Websites:
http://www.lifesciencesite.com
http://www.sciencepub.net

Emails:
editor@sciencepub.net
sciencepub@gmail.com

Life Science Journal

MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

"chemistry of blood stain removal after setting"

AZEEZ MUTIU O, RLLD, CLLM, CText ATI

FEDERAL MEDICAL CENTRE, BIRNIN KEBBI, KEBBI STATE, NIGERIA.
Author's email: azeemone@yahoo.co.uk ,Phone: +2348035283072

ABSTRACT: Blood stains adherence to textile materials or fabrics or hospital linen had been among major challenging stains aside dye transfer from one textile to another. There are many stain removals developed to deal with these problems by different chemical companies globally. All these products have their adverse effects on the properties of the textile fibres that composed the material. For instance, chlorine bleach or oxalic acid can cause tendering of cellulosic fibre like cotton. To remove blood stain, it requires understanding basic chemistry of blood and its constituents. Therefore, other potential stain removals used in this study include: water, detergent, oxalic acid, sodium hydroxide, and alkaline sodium hydrosulphite. Method of data analysis involved evaluation of blood stained fabric sample after treatment through physical comparison of the degree of whiteness obtained with the original white sample (control sample). It was found that sodium hydroxide gave significant removal of the stain, followed by alkaline sodium hydrosulphite while the rest did not show any significant removal.
[AZEEZ MUTIU O, RLLD, CLLM, CText ATI. "**chemistry of blood stain removal after setting"**. *Life Sci J* 2024 ;21(1):49-54]. ISSN 1097-8135 (print); ISSN 2372-613X (online). http://www.lifesciencesite.com. 07. doi:10.7537/marslsj210124.07.

Keywords: blood stain, sodium hydroxide, oxalic acid, detergent, sodium hydrosulphite

OBJECTIVES/AIMS OF THE STUDY

1. To eliminate problem of blood stains in human endeavour especially laundry processing and the healthcare facilities.
2. To reduce laundry processing cost, time and replacement cost.
3. To increase textile materials serviceability and quality assurance of processes linens in the textile care industry globally.
4. To eliminates uses of bleaches and other chemicals in removal of blood stain.
5. To reduce effluents discharge and its treatment cost in laundry operations.

1.0. INTRODUCTION

In healthcare laundry and linen processing, blood stain had been among the major stains encountered during operations. Laundry processors find it difficult to remove blood stain from the linens if allowed stay for certain period of time. But a fresh blood stain may easily be removed with water at room temperature without application of any chemical or bleach during flush operation or break bath. When blood stain becomes set, removal or treatment seems to be cumbersome from the linen. The extent of the difficulty depends on fibre composition of the linen or fabric. Hydrophilic fibre like cotton tends to have more adhesive force or affinity for blood stain because it attracts water soluble stains. In order to remove set blood stain from the linen, it requires understanding the chemistry of blood and its constituents. However, in laundry operations or processing, these stains may be classified as temporary or permanent depending on chemical change that blood undergoes. Fresh blood stain on textile is easily dealt with, by dilution principle using lukewarm water (not hot). This is referred to as 'temporary' because it undergoes physical change. Whereas, when fresh blood is allowed to stay for certain period of time, it brings a kind of change that involves chemical changes. To deal with this situation, chemical reversibility approach is required.

However, in laundry operations or processing, these stains may be classified as temporary or permanent depending on chemical change that blood undergoes. Fresh blood stain on textile is easily deal with dilution principle using lukewarm water (not hot). This is referred to as 'temporary' because it undergoes physical change only. Whereas, when fresh blood is allowed to stay for certain period of time, it brings a kind of change that involves chemical change. To deal with this situation, chemical reversibility approach is required.

1. 2. BLOOD

Blood consists of several type of cells suspended in a liquid medium known as plasma. The circulatory system provides medium in which the blood transports many substances to and from the organs and tissues. The circulating blood frequently supplies oxygen, nutrients for survival and activity of cells of the body and carry away cell products, including carbon dioxide and other waste products. This activity of blood responsible for variation in blood constituents at particular time.

Many substances are recycled through the blood, for instance, iron released during the destruction of old red cell is conveyed by the plasma to site of new red cell production where it is reused.

1.3. CHARACTERISTICS OF BLOOD

The red cells constitute about 45% of the blood's volume and the remaining cells (White cells and platelets) less than 1%.

Plasma- This is a clear fluid portion, slightly sticky, yellow-wish liquid. Within the body, the blood is permanently fluid and plasma is fairly homogeneously mixed. It contains more than 90% water. When blood is shed physiochemical changes are initiated that cause the blood to coagulate.

Blood Clot – The blood clot consists of *microscopic strands of a complex protein, called fibrin, forming a gel* in which the erythrocytes (red cells) and other cells are entrapped.

1. 4. PROPERTIES OF BLOOD

Blood is an opaque red fluid freely flowing but denser and more viscous than water. The characteristic colour is imparted by hemoglobin; brightens in colour when saturated with oxygen and darkens when oxygen is removed.

Note: This change can be resulted from change in the oxidation number of iron present in blood from iron (III) to iron (II).

Plasma Constituents

The plasma is a complex solution containing more than 90% water. The major solute of plasma is a heterogeneous group of proteins consisting about 7% of the plasma weight, plasma protein, exerts an osmotic effect by water tends to move from other extracellular fluid to the plasma.

Fatty Substances (lipids) are present in plasma in suspension and in solution. Other plasma constituents include salts, glucose, amino acids, and vitamins and so on.

Proteins - They are large molecules formed by chain of amino acid, organic acids that contain both carboxyl group and nitrogenous basic (amino group). Chains (Polypeptides) are formed by linkage of the acid group of one amino acid to the amino acid of the next (peptide bond).The characteristics of a protein are determined by the number and types of amino acids and the sequence in which they are arranged.

The major plasma protein is albumin, a relatively, small molecule and its principal function is to retain water in the blood stream by its osmotic effect. Albumin binds certain other substances that are transported in plasma.

Other plasma components - include glucose. Many inorganic substances that are essential; constituents of plasma and the predominant cation (positively charged ion) of the plasma is *sodium*. Because of the effect of its solution on osmotic pressure and fluid movements, the amount of sodium in the body is an influential determinant of the total volume of extracellular fluid. Potassium, the principal intracellular cation, occurs in plasma at a much lower concentration than sodium. Calcium in plasma is partly bound to protein and in part ionized. Magnesium, like potassium, is predominantly intracellular cation and occurs in plasma in low concentration.

Iron, copper and zinc are required in trace amounts for synthesis of essential enzymes; much more *iron* is needed in addition for production of hemoglobin. These metals occur in plasma in low concentration.

The principal anion (negatively charged ion) of plasma is chlorine in sodium chloride and is its major salt. Bicarbonates participate in the transport or carbon dioxide and in regulation of pH. Phosphate also has a buffering effect on the pH of the blood.

1.5. THE BLOOD pH

The PH of blood is kept relatively constant at slightly alkaline level of about 7.4.

1.6. BLOOD AS TEMPERATURE REGULATOR

Heat is produced in large amount by physiological oxidative reactions and the blood is essential for its distribution and expenditure. With this property of blood, it shows that unset blood requires certain temperature (body temperature to keep it in fluid state).

1.7. ADHESIVE PROPERTY OF BLOOD

Adhesive is a substance used to join separate material through surface attachment. The only consistent of blood that possesses this property is protein molecules, this include albumin which also found its use in glue production. Albumin is a type of

protein that is soluble in water and in water half saturated with a salt such as "*ammonium sulphate".*

NOTE: This compound may serve as a blood stain removal in certain situation if properly applied.

From ongoing discussion, it is shown that a major constituent of blood that can be responsible for permanent setting of blood stain on linen or textile fabric of concern is albumin. Albumin is a protein compound which composed of mainly amino acids. Amino acids can act as acids and bases. When an amino acid is dissolved in water, it exists in solution as dipolar ion or zwitterions. This property enables some acids like *oxalic acid* used in laundry processing to remove blood stain from textile materials to form oxalate compounds.

1.7. ELECTROPHORESIS PROPERTY OF PROTEIN

Another important technique for separation of proteins as in the case of blood is based on an electric field, a process called electrophoresis.

Migration of proteins is approximately in proportion to their charge to mass- ratio. Migration may also be affected by the protein shape.

However, in electrophoresis, the force moving the macromolecule is the electrical potential E.

From the above, we can infer that blood stain is a complex stain to remove and required knowledge of different compositions and their mode of attachment to textiles. In the next chapter, we are going to prove relationship of these factors through experimental method in dealing with blood stain after setting.

2.1. METHODOLOGY AND MATERIALS

The method used in this research study was purely scientific through experimental approach. Fresh blood from three different slaughtered domestic bird (cocks) were collected on three same samples of 100% cotton plain weave bedspread material, separately. The samples were completely soaked with the blood and allowed to dry in the sun. After drying, the stained samples were ironed with hand electric iron on both sides at highest temperature setting (6-linen). They were later subjected to treatment in 5% solutions of the different stain removals.

Note: three samples of the same dimension were cut from each stained blood samples and subjected to equal treatment in each bath of the solution.

Materials used are: fresh blood of slaughtered chicken, 100% cotton fabric, thermometer, plastic container.

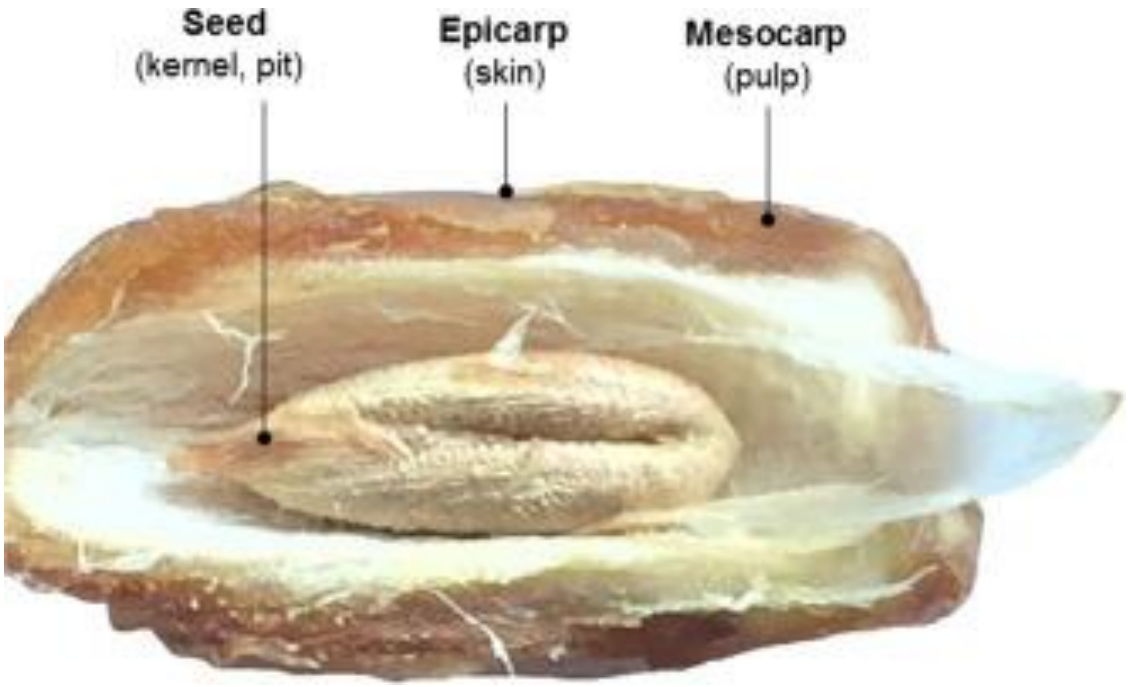
Stain removal: water, liquid detergent, oxalic acid, sodium hydroxide (NaOH), alkaline sodium hydrosulphite setting (reducing agent).

The samples were subsequently immersed in the above solution at temperature range of 50-55^{0}C using thermometer to measure the reading. They were agitated occasionally within a period of 60 minutes and temperature continuously dropped to room temperature. The samples were later rinsed in cold water (2 times), detergent and finally in citric acid to neutralize the remaining alkali.

Method of data analysis and findings. The stained samples were evaluated after treatment through physical comparison of the degree of whiteness obtained with the original white sample (control sample).

2.2. FINDINGS/OBSERVATIONS:

S/N	STAIN REMOVAL	OBSERVATION
1.	Water	No significant removal of the blood stain.
2.	Liquid detergent	No significant removal of the blood stain.
3.	Oxalic acid (ethanedioic acid)	No significant removal of the blood stain. The sample became darker, stiffer and harsh to touch.
4.	Sodium hydroxide (NaOH)	There was a significant removal of the blood stain from the samples. The whiteness of the sample returned to the relative original appearance. During the experiment, the blood appeared brighter and smelt like fresh blood. During the subsequent rinsing, blood stains disappeared and dissolved in the solution.
5.	Alkaline sodium hydrosulphite (reducing agent). (5% NaOH+5% hydros)	There was significant removal of the blood stain from the sample. The degree of the whiteness obtained was nearly what is obtained by the sodium hydroxide solution. At the rinsing stage blood, stain removed gradually until samples became relatively white. The rate of migration of the blood particles into solution was lower in this case.



2.3. DISCUSSION OF FINDINGS

Water alone cannot remove set blood stain based on the outcome of this study. Though it can only serve as vehicle or medium to other stain removals during treatment. It aides its removal in the presence of other chemicals.

Liquid detergent lacks ability to remove blood stain even with the assistance of water. It can only act on insignificant or loosely bound blood stain on the fabric. Stiffness and harshness of the sample is an indication that there was no significant removal of the blood stain from the textile materials or linens.

*Oxalic acid***:** This study suggested that using oxalic acid on set blood stains makes the acid to react with calcium or cations components of the blood to form oxalates which may turn the textile to become harsh and stiff. Therefore, the claim that oxalic acid remove blood stain can only be applicable before setting and it should not be generalized. It rather makes the textile more brittle due to stiffness encountered. This reduces textile tearing strength.

Sodium hydroxide (NaOH)-: From the result of this experiment, there was an indication that the role of alkali cannot be underestimated in the removal of blood stain in an aqueous sodium hydroxide. The protein component of the blood, albumin (binder) was depolymerized. Because amino acid present in the albumin can act as a base or acid due to amphoteric behavior, it enables sodium hydroxide to react with blood to form organic salt which is soluble in water. Therefore, for complete removal of the blood from the textile, there need to exist potential difference (E), between the solution of the sodium hydroxide and the blood on the fabric. The presence of sodium Na+ ion, increased osmotic pressure of the blood to attract water to dissolve blood particles or components. The blood reluctantly released from the fabric due to lack of enough potential difference that exists between the solution and the stained blood on the fabric. At the rinsing stage, there was increase in the rate of migration due to increase in potential difference. In the subsequent rinsing, the rate of migration increased until the whole sample was freed of the blood spot or stain this was due to electrophoresis behaviors of the protein amino acids.

Lastly, *alkaline hydrosulphite* (hydros) behaved similarly to the solution of sodium hydroxide. The only different was due to the presence of high concentration involved, that is 5% sodium hydroxide and 5% sodium hydrosulphite used. This was due to partial equilibrium existing between the solution and the blood stain on the fabric sample. Therefore, high concentration resulted to low potential difference to move the blood particles and its components. The reaction between sodium hydrosulphite and the hydroxide ions reduces the number of available sodium ions to react with blood.

2.4. CONCLUSIONS:-

From the discussion it can be concluded that sodium hydroxide at 5% concentration or below can effectively remove set blood stain provided the stained textile material had not been previously treated with any stain removal. Exposure of the stained material to any source of heat like sun, dryer or electric iron is irrelevant to application of the sodium hydroxide. Albumin of blood is soluble in alkaline solution as many protein molecules or compounds do. The process of removal of set blood stain on textile fabric agrees with the theories of electrophoresis, migration, potential difference, dipolar behavior of protein amino acids. The solutions of sodium hydroxide reactivate osmotic pressure of blood which enables blood to return to fluid state as in the case of fresh blood.

Secondly, alkaline sodium hydrosulphite can effectively remove set blood stains provided no other condition has been given to the stain, prior chemical treatment. The principle of removal is similar to the application of the sodium hydroxide solution.

Thirdly, oxalic acid, detergent with medium alkaline or pH and water cannot on their own remove set blood. The oxalic acid and detergent leave textile material with stiff handle. They leave stain spots on the affected articles after treatment.

Lastly, effective and efficient application of sodium hydroxide in the laundry operation can reduce replacement cost, chemical cost, processing time, possible damage to textiles especially cellulose fibres and overall processing/ production cost. It is therefore recommended to the laundry specialists to introduce sodium hydroxide at the stage when no other chemical or detergent is present when dealing with blood stained linens or textiles in laundry operations. Application of sodium hydroxide remains alternative to other blood stain removals used in laundry processing. Any temperature below 55^0C is suitable at the stage of application. The heat dissolution of sodium hydroxide in water will provide required heat of reaction. Therefore, there is no need for external source of heat.

However, the cellulosic fibres and other textile fibres with exception of protein fibres (wool, silk, hairs) can undergo this treatment in caustic solution at reasonable concentration (5% below) without fear of strength or colour loss.

Reference

[1]. Association for Linen Management's CLLM training manual, (2009), Chemistry section, page 289.
[2]. American Cleaning Institute's (ACI), Stain Removal Chart,www.cleaninginstitute.org
[3]. Britannica Micropaedia (1998), Vol.9, page 26.
[4]. Britainnica Micropaedia, (1998), 15th Edition, Vol.15, pages 125-128, Encylopaedia Britannica, Inc., Chicago
[5]. David L. Nelso, Micheal M. Cox (2005), Principle of Biochemistry, 4th edition, W.H Frexman and company, New York.
[6]. Paramedical Journal (Jan- March, 2004) vol. IV, No 1,page 24.

1/12/2024