that treated cultured pearls with similar "chocolate" colors are also present in the market from sources other than Ballerina Pearl Co. Since the treatment process is proprietary, and the starting materials may come from various sources, there is no guarantee that Chocolate Pearls from other companies will show analogous results.

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