

## THE INNOVATIVE WET-DYEING BATIK T-SHIRT TECHNIQUE

ABRAHAM EKOW ASMAH<sup>1</sup>, VINCENTIA OKPATAH<sup>2</sup> & SAMUEL TEYE DAITEY<sup>3</sup>

1, 2 & 3. Department of Integrated Rural Art and Industry, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi-GHANA

### ABSTRACT

Dye-print crafts in Ghana have assumed a multidisciplinary experimentation stage, where several types of integrative approach to fabric decoration require the knowledge of scientific discipline and expertise. This paper investigates the prospect of utilizing appropriate materials, techniques and a coordination of individual creativity to achieve an innovative wet dyeing T-shirt batik print. It emphasises on creating an innovative T-shirt wet dyeing effect as the background, to mount a batik printed effect. This integrative dye-print style with the vat dye used the experimental and descriptive approach under the qualitative design methodology. The result of the research showed an attainment of a dye-print colouration that produced a diversity of watery background shadow coloured images mixed with a contour batik print definition of shapes on the T-shirt via the dyeing by absorption. The product positively competes with traditional table-dyed and batik, and also conveys visual dynamism inherent in both tie-dye and batik prints that exhibit groundbreaking domino effect. Discussions were based on academic and functional contexts. The advanced dye-prints have tremendous significance for batik design concepts to enhance coloured dye-printed T-shirt fabrics in the local batik industry.

**Keywords:** Tie-dye, batik, wet-dyeing, T-shirt, dye-print colouration.

### INTRODUCTION

Textile embellishment, a creative form of self-expression in fabric design, uses countless media and procedures to produce dyed and printed fabrics (Asmah et al, 2015). In Ghana, T-shirt ornamentation comes in different form by beading the neck line, printing the back and the front part of the T-shirt, using the patchwork technique on the upper parts of the T-shirt, by embroidering its chest part and commonly by tie-dyeing the entire cotton T-shirt or by the waxing technique. Historically, there are numerous ways of decorating cotton T-shirt or cotton fabric via the dyeing process in Ghana, though resist dyeing techniques originated in the far east dating back to the 5th century B.C. (Miles, 1994; Miles et al, 2010) this technique applied on T-shirts or textile fabrics, especially in Ghana, are treated most popularly by preventing the cotton T-shirts or materials from accepting the dyes that the rest of the fabric receives (Picton et al, 1989). Traditionally resist dyeing techniques in Ghana include tie-dyeing, hot wax resist technique, starch paste resist, tritik, table-dyeing or marbling, tubular-dyeing, knotting, twist and coil technique and the clamping methods (Asmah, 2004).

Batik, as a form of resisting decorative technique, is a fabric dyeing method which uses wax or paste to create patterns and designs. It is well known throughout Japan, India, and Indonesia (Sandberg, 1989). The designs are created with fabrics when melted wax or prepared paste (a dye-repellent matter) is applied in areas of the cloth to prevent them from absorbing colours when the cloth is dipped into dye. The wax or paste applied is also used to control colours from spreading out from a particular area to create motif when the resisted cloth is dyed (Belfer, 1977; Asmah, 2004)). A method thought to be over a thousand years

old, today; engages the use of foam, metal or wooden blocks, tjanting, brushes and broom as tools to register manually the melted wax onto the T-shirt or the fabric.

The most common material used is the paraffin wax mixed with bee's wax referred to as batik wax instead of the traditional cooked cassava starch pastes to prevent dyeing in designated areas. The wax fuses with the fabric to create an impermeable seal and thus stops any area under the wax from soaking-in colour. The presences of the bee's wax used to produce the batik wax, creates a strong bond between the fabrics and resist leakage during multiple dye-baths. The tint of the batik cloth is dependent on the desired colour saturation determined by the temperature of the dye bath submerged, the length of time and the adjustment of its colour saturation. The contrast of dyed and untouched fabric etches out the lines and textures of the design, as the wax is removed, using hot water and the possible addition of alkaline solvents. Depending on the desired result, the process can be repeated to create layers of colour with complex images.

The tie-dye technique involves various methods of folding fabrics, tying, binding and dyeing of the fabric in a dye bath. The bindings prevent the tied portions of the fabric from receiving the dye and the bonded parts untied, reveal the designs created. Diverse cultures have different names for this technique, Plangi, for Indonesia (Asmah, 2004: Picton et al, 1995), Bandharu in India (Asmah, 2004: Picton et al, 1995), Adire Eleso for Nigeria (Adetoro, 1972: Oparinde, 2012), and Shibori in Japan (Belfer, 1977: Asmah, 2004).

Resist dyeing in the form of starch paste is similar to hot wax resist dyeing, but a cooked soluble flour paste is applied to the fabric instead of hot wax. The technique is extensively used throughout Asia and Africa, particularly Nigeria, where such process is referred to as Adire Eleko (Adetoro, 1972: Oparinde, 2012: Asmah et al, 2015). The tritik technique refers to thread stitches sewn tightly into the cloth and gathered to form the resist. Though other cultures have adopted this traditionally Indonesian technique, it remains one of the easiest form of resisting in West Africa. In marbling, the fabric is bunched up into a wrapped ball created by gathering the fabric in all directions, tied or stitch and produced by the tabletop dyeing method. The result after dyeing, indicate a blend of texture revealed after untying the fabric. As the name implies, tubular-dyeing is dyeing the fabric while still wrapped around a tube. The resultant effect forms a V-textured, linear coloured patterns (Asmah, 2004).

With the knotting technique, as the name suggests, the fabric goes through a series of knots at desired intervals along the folded length of the fabric. The resultant product forms patterns of wavy lines. The twist and coil technique also produces a tight twisted fabric that coils itself backwards. The result is a W-shaped series of movements throughout the fabric after dyeing (Asmah, 2004). The tools and materials needed are the same as those used for the knotting technique. The clamping methods make use of solid flat objects like wooden boards pressed against the fabric and tied at both ends with threads to form the resist (Belfer, 1977: Asmah, 2004).

With the advent of modern technology, decorative techniques on T-shirts have seen innovative changes in its dyeing applications resulting in interesting and unique fashionable products. (Fig., 1 & 2) Furthermore, these techniques adapted, combine with other forms of fabric decoration. A new form of batik that is a mélange of tie-dye and batik techniques is now invoked. Intricate designed fabrics are created by using some, all, or a combination of these techniques outlined above. (Fig., 1)



Fig., 1: T-shirt and Mercerized cotton jointly designed in a combination of Tie & Dye and batik



Fig., 2: A Designed T-shirt in purely batik

T-shirt batik making in Ghana, plays an important role as an art form, a useful Friday-wearable fabric, and a means of work for many youth and are seen as a growing significant culture phenomenon well known for its quality and intricate designs.

## MATERIALS AND METHODS

The methodology adopted, helped to study table dyeing production procedures, the characteristics of cotton T-shirt dyeing fabrics and its possibilities to relate to wax print techniques. The studio experiment or the practice base methodology depended on studio activities under the qualitative research to help use the analysis established to create the innovative wet-dyeing batik T-shirt prints. It also gave a holistic picture of what goes on in the dyeing industry (Frankel et al, 1993). The activities of the experiments conducted and its results were recorded carefully, and critical observations made. Both primary and secondary data were utilized in the study. The purposive sampling technique was used in selecting the materials for the study.

Materials used for the project were as follows; cotton T-shirt due to their versatility, adaptability, durability and affinity to the dye used, vat dye, sodium hydrosulphite, sodium hydroxide, tracing paper, water, mild detergent, heat source (coal pots), metal bucket, aluminium pots, plastic cups and spoons, big bowls as dye-baths, rubber gloves, thumb-tacks, small plastic palette bowl for measuring dyes, wax, aprons, wooden slate, hand gloves, syringe and wooden stick for dewaxing. Tools and equipment employed in the project included, a pen and pencil, a ruler, tjanting, working table, pressing iron, working shed, camera, computer and water reservoir.

The two main criteria in opting for the vat dye are its behaviour during and after washing and its higher colour yields (Asmah et al, 2015). Gutjahr et al, (1994), reiterates that vat dyes provide a good range of fast colour properties. They are water-soluble, have an affinity for cotton T-shirts and after dyeing can be oxidized to turn the soluble vat dye into insoluble dye. Such reversibility of its reaction requires the use of both sodium hydrosulphite ( $\text{Na}_2\text{S}_2\text{O}_4$ ) and sodium hydroxide ( $\text{NaOH}$ ) to improve dye solubility (Asmah et al, 2015). In principle, controlled dyeing on a plain-coloured fabric diffuses rapidly within the fibres of the T-shirt fabric as it goes through the mechanisms of dye fixation (Gutjahr et al, 1994). According to Asmah et al, (2015), the dyeing operation is accelerated and its fixation during and after oxidation attains an adequate fastness level.

In this tropical climate, cotton T-shirt is a highly preferred choice due to its soft, breathable, eco-friendly, affordable, and organic nature. T-shirts come in a variety of different materials, from cotton and linen with polyester and rayon. The major material used for the study was the Pima cotton plain T-shirt fabric used normally for the production of table top dyeing due to their absorption rate, texture, longevity, weight, availability, free of finishes, comparative strength, affinity for vat dyes and its ability to hold its shape even after numerous washing and wearing (Asmah et al, 2013). It is also of high-quality that resist pilling and stretching and only get better with wear. However, its defect is a bit of shrink after the first wash under high temperature. T-shirt print has been the favourite clothing among youngsters, often used to portray their personality and style. With changing time and fashion, these T-shirts have seen many innovations and technological advances that have made this clothing, even more modern and popular among people of all age groups.

### Dyeing Procedure

For this study, two new cotton T-shirts weighing 135 grams each were immersed in cold water for 2 minutes and removed onto the working table without squeezing out the water from the T-shirts. This was very important because the essence of the results depends on it. The wet T-shirts were immediately marbled by gathering them separately to form loose circular shapes on the working table (Fig., 3). The prepared vat dyes were then gradually distributed on the wet T-shirts with the help of a syringe per each colour dye for the first T-shirt and the use of the tablespoon per each colour dye for the second T-shirt. (Fig., 3)



Fig., 3: T-shirts Marbling and dyeing on a table top



Fig., 4: End product of a Marbling T-shirt dyeing via the table spoon

The two dye mixture ratios, labelled (A and B) were used as shown in Table 1 for all dyes (red, lemon green, and brown) applied for each T-shirt. Mixture A and B used the same ratio for each T-shirt fabric; 5 grams of powdered dye, 10 grams of sodium hydrosulphite and 10 grams of sodium hydroxide. The only difference between them was the quantity of water added after mixing Mixture A which was 0.5 litre of water and virtually maintaining the normal proportion of water enough to dissolve the ingredients in the preparation for Mixture B with only an addition of 29.58 ml of water after preparation (Table 1).



Table 1. Dyeing ratio for T-shirt prints

A	Quantity	B	Quantity
Water	0.5 litre	Water	29.58 ml
Powdered dye	5 grams	Powdered dye	5 grams
Sodium hydrosulphite	10 grams	Sodium hydrosulphite	10 grams
Sodium hydroxide	10 grams	Sodium hydroxide	10 grams

After the normal preparation of the vat recipe for Mixture A, a lot of water (Table 1) was added to achieve a diluted tint of the colour. Mixture B followed the same normal procedure for mixing all the three ingredients of dyes and chemicals with an additional 29.58ml of water to achieve a normal bright colour. This was done for all the three colours selected for each T-shirt.

With the mixtures ready to be used, Mixture “A” group of dyes in three separate palettes bowls were siphoned one after each other into 3 syringes and distributed all over one of the wet-out T-Shirt on the working table. The other group of three separate dyes for Mixture “B” were then distributed over certain selected portions of the marbling T-Shirt, arbitral this time with the help of only the tablespoon (Fig., 3). The T-Shirts were allowed to lie on the working table for a duration of 45 minutes to 1 hour. The T-Shirts were then removed and hanged on a drying line to oxidize and dry. The two T-Shirts registered a bleeding effect all over after drying to make room for further work to begin (Fig., 4 & 5). The selected design pencil sketches in the sketchbook were transferred onto the already dyed T-shirts.

The next stage was to prepare the marbled T-shirt by inserting a cut-out plywood slate that fit perfectly into the T-Shirt as the melted wax on a controlled stove was made ready. A tjanting tool made of foam (Fig., 6) that works almost the same as a real metal tjanting tool was used to draw over the pencil or pen outlines design on the T-shirt (note that any motif can be drawn using a 6B pencil before waxing). The melted wax was picked with the tjanting tool and applied as desired based on the drawings on the T-Shirt. (Fig., 6) As the waxing progressed, the composition was refined. Areas intended to display the background marbled colour of the T-shirt were covered with wax. The moderately hot wax used was to avoid the spread of the melted wax into undesired areas of the T-shirt. To achieve the perfect temperature of the melted wax demands practice. After the completed images, the tissue was submerged into a dye bath set at pH 6 in a similar dyeing procedure used for mercerized cotton fabric.



Fig., 5: End product of a Marbling T-shirt dyeing via the syringe

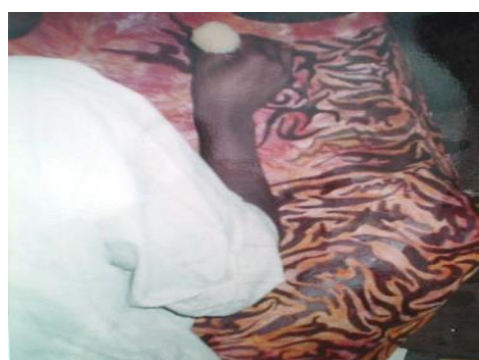


Fig., 6: Dyed T-shirt being waxed with an improvised tjanting tool

Dyeing is essentially a mass transfer process where the dye diffuses in solution, adsorbs onto the fibre surface, and finally, within the fibre heightened by its many sources of colour variations, such as dyes, substrate and preparation of substrate, dyeing auxiliaries used and water. The implication of such processing coupled with variables such as time, temperature, and dye liquor ratio (pounds of dye bath to pounds of cloth) appropriately applied to the T-shirt prints realized a good dyeing result. To ensure thorough penetration, the concentrated solution of dyes and chemicals were made to move evenly and uniformly to the T-shirt fabric by intermittent hand pouring of mixed dyes onto the dyeing T-shirt while on the working table for the first experiment and the use of the tablespoon for the distribution of the second experiment. This dyeing system ensured that the potency of most of the liquid dyes utilized was completely exhausted and appreciably dissolved into the dyeing T-shirts.

Dewaxing was done by melting the wax off the T-shirt surfaces. In order to make this happen, a big basin of water was boiled. Usually this was done over an open fire pit, but other means of heating the water would suffice. The T-shirt fabrics with wax were submerged into the hot water, turned several times and quickly pulled out into the cold water basin to the left over wax to drip off completely after washing. The mechanical finishing operation, other than preparation and colouring, carried out improved upon the appearance and usefulness of the T-shirt after it was dewaxed, washed in an alkaline solution, dried and given an ironing treatment to complete the fixation process. (Fig., 7 & 8) This rendered the resultant products to attain wash and light fastness.



Fig., 7: Final product of a Marbling T-shirt dyeing via the table spoon

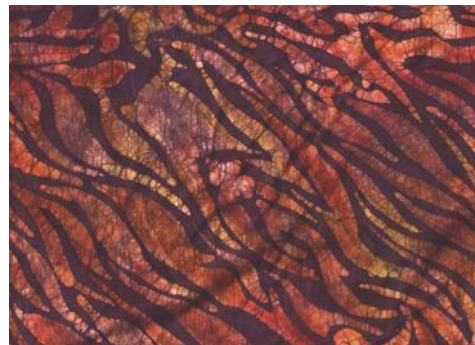


Fig., 8: Final product of a Marbling T-shirt dyeing via the syringe

## RESULTS AND DISCUSSIONS

The introduction of an innovative wet dyeing T-shirt technique into tabletop dyeing gives its dyeing fraternity a new concept of marbling dyeing. The unique way of preparing the vat for colouration by introducing additional water to the mixture of sodium hydroxide and sodium hydrosulphite, gave a watery light tint colour effect that proved successful. The adaptation of such a technique to the normal vat dyeing process to produce a streaky background for a resist printed fabric, gave rise to a unique design surface for the project. The resultant effect of the project comparatively, was remarkable, coupled with the variability outcome of colouration over the traditional table top dyeing method, prepared under the normal table top dyeing procedure.

Technically, the composition of the recipe dyes is scientifically simple yet varied to yield, a resultant effects determined not only by the constituents of the dye recipe used, but by the wet out technique of the T-shirt, the nature of the substrate and the application of the vat dye

mixture utilized. In this application, vat dyes were converted to a water-soluble form that had an affinity for the T-shirt and were subsequently converted back to their water-insoluble form, giving good permanence under wet conditions (Asmah, 2004). The soluble state of the dye diffused uniformly into the fibres of the T-shirt fabrics, exhaustively dyeing the T-shirts on the table during the entire dyeing period. The presence of the watery dye liquor on the table top aided the streaky formation of the dye colours on the T-shirt fabrics as there was no movement or disturbance of the T-shirts placed on the table (Asmah et al, 2015). The relevance of its stationary position, increased the streaky shade of colour effect in that area as the dye in this setting, attained maximum diffusion due to the concentration of dye within the dyeing period.

At the end of the dyeing period, this same streaky colour effect revealed gave an easy flowing natural path which aided the designed composition of the resisted areas. The induction to the design values the designer adopted was based on the water-like flowing design concepts. With this philosophy, the path of the waxed areas simulates the demonstration of a spilled water movement effect displayed on an oily substrate. The resultant abstracted design effect achieved was nothing short of the design registered on a zebra skin that reflects the visual illustration of animalistic subjects that relate to the beauty of nature. The aesthetic principles of design demonstrated an artistic design approach, however, the execution, focused more on the aesthetic background achieved by the wet dyeing technique.

The printing processes involved the use of three ingredients - water as a solvent, sodium hydrosulfite ( $\text{Na}_2\text{S}_2\text{O}_4$ ) and sodium hydroxide ( $\text{NaOH}$ ) as auxiliary sodium agents. The dyeing was done using the table top dyeing technique - where the process included the preparation of the dye recipe, the wet out and the marbling of the T-shirt fabrics on the working table, oxidation, drying, waxing, dyeing of the final colour, dewaxing, washing, drying of final products and fixation by ironing of the T-shirt fabrics. With such clear methodology, repeating the operation can easily be followed. The project successfully applied the four basic steps common to table dyeing process which are; dissolving or dispersing dye, diffusing dye onto the fibre surface, absorbing dye onto the fibre surface and diffusing dye into the fibre (Asmah et al, 2015). This ascertained the fact that the dyeing technique adopted by pouring of the dye liquor onto the T-shirt fabric placed on the working table was appropriate for the study. The dyeing T-shirt remained in contact with the dye liquor deposited on the dyeing table for better results throughout the entire dyeing period.

The indication of proper contact of the cotton T-shirt material with the dye liquor, as the dye molecules migrated from the dye solution and entered the fibres over the entire dyeing period of 45 minutes to an hour duration attested to its affinity. An affirmation that the dyeing process, auxiliary sodium chemicals and controlled dyeing conditions used in the dyeing process accelerated and optimized the migration process (Adanur, 1995: Asmah et al, 2015). Such dyeing condition helped fix the dye in the fibre after which the T-shirts were washed to remove unfixed dyes and chemicals after oxidation. This was done to ensure level dyeing, even after drying, as the dyed T-shirts went through a series of washing to remove un-bonded or unreacted dyes before aeration over the drying lines. This action rendered the resultant products to attain wash fastness after ironing.

The manual finishing procedure, other than the preparation and colouring, carried out also enhanced the appearance and efficacy of the T-shirt fabrics after the ironing treatment to complete the fixation process. The implications are that the wet-dyeing batik T-shirt print is achievable and its improvement and sustenance will be enhanced if learning institutions are

engaged in this dyeing operation. Other entrepreneurs and fashion houses can also benefit immensely from this product if they can take advantage of this study to engage dyers to customize their products. The study will inspire creativity, especially among educationist and textile instructors to sustain design education in textiles, in fabric decoration, and innovations in the traditional textile industry in Ghana.

## **CONCLUSIONS**

The strong consumer-led demand for cellulosic T-shirt fabrics in Ghana, in this tropical conditions presumably becomes relevant to the persisting fashion for organic clothing. In most cases, these goods are coloured in a wide gamut of shades to meet the highest possible levels of wet and light fastness and easy-care requirements of modern life, so it is, with the outcome of these two experiments.

Obviously, the above mentioned technology involving the making, modification, utilization of knowledge of tools, methods and dexterity to improve upon a pre-existing table top dyeing effect, coupled with a waxing method registered an innovative, wet-dyeing batik T-shirt technique. These underlying principles guided the project in the application of applied technology and material science to develop this new product (Shuaib, 2012). The project best describes the aesthetic value, technology designed and the functionality of the wet-dyeing batik T-shirt fabrics.

Vat dyes are becoming increasingly popular for dyeing cellulosic fabrics in Ghana because of their wide shade range, ease of application and excellent wet fastness properties. All these dyeing systems, presents an increasing efficiency of vat dye penetration of an alkaline dye bath conditions. The dependency on fabric affinity to dye hinges on the chemical structure of the dye and fabric molecules and the interactions between them. Thus, chemical bonding plays an important role in how and why vat dyes work. The structures of vat dyes are rather well known and still the most important colourant for cotton T-shirt fabrics. This underscores the importance of dye affinity for cellulosic substrates that requires the dye to remain within the polymer matrix when water swells the substrate.

The outcome of the research displays a diversity of watery coloured background images mixed with a detailed wax outline pattern print definition. To be abreast with changing trends traditional wax designers are now challenged to be innovative in their dyeing and waxing techniques of T-shirt decoration acceptable by most consumers. This will broaden the choice of T-shirt decoration and provides inspiration to strengthen the drive of the Ghanaian traditional fashion industry to command a broader spectrum of youthful appeal. Such technique adds to the existing traditional tabletop dyeing products and increase the options available to both producers and buyers of T-shirt fabrics and provides a new business opportunity for Ghanaian dyers and fashion producers.

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