The Specificity of BLUESTAR® FORENSIC

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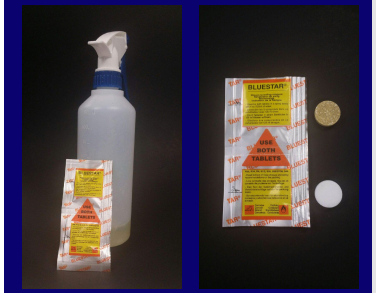
ABSTRACT

BLUESTAR® FORENSIC is a reagent utilized to detect trace amounts of blood. However, reaction to other substances has been reported in the past. In this study, 146 different substances were tested with BLUESTAR® FORENSIC to determine the specificity of the reagent. Only chlorine bleach based products were found to give false positives.



BLUESTAR® FORENSIC Training Tablets

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INTRODUCTION

Because biological evidence is strong evidence in the courtroom, the use of screening tests to establish the possible presence of different biological fluids has become a routine procedure in forensics. One of the most common and often one of the most valuable forms of evidence found at crime scenes is blood. Although, criminals frequently attempt to clean the blood after committing a crime, and bloodstains might not always be apparent to the investigator, evidence might remain at the scene even after several years [Paonessa, 2008]. In the last decades a variety of chemicals including BLUESTAR® FORENSIC have been developed to reveal those traces [Tobe *et al.*, 2007].

What is BLUESTAR® FORENSIC?

It is a cheminoluminescence (CL) presumptive test for the detection of blood based on luminol. In 2000, a biochemistry professor at University Claude Bernard of Lyon (UCBL), Loic Blum, PhD., developed the reagent for the ROC Import Company (Monaco) [Bluestar, 2014]. BLUESTAR® FORENSIC was originally made for hunters to help locate wounded animals and adapted later to use in crime scenes investigations [Dilbeck, 2006]. The product has also been recommended for archeological/historical research and fish monitoring [Colotelo *et al.*, 2009; Gundy PJ n.d.; Paonessa, 2008]. When using BLUESTAR® FORENSIC, a chemical reaction between its components and the hemoglobin in the blood produces a chemical luminescence visible in the dark [Bluestar, 2014].

Why BLUESTAR® FORENSIC is a good choice for Crime Scene Investigation?

Several properties make BLUESTAR® FORENSIC a valuable tool in the field of forensics. Among them are its extremely sensitivity. The reported sensitivity by the manufacturer is 1:10,000 and Tobe *et al.* (2007) reported 1: 100,000, although previous studies have reported sensitivity of 1:1,000,000 dilutions in some substrates [Gavrilovic & Webb, n.d.; Watkins & Brown, n.d.]. Also of great importance is its strong long-lasting luminescence that does not required total darkness to be visible [Bluestar, 2014; Dilbeck, 2006; Tobe *et al.*, 2007]. When using BLUESTAR® FORENSIC, an experimented crime scene investigator can easily differentiate between a bloodstain and a false positive because the luminescence differs in color, intensity and duration [Bluestar, 2014]. In addition, the reagent is safe for the investigator and does not affect further DNA or ABO typing [Bluestar, 2014; Jakovich, 2007; Watkins & Brown, n.d.]. BLUESTAR® FORENSIC is easy to mix in the field and available in various versions; it has a long shelf life and does not require any special storage condition [Bluestar, 2014]. Once the reagent is mixed, it is stable and can be used for hours, or even several days. The chemical can be sprayed several times on the same bloodstain and still will give the same luminescence, allowing the investigator to take reliable photographs. BLUESTAR® FORENSIC can be used in both indoor and outdoor crime scenes, as well as to reveal older and recent bloodstains that has been cleaned-up possibly to conceal blood evidence. It can also be utilized in crime scenes where blood has been diluted by rain and no longer visible or on victim and/or suspect's clothing that has been laundered.

The scope of this study

It has been reported in the past that substances other than blood can also cause BLUESTAR® FORENSIC to glow [Creamer *et al.*, 2005; Ford & Webb, n.d.; Tobe *et al.*, 2007]. With research on Bluestar false positives as limited as it is, the goal of this study was to identify substances that could give false positive results by testing 146 samples including cleaners, foods, beverages, and personal care items among few miscellaneous products with BLUESTAR® FORENSIC.

Figure 1. Soft Scrub-Bleach Gel

Figure 2. Clorox Cleanup

Figure 3. Clorox Cleanup Stain Remover-Whites

MATERIALS AND METHODS

In this study, 146 different substances (Table 1) were tested with BLUESTAR® FORENSIC Training Tablets. Each BLUESTAR® FORENSIC Training Tablets individual package contains a white tablet (HYDROGEN PEROXIDE-UREA) [Bluestar® Material Safety Data Sheet 2012a], and a beige tablet (SODIUM HYDROXIDE AND 5-AMINO-1,2,3,4 TETRAHYDROPHTHALAZINE-1,4DIONE) [Bluestar® Material Safety Data Sheet 2012b]. The reagent was prepared according to the manufacturer's instructions by dissolving the two tablets in a spray bottle with 125ml (4oz) of distilled water, and used within three hours. Personal protective equipment was used as recommended by the MSDS for personal protection and to avoid contamination. A Canon Eos Digital Rebel XS camera was utilized on a tripod with a shutter cable release attached to record the positive results. The camera settings were as follow: *f*/8 aperture, 2.5seconds exposure time, ISO 400, 18mm focal length on manual focus, and no flash was used. Samples were positioned on two 12"X12" glass panes on a table covered with white paper towel. The glass panes were cleaned with Windex and covered with Glad plastic film between each sample. A blank experiment was first carried out by spraying the plastic film in the glass pane with Windex and BLUESTAR® FORENSIC to assure the cleanser product did not react. The lights of the room were turned off and a 12"x12"x12" cardboard surrounded three sides of the glass panes to decrease the amount of light into the sample's area. All 146 substances and two positive controls (whole human and pig blood) were sprayed twice at room temperature with BLUESTAR® FORENSIC and immediately checked for a bluish luminescence indicative of a positive reaction. We did not let the samples dry. Positive reactions were recorded and photographed.

FOOD	REACTION	FOOD	REACTION	PERSONAL CARE	REACTION
Bakers & Chefs	N	Gatorade Strawberry Watermelon	N	Purell Hand Sanitizer	N
				Bath & Body Works-Bali Mango (Mist)	N
Coca-Cola Classic	N	Cherry Tomatoes	N		
Hershey Double Chocolate	N	Vendange Chardonnay Wine	N	Edge Sensitive Skin (Shave gel)	N
Kosher Salt	N	Jell-O Sugar Free Raspberry	N	Lactovit (Deodorant)	N
Emergen-C Pink Lemonade	N	Twinning's London Tea	N	Clinique happy heart (Perfume)	N
				Herbal Essence-Moroccan My Shine (Hair shampoo)	N
Banana Flesh	N	Sysco Mayonnaise	N		
				Herbal Essence-Moroccan My Shine	
Banana Peel	N	Traditional Medicine Organic Ginger Aid Tea	N	(Hair conditioner)	N
				Degree Clinical + Clean (Deodorant)	N
Tangerine Peel & Flesh	N	AFC Sweet Chili Sauce	N		
				Bath & Body Works-Wild Passion Flower (Hand soap)	N
Carrot Peel & Flesh	N	Eggplant	N		
Red Potato Skin & Flesh	N	Green Onion Leave	N	Coppertone Stectra3 Sun block	N
Grapefruit Peel & Flesh	N	Kiwi	N	Saler Mix Hair Dye	N
Quaker Natural Oatmeal	N	Radish	N	Nivea Soft Moisturizing Cream	N
Quaker Cinnamon Spice Oatmeal with Lactate Fat Free Milk	N	Celery	N	Colgate Total tooth paste	N
Heinz Ketchup	N	Ginger	N	Revlon Lip Gloss 040	N
Tropicana Orange Juice Vitamin D	N	Dryed Tyme (Spice World)	N	Angel on Mine-Baby Powder	N
Natural Green Pepper	N	Fresh Corn on Cob	N	Dove (Deodorant)	N
Mango Skin & Flesh	N	Leek	N	Sally Henson Clear Nail Polish	N
Egg Yolk, Egg Whites & Shell	N	Leek Leaves	N	Clear Care Eye Contact Solution	N
Strawberry	N	Apple Banana (Skin and peel)	N	L'Oreal Bare Naturale (Cosmetic)	N
Cabbage Green	N			Lancôme Juicy Tube Lip-gloss	N
Raspberry	N	CLEANERS		Revlon Lipstick 845 Sheer	N
Blueberry	N			Almay Pure blends Eye Shadow	N
				Acne Free Terminator 10.	
Onion Skin & Flesh	N	Finish (Dishwasher soap)	N	10% microBenzoyl-Peroxide	N
Pear Peel & Flesh	N	Pledge	N		
Natural Mushroom	N	Lysol Lemon/Lime	N	MISCELLANEOUS	
Lime Juice and Peel	N	Soft Scrub-Bleach Gel	Y		
Lemon Juice and Peel	N	Clorox Cleanup Stain Remover-Whites	Y	CVS Insect Repellent	N
Cucumber	N	Clorox Cleanup	Y	OFF (Insect repellent)	N
Cherry	N	Goddards (Stainless steel cleaner)	N	Hot Shot-Insect Killer	N
Apricot Skin & Flesh	N	Weiman (Leather wipes)	N	Niagara-Original (Spray starch)	N
Asparagus	N	Windex Original	N	WD-40	N
Parsley	N	Tilex- Mold & Mildew	Y	Melotonian (Spray paint)	N
Cilantro	N	MR. Clean Lemon	N	Mobil 1 Synthetic 10-w30	N
Spinach	N	Lysol Citrus	N	STP (Gas treatment)	N
		ZEP Commercial Marble, Granite & Quartz			
Spiral Organic coconut virgin oil	N	Cleaner	N	Specticide Bug Stop	N
Snapple All Natural Fruit Punch	N	The Treatment (Upholstery Shampoo)	N	OXY Clean- Max Force (Laundry)	N
Brugal-Rum	N	Floor Blaster Wood Cleaner	N	Spartan-SD20 (Degreaser)	N
Absolute Vodka	N	Kirkland's Surface Cleaner-COSTCO BRAND	N	Nature's Green Magic (Wash&Wax)	N
				Tide + High efficiency w/ Febreeze-Renewal	N
Newman's Own Mild Sauce- Salsa	N	Monster Screen Cleaner	N		
Kikkoman Soy sauce	N	Weiman (Cook top glass)	N	Top Paw 'No Go' Training Aid	N
Turnip Root	N	Vinylex (Vinyl protectant)	N	Behr Wall Paint Satin	N
Broccoli	N	Pledge Floor care	N	Pure Acetone	N
				Studio 35 Beauty (Nail polish remover)	N
Gia Russa Balsamic Glaze Vinegar	N	Folex Instant carpet Remover	N		
Pineapple	N	Cascade Complete	N	Krylon Fusion Spray (spray paint)	N
Dill	N	Palmolive antibacterial	N	Hydrogen Peroxide	N
Parsnip	N	MR. Clean Lavender Scent	N	Paper-Mate Red Ink	N
		Dispatch Hospital Cleaner Disinfectant w/Bleach	Y	Evident Black Fingerprint Powder	N
Mahi Mahi fish	N				
Herbalife-Protein Powder	N	Ajax Oxygen Bleach Cleaner	N	Magnetic Fingerprint powder	N
		Ajax Oxygen Bleach Cleaner mixed with water	N	Pink Floresent Fingerprint powder	N
Instant Coffee	N				
		Fabuloso Lavender	N	Evident Ridge Builder	N
				Sirchie Small Particle Reagent, UV	N
				Sirchie Amido Black	N
				Ronsonol (lighter fluid)	N

Table 1. Specificity result for 146 substances
A positive reaction was any immediate color change/glow after spraying BLUESTAR® FORENSIC to the substance.
Y indicates a positive reaction. N indicates no reaction

RESULTS & DISCUSSION

Our experimental results showed that only five out of the 146 samples tested (table 1) gave a positive reaction to BLUESTAR® FORENSIC: Soft Scrub-Bleach Gel (Figure 1), Clorox Cleanup (Figure 2), Clorox Clean-up Stain Remover-Whites (Figure 3), Tilex Mold and Mildew (Figure 4) and Dispatch Hospital Cleaner Disinfectant/ Bleach (Figure 5). These five samples are bleach-chlorinated products. The oxygen bleach "Ajax" did not react with the reagent because it is a non-chlorinated but a Calcite-based cleanser. In addition, our findings corroborated that the cheminoluminescence observed in bleach-based products is clearly distinct from that observed in the presence of blood, allowing the investigator to visually differentiate the higher intensity and longer reaction of blood without difficulty

While other authors [Dilbeck, 2006; Tobe *et al.*, 2007] and the manufacturer have reported false positives for a number of substances including chlorine, turnip flesh, banana pulp, radish flesh, leek, green beans, ginger flesh, carrots, tomatoes, tomato sauce, tomato sauce with meat, red onion, red kidney bean, horseradish, 0.1M ascorbic acid, household detergents, some paints and varnishes, copper, certain iron metabolizing plants such as lichens, thyme and some tree mosses, and certain soils containing iron among others; in our study, only chlorine-based products showed the luminescence in the presence of BLUESTAR® FORENSIC. All our food products (either their skin or flesh) showed a negative reaction to the chemical. The reason of this discrepancy might be that our method of testing was different from that used by other authors who utilized a different substrate and let the samples dry for several hours. Another fact could be that some studies were made out of the U.S. where food products were probably grown and harvested under different conditions and using different chemicals. There are several limitations to this study for which future research is recommended. This study did not address a range of different substrates that can be encountered at crime scenes. Additionally, same products from different manufactures should be tested, especially food products, personal care items and some miscellaneous.

In conclusion, our study demonstrated that BLUESTAR® FORENSIC is sufficiently specific and reliable to use as a presumptive test for the detection of latent bloodstains during crime scene investigations and, ultimately, it is hoped that the outcome of this study will result in better investigation.

Figure 4. Tilex-Mold & Mildew

Figure 5. Dispatch Hospital Cleaner Disinfectant w/Bleach

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