UNIVERSITY OF CAPE COAST

EFFECTS OF LOCALLY MANUFACTURED SOAPS ON COLOUR, STRENGTH AND ELONGATION OF SOME SELECTED GHANAIAN PRINTED COTTON FABRICS

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BY

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Thesis submitted to the Department of Vocational and Technical Education of the Faculty of Education, University of Cape Coast, in partial fulfilment of the requirements for award of Master of Philosophy Degree in Home Economics

JUNE 2012

DECLARATION

Candidate’s Declaration

I hereby declare that this thesis is as a result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate’s Signature:... Date............................

Name: Seyram Ama Kwame

Supervisors’ Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Principal Supervisor’s Signature: FAKwakye. .... Date.............................

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Co-supervisor’s Signature: .... Date..............................

Name: Ms. Modesta Efua Gavor

ABSTRACT

Despite the highly attractive and durable nature of most Ghanaian printed cotton fabrics they tend to depreciate faster in colour and strength over a short period of use due to poor laundry culture and fabric care. The effects of two Ghanaian locally produced soaps (Key soap and Azumah blow) on colour; strength and elongation of two Ghanaian printed cotton fabrics (GTP and ATL) were investigated using an experimental approach.

Simple random sampling method was used in selecting sample specimens for the study. The Gyrowash 315, Hounsfield H5K-5, and a magnifying glass were used in washing, testing tensile strength and elongation, and determining thread count of the specimens, respectively. ANOVA was used to test the significance differences in the effects of the two soaps on the specimens. Azumah blow soap had higher total free alkali of 1.57 compared to the specified maximum of 0.3 and higher percentage solubility in ethanol of 38.5% compared to the 20% maximum specified standards, but those of key soap, however, were consistent with the Ghana Standard Board's specified limits.

There was a significant difference in the effect of both soaps on colour fastness of GTP and ATL cotton fabrics with Azumah blow having the highest negative effect. GTP lost 1.5 units of colour when washed with Azumah blow and only 1unit with key soap. Whiles ATL maintained its original colour when washed with key soap; it lost 1 unit of colour with Azumah blow. The Ghana Standards Board should ensure that local soap manufacturers adhere to the standard specifications of laundry soaps.

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DEDICATION

To my husband Justus P. Deikumah, and my daughter, Beata F. Deikumah.

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LIST OF ACRONYMS

ANOVA	Analysis of Variance
ATL	Akosombo Textile Limited
GS	Ghana Standards
GSA	Ghana Standards Authority
GTP	Ghana Textile Printing
ISO	International Standards for Organisation
WF	Weft
WP	Warp

CHAPTER ONE

INTRODUCTION

Background to the Study

Printed cotton fabrics are important in human endeavours. Joseph (1988) indicated that human beings use a variety of cotton fabrics daily for various purposes such as apparel, home furnishings and conveyor belts, among others. Cotton fabrics are named according to the methods used in their manufacture and labelling (Anin, 1974) which add aesthetic value to their many colours and designs. Cotton prints are both imported and locally made for use in Ghana. However, the Ghanaian textile prints can be obtained in different colours and designs comparable with the imported textile prints.

The Ghanaian cotton prints include products of the Tex Styles Ghana Limited formerly known as Ghana Textile Print (GTP) and Akosombo Textile Limited (ATL). Ghanaian real prints such as real wax, real java, batik, tie and dye, and fancy prints are extensively used by both Ghanaian and foreign consumers for clothing and other purposes. With the cost of the Ghanaian real wax prints comparing favourably with imported ones, as well as its aesthetic appearance, many Ghanaians and foreigners have developed the liking for Ghanaian real wax prints.

The growing consumer awareness of knowing what he or she gets for his or her money plus intensifying competition have become significant in daily life. Consumers consider the performance and durability of the cotton fabric they purchase in terms of its tensile strength, colour fastness, and elongation when subject to stress such as washing (Joseph, 1988). Many factors, including the type of soap used in washing, therefore become important determinants in the colour fastness, tensile strength and elongation of cotton fabrics.

Cleansing products play an important role in the daily lives of people. Their regular use help people to stay healthy, care for their home and belongings, and make the surrounding more pleasant by removing soils, germs and other contaminants (Ameyibor & Wiredu, 1991). These products are effectively and safely used by millions of people in homes, schools, businesses and healthcare settings for yielding improvements in both hygiene and the overall quality of life. Cleansing products have found uses in different applications, such as personal cleaning (skin care, body care, and hair care), laundry cleaning, and dish wash cleaning and household products cleaning.

The origin of cleansing products dates back to prehistoric times where the Ebers Papyrus, (1500 B.C. Medical document) describes the manufacturing of soap-like material by combining animal and vegetable oils with alkaline salts. This soap-like substance was found to be helpful in the treatment of different skin diseases as well as washing. According to a Roman legend, soap got its name from mount Sapo, a place where the Romans offered animal sacrifices. Apparently, the fat from the animals got mixed with the wood ashes and got washed downhill where the women noted that using that mixture for their washing made their clothes cleaner (Maine, 1995). The first soaps were manufactured in ancient times through a variety of methods, most commonly by boiling fats and ashes.

In Ghana, oral history people indicate that before the pre-colonial era, people living in the rural communities used various types of products such as leaves of pawpaw trees, tea grasses, lemons, ashes and stone as a cleaning product (personal interview). According to Amenumey (2008), during the pre-colonial era, people of Ghana developed a number of skills and crafts on their own and practiced them long before their contact with the Europeans. These crafts formed the bases for a number of countries that developed. The product of these crafts and industries were exchanged both inside and outside the country.

Soap making is another industry of long standing where the industry uses raw materials and employed local skills in producing the local soap. Peelings of crops like plantain or yam, maize or millet stalk were burnt to ashes. The ashes were then boiled in palm oil, to which other ingredients like herbs were added until the mixture thickened smoothly and settled. After it had cooled, it was rolled into balls or cut into various shapes. The quality of the locally produced soap was such that in the early days of European contact, it more than coped with the competition from the European imported type. It has been claimed that in the 17th Century, the preference of the people for local soap had become so great that the Portuguese banned the importation of this commodity to other West African places within their sphere of influence (Amenumey, 2008).

Manufacturing of soap and detergent has increased in recent times and as a result many industries have been established in Ghana (Amenumey, 2008). Among the major factories that produce washing soaps in Ghana are Unilever Ghana Limited and PZ Cussons Limited. Examples of washing soaps produced by these companies include key soap, sunlight washing soap, brillant, gardian, canoe soap, among others. There are also small-scale industries that produce soaps for washing and bathing. Notable soaps they produce are “alata” soap, “amonkye” soap, “Azumah blow” soap, “ameenshangari” soap, “propa” soap, etc. These soaps are mostly used by rural and peri-urban dwellers.

The large factories in Ghana use standardised processes (uniform quantity of ingredients, time for mixing, temperature control, etc.) in their soap production. They develop their products on the basis of sound scientific research and technological data, which conform to the Ghana Standards Authority’s specification as well as international standards. On the contrary, the small-scale soap producers use non-standardised processes in their soap manufacturing. The difference in the manufacturing processes of the soaps is likely to have different effects on cotton fabrics when subject to washing (Atkins, 2003).

Although the prices of the non-standardised locally-made soaps are relatively cheaper than the standardised soaps, many concerns have been raised by the rural dwellers that patronise the non-standardised locally-made soaps about the quality of the product. While some complain about the strong alkalinity, others also complain about the effects on the texture, colour, strength and elongation of the fabrics. They raise concerns about the quality of the small-scale manufactured soaps as compared to the standardised soaps.

It is, therefore, worthwhile that thorough and scientific investigations on these complaints are carried out. Hence the motivation to study the effects of locally manufactured soaps on the strength, colour and elongation of some selected Ghanaian cotton prints.

Statement of the Problem

The Ghanaian cotton printed fabrics have been perceived as being more adaptive to the cultural settings than the imported ones, following their different colours and attractive designs (Tabi, 1977). Despite the attractive attributes of these Ghanaian textile prints, it has been observed that most of them tend to depreciate in quality, strength and colour over a short period of time as compared to the imported prints (Adams, 1994). According to Aggor (1991), the degree of colour loss, tensile strength, and elongation of the fabric depend on the type of print and the kind of soap used in washing the textile. Many Ghanaians believe that locally-made soaps have damaging effects on the strength and colour of Ghanaian printed fabrics (Tabi, 1977).

Many studies by several researchers revealed different outcomes with respect to the use of soap on the performance of a fabric. For example, Agbo (2005) found that the use of salt, potash and Africa black soap for washing clothes increase colour fastness during washing. El-Bayouni (1980) also found that the use of soap for washing causes the colour of prints to run as well as weaken the fibre contents of fabrics. Mehta and Bhardwaj (1998) indicated that a quality fabric must perform satisfactorily in normal use, be able to withstand normal wearing, laundering and dry cleaning without fabric tearing or colour fading.

The study therefore examines the effects of key soap which is a standardised locally-manufactured soap and ‘Azumah blow’, a non-standardised locally-manufactured soap, on the performance of ATL and GTP cotton prints during washing.

Purpose of the Study

The purpose of this study was to investigate the effects of two locally manufactured soaps on colour, strength and elongation of Ghanaian printed cotton fabrics after three washing cycles.

Research Objectives

The main objective of the study was to investigate the effects of two locally manufactured soaps on the strength, colour and elongation of GTP and ATL cotton prints after 3 washing cycles. The specific objectives were to:

1. Establish the chemical composition and quality standards of key soap and ‘Azumah blow’ soap.
2. Compare the effects of key soap and ‘Azumah blow’ soap on colour of GTP and ATL cotton prints.
3. Compare the effects of key soap and ‘Azumah blow’ soap on the strength and elongation at break of GTP and ATL cotton prints.
4. Investigate the effect of washing cycles on colour, strength and elongation at break of GTP and ATL cotton prints.

Research Hypotheses

1. H_0: There is no significant difference in colour fastness between GTP and ATL cotton prints when washed with ‘Azumah blow’ soap after 3 washing cycles.
2. H_0: There is no significant difference between the colour of GTP and ATL cotton prints when washed with key soap after 3 washing cycles.

3. H_0: There is no significant difference in tensile strength between GTP and ATL cotton prints when washed with ‘Azumah blow’ soap after 3 washing cycles.
4. H_0: There is no significant difference between the strengths of GTP and ATL cotton prints when washed with key soap after 3 washing cycles.

Significance of the Study

The results of this study could help those who train people to produce soaps on small-scale basis to improve upon their products by using acceptable methods of soap preparation as well as the right quantities of ingredients. This is because consumers are concerned about the quality of items they purchase.

Secondly, the findings of the study would also serve as a resource material for educating consumers about the proper care of their clothes through proper choice of laundry aids. Thirdly, the Textiles and Clothing industries could also use the results of this study to improve the quality of their products as well as provide appropriate labelling for clothing items to meet consumer satisfaction with regard to selection and care of these clothing items. Fourthly, the results would serve as existing literature for teaching, research and outreach activities. Finally, the study would provide the baseline data or reference for further research in the area.

Delimitation of the Study

The scope of this study covered an indigo Ghanaian Real wax cotton printed fabrics from Tex Style Ghana Limited (formally Ghanaian Textile Print (GTP) and Akosombo Textile Limited (ATL), Two different types of soaps, commonly used by rural and peri-urban dwellers (i.e. key bar soap and

"Azumah blow" soap) were chosen. The specimens were subjected to three washing cycles, and colour, strength and elongation of fabrics were tested for.

Limitations of the Study

The limitations of the study relates to power fluctuations which affected continuous washing of the fabrics. Thus, the washing process had to be restarted anytime the power went out. This resulted in the preparation and use of more specimens. The study was also limited by the use of textile fabrics from two local manufacturing companies and soaps from two local manufacturing companies out of the several locally manufactured soaps and textiles. This limited the possibility of generalising the results for all textiles wax cotton prints.

The study was again limited by focusing on three performance indicators of textile fabrics. In other words, the performance of fabrics can be measured with reference to so many indicators, but the study focused on only three. This restricted the conclusions on the performance of the fabrics as they underwent washing to only the three indicators.

Definition of Terms

Strength of Fibre: It refers to the ability to resist stress. It is expressed as tensile strength, in pound per square inch, or tenacity, in grams per denier.

Key Soap: It is a brand name given to the bar soap manufactured by Uniliver Ghana limited for washing purposes.

Printed Fabrics: They refer to fabrics that have been decorated by motifs, patterns or designs after they have been constructed.

Fabric Count: It refers to the number of warp yarns (ends) and filling yarns (picks) per unit distance as counted whiles the fabric is held under zero tension, and is free of fold and wrinkles (Chorwdhary & Poynor, 2006).

Fabric Weight: It refers to the mass per unit area measured in ounces per square (ASTM standards as cited in Chorwdhary & Poynor, 2006).

Colourfastness: It refers to the quality of a dyed material possessing resistance against washing, bright light exposition and gas or by rubbing (TextileGlossary.com, 2010).

Elongation: It measures the percentage change in length before fracture.

Type 1 laundry soap: Laundry soap with no builders or fillers (Ghana Standards [GS] 71: 2006).

Type 2 laundry soap: Laundry soap with builders and fillers (GS 71: 2006).

"Alata" soap: It is a locally-manufactured (unstandardised) soap made from plantain peels.

"*Azumah blow" soap:* It is a locally-manufactured (unstandardised) soap made from caustic soda, palm oil and water.

"*Amonkye" soap:* It is a locally manufactured (unstandardised) soap made from cocoa husks.

Organisation of the Rest of the Study

The rest of the study was divided into four chapters. The second chapter is a review of literature relevant to the study. It covers properties of cotton fabric, historic background of soaps, components of soaps, effects of laundry on naturally-coloured cotton, and standardisation of soaps and performance of cotton textile fabrics. It again presents the theoretical and conceptual frameworks of the study.

Chapter Three is a discussion of the methodology used for the study which includes the research design, materials, sample and sample preparation, instruments, data collection procedure, and the data analysis. Chapter Four presents the results and discussion of the study. The last chapter, which is the Chapter Five, provides the summary of the study, draws conclusions and recommendations for the study.

CHAPTER TWO

REVIEW OF RELATED LITEATURE

This chapter reviews related literature on the theoretical and conceptual frameworks underlying the study. The review includes historical background of soaps, soaps and detergents, general cleaning action of soaps and detergents, effect of soaps and detergents on washing, effect of laundry on cotton fabrics, effect of detergent on colour fastness of dyed cotton textile fabrics, and assessment of colour fastness with respect to colour change.

Theoretical Framework

The study was guided by three theories, which are the theory of input-output analysis, the standardisation theory and the basic fibre theory. The theory of input-output analysis is traced to the work of Leontief in 1986. Krashen (1994) defined input as something put into a system or expended in its operation to achieve ‘output’ or a result. Output, on the other hand, is defined as the information produced by a system or process from a specific input (Hector & Craft, 1999). According to Galbraith (1999), the output of any process is a function of the combination of the various inputs used and the reactions among the various inputs. These include the type of material, quantity of each material, time each material is introduced, and the strategy used to combine the materials. Thus, different combination factors of the same materials are likely to produce different results.

Dietzenbacher, Heinz and Lager (1998) specified that input-output analysis is used to trace the reasons underlying the behaviour or reaction of certain products. The theory postulates that the behaviour or the efficacy of any manufactured product depends on its ingredients. The input-output analysis is also used to predict the behaviour of manufactured products (Anwar & Tonak, 1994). According to Hector and Craft (1999), this is done by using the characteristics and properties of the various ingredients, and the reactions likely to be generated among the ingredients.

The ingredients and processes used in making soaps are therefore critical in determining their effects on fabrics. In other words, the differences in the effects of soaps on fabrics can be attributed to the differences in the methods and ingredients in preparation. However, the consistencies in the effect size of particular soaps on fabrics are likely to be affected by the uniformity in production. According to Bengt (1998), ensuring uniformity in the production process is explained by the standardisation theory. The study therefore employed the input-out theory to assess how soaps conform to standards as well as how differences in their chemical compositions affect textile fabrics during washing.

The theory of standardisation explains the process of adopting the same procedures or methods in order to achieve comparable (harmonised) results (Henning, 1998). Its origin is attributed to Sir Henry Dale in 1926, when he prepared the first International Standard for insulin which was adopted by the League of Nations Health Organisation (the forerunner of the World Health Organisation). According to Jeffcoate (1991), the term “standardisation” encompasses the reference measurement procedures and reference materials (that is, the reference measurement system) required to achieve uniformity and certain level of quality and quantity in product manufacturing. The Clinical and Laboratory Standards Institute (2006) pointed out that the establishment of reference systems requires a reliable transfer of analytical accuracy bases by means of a network of reference laboratories performing the reference methods in well-standardised operating conditions.

Brunsson (1998) defined standards as sets of text that suggests or advises how something should be, or should be done, that is directed at general categories of organisations. Hallstrom (1998) identified two basic kinds of standards – technical standards and procedure standards. Technical standards are those which provide information about how something should be constructed. Procedure standards look at the method by which something is constructed. This includes pieces of advice given on the quality of a production process.

Standards specify the methods for interaction, the measures of equivalence, the limits of performance, quality, or degrees of compatibility (Panteghini & Forest, 2005). According to Peake and Whiting (2006), standards may also include safety, reliability and test methods. The use of the standardisation process ensures the traceability of results to an accepted reference measurement system and greater certainty that a result is close to the "true value" (Stöckl, Cabaleiro, Van Uytfanghe, & Thienpont (2004).

Henning (1998) indicated that knowledge about the effect of every ingredient as well as records or documentation on the procedure and the quantity of each ingredient used in manufacturing is essential in establishing standardisation. Peake and Whiting (2006) also reported that the uses and methods of application of products are to be considered during standardisation. The differences in the uses or methods of application of the same product are likely to have different effects. In the application of soap in washing, the properties of fabrics play a significant role. That is, the application of the same soap on different fabrics is likely to have different effects. However, the basic fibre theory explains how differences in the fibre properties affect the performance of fabrics as they undergo strain.

The basic fibre theory was propounded by Joseph in 1988. The theory explains that the properties of textile fibres provide the standard reference on key aspects of fibre performance. The theory divides the properties of fibre into primary and secondary properties. The primary properties include tensile strength, flexibility, spinning quality, uniformity and high length-to-width (breadth) ratio, whilst the secondary properties include the physical shape, density or specific gravity, colour, lustre, moisture regain and absorption, elastic recovery and elongation, resiliency, thermal behaviour, resistance to biological organisms, and resistance to chemicals and other environmental conditions.

According to Hearle and Morton (2008), the performance of textile fabrics in the form of their use and care depends on their properties and characteristics. This implies that differences in the fibre properties of textile fabrics are likely to yield different results as they undergo the same strain test. The study used the theory to examine the physical properties of the fabrics and to ascertain how differences in the two fabrics influence their performance.

Conceptual Framework

In Ghana, different fabrics and soaps appear on the market. Consumers' preference for a particular fabric is affected by type of fabric as well as the colour and motif of the fabric. However, the type of soap used in washing also affects the performance of the fabric during its care and maintenance. The conceptual framework can be explained as follows:

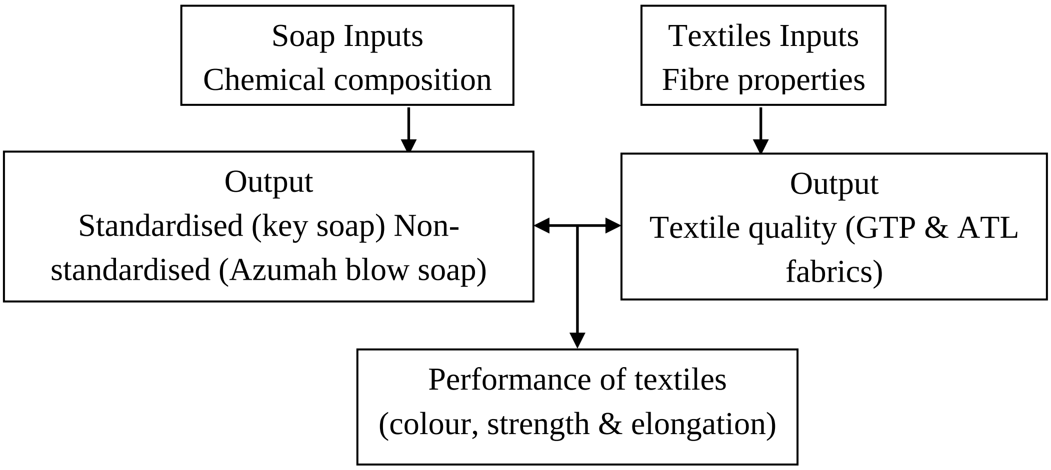

Figure 1. Framework for analysing the effect of soaps on the performance of fabric

The study was guided by three theories described, which are the theory of input-output analysis, the standardisation theory and the basic fibre theory. The inputs or ingredients of any manufacturing process are critical in determining the quality of the output. The composition of the various ingredients in soap preparation ensures the standardisation or non-standardisation of the output. In other words, the differences in the effects of Key soap and Azumah Blow soap on fabrics can be attributed to the differences in the methods and ingredients in preparation of the two soaps.

The ingredients and processes used in making the fabrics, which include chemicals forming the colour, are very critical in determining the properties of fabrics produced for the market such as GTP and ATL.

According to Hearle and Morton (2008), the performance of textile fabrics in the form of their use and care depends on their properties and characteristics. The fibre properties of textile fabrics such as the yarn count, weight and weave type determine the quality of textile fabrics in terms of their ability to resist stress. Accordingly, differences in the performance of textile fabrics such as colour fastness, tensile strength and elongation are determined by the differences in their fibre properties.

The performance of textile fabrics during washing depends on both the chemical composition of the soap and the fibre properties of the textile fabrics. The application of soaps of different chemical compositions is likely to have different effects on textile fabrics as Hearle and Morton (2008) asserted. The standardised soap (key soap) and the non-standardised soap (Azumah Blow) were used to wash the fibres from the GTP and ATP fabrics to determine the differences in performance of the fibres which with regard to the three properties colour, tensile strength and elongation after three cycles of washing.

Real Wax Cotton Printed Fabrics

Real wax cotton printed fabrics are defined as those that have been decorated by a motif, pattern or design applied to the fabric after it has been constructed (Joseph, 1988). According to Adams (1994), they can be identified from other fabrics by the indigo colour or Prussian-blue which is present in almost all prints of “Dumas”, which is a name of a Dutch trader. They are usually printed by the use of vat dyes. They are printed by a wax reservation process and also by duplex printing method in which a design is printed simultaneously on both sides of the fabrics. It also involves the use of the rollers and a different roller for each colour.

Yoruba (2008) indicated that the development of the African print fabric has been referred to as the result of a long historical process of imitation and mimicry. Views on how Dutch wax prints entered the West African market differ. One view is that in the late 1800s, Dutch freighters on their way to Indonesia from Europe stocked with their machine-made batik textiles stopped at various African ports, and subsequently an African client base grew. Another suggestion is that the Dutch wax fabrics did not do as well as expected in the Indonesian market, due to economic restrictions imposed on the sale of foreign textiles at the beginning of the 20th Century to protect locally made batik textiles. In order to prevent a loss, the target market switched to West Africa.

There is also the theorised role played by the homecoming of the West African indentured soldiers for the Dutch in Indonesia, also known as the Black Dutchmen. They served between 1810 and 1862 and many had taken Indonesian brightly coloured cloths with them on their return home as gifts for their families. Thereafter, local interest in the fabrics grew, and the Dutch wax prints were the closest imitation available. It is certain that Dutch wax prints started out as cheap mass-produced imitations of Indonesian cloths locally produced in Java (Wendren, 2008).

Colonial powers, particularly the Dutch and the English, played heavy roles in industrialising the batik production techniques and popularising the resulting textiles in foreign markets. The cloths were originally intended for the Indonesian market but they found a more enthusiastic market in the Gold

Coast (modern day Ghana) where they became symbols of high quality and fashion. From the Gold Coast, these fabrics spread into other West and Central African markets.

In the second half of the 19th Century, West Africans embraced these Dutch wax prints, using and assimilating them into societies as a part of culture and self-expression. Wax print cloths became extremely popular and over time the Africans customised and personalised the designs. African fabric goes by a multitude of names such as Dutch wax print, Real English Wax, Veritable Java Print, Guaranteed Dutch Java, Veritable Dutch Hollandais.

Most African fabrics are 100% cotton and are used to make traditional and modern clothing (Lauren, 2010). They are also used for patchwork and quilting, textile art, tailoring, embroidery, home furnishings, accessories or bags. They are made for hard weather and work and do not tear easily, as the native Africans who make and utilise them understand that farming, traveling long distances and harsh sun are all factors they must consider when making fabrics. Although there may be dozens of types of African fabric designs and styles, there are a couple that are the most sought after and the most traditional.

Nowadays, they are primarily made in Ghana and have strong cultural, social and economic importance (McCall, 2011). Currently, Ghana is home to several fine and high quality wax print. They include real wax, real java, batik, and tie and dye. The patterns on the prints tell stories of relevance to the wearer, such as proverbs, poems and traditional African fables (Lauren, 2010). The colours also hold significance as they can represent social standing, age, tribal orientation and marital status. There are four major companies in the textile industry in Ghana and they are the Ghana Textile Manufacturing Company (GTMC), Akosombo Textile Limited (ATL), Tex Style Ghana Limited (formally Ghana Textile Product (GTP), and Printex. In Ghana, the excellent colourfastness of real wax might be due to the dyes used. Despite the durability of Ghanaian real wax prints, Aggor (1991) reported that they tend to lose colour, and the degree of colour loss depends on the type of prints.

Properties of Fibre

Fibre is a type of material having continuous filaments and somewhat similar to lengths of thread (Behera & Karthikeyan, 2006). They can either be spun or twisted into yarns or can also be directly compressed into fabric. The textile, home furnishing industry makes use of many different types of fibres as its raw materials. According to Behera and Karthikeyan (2006), there are a number of factors influencing the development and utilisation of all different fibres. These include ability to be spun, availability in sufficient quantity, economy of production and properties desired for manufacturing a particular product.

Fibres can be classified into natural fibre and man-made fibre (Goff, 2011). Natural fibres can be sourced from plants, animals and minerals (such as vegetable fibres, animal fibres and mineral fibres) whereas man-made fibres include cellulosic and non-cellulosic polymer fibres. The fibres can also be sourced from mineral fibres, metallic fibres and rubber fibres. Fibre properties such as length, diameters, density, cross-sectional shape, yarn crimp, tensile strength and elongation play major roles in the performance of fabrics.

Length

Natural and synthetic fibres cover a fairly broad spectrum of dimensional and performance characteristics. According to Goff (2011), a basic characteristic of fibrous materials is that they have high length-to-diameter ratios. Natural fibre length vary from 0.1 inch for cellulose pulp fibres and asbestos fibres, up to 5 inch or more for wool, and as much as 40 inch for flax, while many synthetic materials are available in continuous filaments. All natural fibres, with the exception of silk, must be spun into yarns in order to serve as useful textile materials. Silk and the synthetic fibres may be utilised in continuous filament into selected short lengths (staple), from 1 inch to as long as 15 inch and then spun in yarns. In cotton, the longer the staple length, the better the quality. Measurement of the staple length is accomplished by laying out a uniform array of fibres of progressive lengths from the longest to the shortest. Both the average and mean staple length and the distribution of fibre lengths are calculated.

Diameters

Typical textile fibre diameters range from 0.01 to 0.044u, for asbestos fibrils, 0.5 – 0.6u for spider “silk”, and 3-500u for apparel and industrial fibres, Fibre softness or flexibility is a function of diameter, and fineness or quality is particularly significant for cotton and wool fibres. The quality or grade of wool is determined on a statistical basis of distribution around the mean are measured. Wool is thus classified into many grades.

Density

The density of fibres may be determined, by classical physical means, for example, precise microscopic measurement of length and cross-sectional area, and weight. The relationships between fibre length, diameter, and density result in a common and useful criterion of fibre (or yarn) size (Stylios, 2001). Both weight-per-length and length-per-weight systems are utilised. The weight per length (or the inverse) of such natural fibres as wool, cotton, and flax, is not commonly measured, since staple length and diameter are usually considered sufficient to define fineness.

For silk or synthetic filaments, the term denier has historically been, and continues to be employed (Hu, 2004). Because this is incompatible with metric-decimal nomenclature, international scientific and standards organisations are now using the Tex system. The Tex in grams per kilometre is the international preferred Unit to describe linear density. Both the Tex and the denier systems are direct, that is, the “heavier” the filament or yarn the greater is the denier or Tex number. The Tex is one-ninth of the denier.

Cross-sectional Shape

Fibres vary in their cross-sectional shape which is of prime influence in governing the stiffness and flexural rigidity characteristics (Centeno, 2011). The cross-sectional shape also influences the tendency of fibres to pack together in yarns. Silk fibres, because of their triangular shape, can pack compactly to give small diameter, dense yarns. However, the position of fibres in spun yarn is normally so random that to a large extent, yarn density becomes independent of fibre cross-sectional shape.

Yarn Crimp

In addition to fibre crimp, there may be yarn crimp, which can take two forms (Ramkumar, Purushothaman, Hake & McAlister 2007). First, there can be high frequency-low amplitude waviness in the yarn itself. Second, sine a woven fabric is composed of interlaced warp and filling yarns, each warp or filling yarn (or both) must assume a wavy path as it goes under an orthogonal yarn in order to be accommodated within the fabric structure. This waviness is called “yarn crimp”.

Refractive Index

Goff (2011) explained that most textile fibres exhibit greater molecular orient-ation or order in their longitudinal direction than in the direction of their transverse axis. Since refractive indexes are correlative with fibre orientation, most textile fibres have different indices in the longitudinal and transverse directions. The quantitative difference between the two indices is called birefringence and it is a measure of the degree of anisotropy of the fibre. To a considerable degree, birefringence correlates directly with the tensile strength of fibres.

Tensile Strength

Tensile strength is an important, but probably overworked, criterion of textile performance. Textile fibres exhibit viscoelastic behaviour. Following the reason of this visco-elasticity, fibre deformations and recoveries are time-dependent. The fibre is said to exhibit “creep” upon load application, and “creep recovery” upon load removal.

Elongation to Rupture

One of the most important properties of textile fibres is their ability to elongate under an applied load. Without this ability, they would be so completely brittle that they would be harsh coarse and useless. Elongations to rupture are usually measured in conjunction with the determination of tensile strength and tenacity.

Load-elongation Behaviour

The load-elongation behaviour of natural fibres is well defined. For example, wool has low strength and high elongation, whereas cotton has a significantly higher strength but appreciably lower elongation to rupture. It is generally axiomatic that strength and elongation are inversely related. That is, the higher the strengthening, the lower the elongation. The structure of warp and weft yarns is depicted in Figure 2.

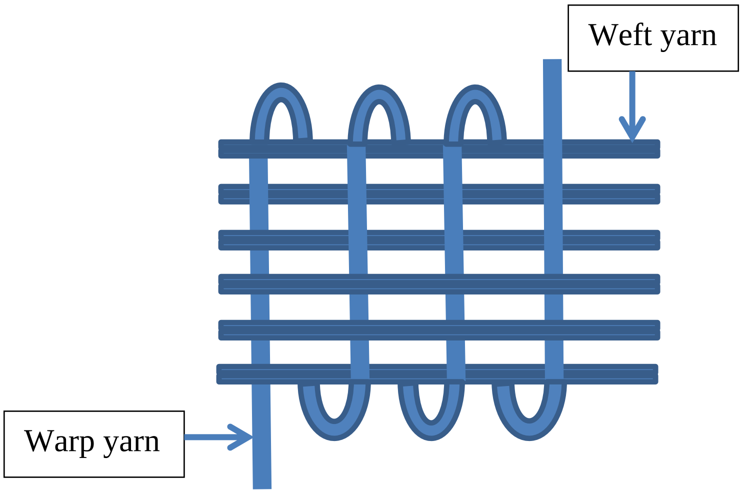

Figure 2. Structure of warp and weft yarns

Properties of Cotton Fabric

Cotton fabric is one of the world’s oldest known fabrics, dating back to ancient Egypt and prehistoric Mexico (Goff, 2011). Mass-production of cotton fabric began in the 1700s with the invention of the cotton gin. Cotton continues to be the most used fibre in the world and the most popular fabric for clothing in the United States of America. It is used to make blouses, shirts, singlets, shorts, and jackets. It can also be made into bedspreads, pillowcases, carpets and curtains. Cotton fabrics are known for their softness, versatility, lightness, and elongation.

Versatility

Cotton fibres can be dyed any colour, and are known for retaining colour well (Goff, 2011). Since they have good colour, they are good to print on. Cotton is also versatile and can be woven into cloth for several purposes.

Wrinkling

Many cotton clothing items are treated with a finish that helps the fabric resist wrinkling. According to Ramkumar et al. (2007), if cotton is exposed to sunlight for extended periods of time, it can weaken.

Absorbency

Cotton absorbs liquid well, in a large capacity. Cotton fabric can absorb up to 27 times its weight in water, according to Centeno (2011). This makes cotton clothing comfortable, because it absorbs sweat. It also explains why cotton is used for towels and washcloths. This property makes it comfortable to wear cotton fabrics in the tropics. It absorbs sweat which evaporates and cools the body.

Breathability

Cotton fabric allows air to flow through freely. The fabric absorbs sweat and releases it on its surface. According to Ramkumar et al. (2007), this is often described as the fabric “breathing”, and it is considered as an asset in clothing, particularly in warm climates.

Cotton Fibre Elongation

Elongation is specified as a percentage of the starting length. Textile products without classify would hardly be usable (Goff, 2011). They must be deformed and also return to the original shape. The fibre elongation should be at least one to two percent. The greater crease resistance of wool compared with cotton arises due to difference in their elongation.

Historical Origin of Dyes

The technical definition of a dye is a compound that can be fixed on a substance in a more or less permanent state that evokes the visual sensation of a specific colour or hue (Joseph, 1986). The purpose of a dye is to absorb light rays on a selective basis, causing the substrate fabric to reflect the rays that are absorbed. The ability or an organic compound to create this desired colour derives from the presence of chemical groups called chrornophore substances that include chromophores are made up of such organic molecular arrangements as the azo group, thio group, anthraquinoid group, quinoid nucleaus, the pyrazine ring, quinopthalone structure, lactone ring, carbonyl group and the tctrabenzoprophyrazine nucleaus (Tooley, 1971).

Dyestuffs and dyeing are as old as textiles themselves, predating written history. Lighter bleaching was for many centuries carried out using organic dyes extracted from plant materials (indigo) and occasionally from animals such as insects (cochineal) or molluses (Tooley, 197 l). Fabrics dating from 3500 B.C. have been found in Thebes that still possess the remains of blue indigo dye. Fabrics discovered in ancient tombs in Egypt were coloured yellow with dyes obtained from safflower plant (Dyers thistle).

The Indians and Persians were using plant materials to dye silks brocades and wool before 2000 B.C. In Roman times, tyrian purple was extracted from a Mediterranean mollusk (Murex) and the rich colour obtained were only used by persons of the highest rank (Patro, 1971). Beautifullycoloured fabrics dating back several thousand years have been unearthed in China, Asia, Minor and some sections of Europe.

Until 1856, all dyestuffs were made from natural materials mainly animal and vegetable matter with a few minerals for special colours. One of the animal sources was a tiny insect found in Mexico from which a bright red dye was extracted. This was used by the Aztecs to colour their fabrics and when the Spaniards invaded Mexico in 1518 they called the insect and the dyestuff cochineal. By 1500 B.C., Tyre had become the centre for the trading and manufacture of this purple dye. It was extremely costly to produce the dye, because approximately 1200 tiny animals were needed to obtain just 1 gram of dyestuff.

Logwood, extracted from the pulp of the logwood tree produced excellent dark colours, particularly blacks and browns and is still employed to some extent in colouring fabrics for special purposes. Another extremely old colour that is still used today is indigo. This blue colour has become popular in making special types of designs for modern fabrics. Early efforts at colouring fabrics posed serious problems because few of the natural dyes formed a colourfast combination with fibres. Eventually, scientist found that this defect could be partially overcome by the use of mordant – mineral compounds that render colours insoluble.

The year 1856 marked a turning point in the history of dyes. Sir William H. Perkin, while trying to synthesis quinine ($C_{2}0H_{24}$ $N_{2}0_{2}$) from alkyl to Iodine ($C_{10}H$ $_{13}N$) by oxidation, working in an improvised laboratory at his home in Norwood and this accidentally turned into the production of the first synthetic dyestuff, a purple colour called mauve, a basic dye. This discovery launched the modern dyestuff industry. Today, nearly all dyes are synthetically compounded and in most cases they are superior in every way to natural dyes.

The development of artificial dyes has been rapid and the available dye s number in the thousands. However, research into the development of dyes continues. New fibres and fibre modification frequently require a new type of dyestuff. Various finishes applied influence the dye selected and create a need for something better. Thus, the desire for new and different colours creates a need. The continued search for colours that will withstand all possible environmental conditions encourage the researcher to continue to seek new types of dyestuff; and emphasis on discontinuing the use of chemicals suspected of being potentially carcinogenous has made it essential to try to find new dyes to replace those identified as hazardous to health (Joseph,1986).

Classification of Dyes

Dyestuffs are widely used for colouring diverse materials such as paper, plastics. Leather, wax polish, anodised aluminium and cosmetics. A few carefully selected dyes such as cochineal are also permitted as colourants in the manufacture of sweets, jellies, custard powder, ice cream and other foodstuffs. By far, the most important application of dyes, however, is to colour textile fibres (Joseph, 1981).

Dyes can be classified in several ways such as, the hue it produces chemical composition and according to the method of application and types of fibres to which they are successfully applied. For this discussion, the classification will be based on the method used in applying the colour or dye to the fabric. The types under this classification are suggested by Joseph (1986) and Tooley (1971). However, the authors specify that the dyes most commonly used in the cotton industry are vat dyes, reactive, azoic, and direct and sulphur dyes.

Vat Dyes

The vat dyes are the oldest of dyestuffs and the name originated in the making of the old indigo dyes, when the dyestuff had to be steeped for some days in a vat before it could be used. As described by Joseph (1986) and agreed by Wingate and Mohler (1984), vat dyes exhibit an outstanding colourfastness to washing chlorine bleach, light, cross-dyeing and mercerising than do other dyes.

Vat dyes are insoluble in water and have no affinity for fibres until they are converted to a product that is soluble in an alkaline solution. Vat dye are used on cellulosic fibres such as cotton and rayon and before they are applied to the fabric they are first applied in a water-soluble form then oxidised to produce the final colour. Wide choices of colour are available in vat dyes.

Direct or Substantive Dyes

These dye are applied directly and primarily to cotton, linen and rayon and sometimes on protein fibres and polyarnides requiring no mordant. These dyestuffs, like acid dyes are salts of colour acids. They comprise the largest and most commercially significant group of dyestuffs and give bright deep colours (Smith & Block, 1982). Before the dyestuff is applied, Joseph (1986) indicated that the dye is dissolved in a water bath and a salt is added to control the absorption rate of the dye by the fibre. The amount of dyestuff absorbed depends on two main factors, the size of the dye molecule and the size of the pore opening in the outer surface of the fibre.

Smith and Block (1982) again described direct dyes as being good to light fastness, resist perspiration, fast to dry cleaning solvents, do not crock readily and exhibit good resistance to atmosphere fumes. However, they are not wash-fast and may bleed because of their solubility in water, the laundry process tend to dissolve some of the dye and remove it from the fabric. Joseph (1986) further explained that for the dyes to be wash-fast, they have to be developed and this is done by applying finishing compounds such as those substances used to provide easy care. For instance, formaldehyde after treatment of direct dyes has been quite successful in making direct dyes relatively resistant to the effect of laundering.

Reactive Dyes

Unlike most dyes which depend upon physical absorption of the dye to hold it within the fibre, reactive dyes form chemical bonds with the fibre. The reaction as described by Wingate and Mohler (1984) is done by coupling the colour to the fabric by a reaction with the hydroxide group of the cellulose molecule. So here the dye molecule becomes an integral part of the cellulose. These reactions therefore make reactive dyes most appropriate for dyeing cellulosic fibres.

They have excellent colourfastness to light, dry-cleaning and fumes. However, Joseph (1988) stated that reactive dyes have a high susceptibility to damage from chlorine bleaches, alkaline perspiration. Fading also varies from very good to excellent depending on the particular dyestuff.

Azoic or Naphtol Dyes

Azoic or Naphtol dyes are believed to produce brilliant and fast colours at relatively low cost (Joseph, 1986). Azoic dyes produce colour as a result of chemical action in the fibre between a diazotised amine and a coupling agent. Thus the fibre is treated in a cold caustic solution of a beta-naphthol derivative which is absorbed by the fibre and then immersed in a dye bath (Smith & Block, 1982). The dyestuff used with the coupling agent is often an azo compound of some type. After the dye application, the fabric is treated in hot detergent solution to attain or develop the desired colour.

Azoic dyes are used for cellulosics and to some extent for man-made fibres. These dyes produce brilliant shades particularly reds, violets and burgundy. Azoic dyes again offer good fastness to washing, light chlorine and peroxide bleaches. However, they have poor resistance to rubbing or crocking.

Sulphur Dyes

Sulphur dyes or colours are used on cotton and other vegetable fibres. They are prepared from organic compounds, such a phenols and pheuvlamines, by heating them with sulphur or sodium polysulphide solution. They are unique dyestuffs in that they all possess sulphur linkages in their molecular framework. Sulphur dyes are widely selected for dark shades such as browns, blacks and navy blues, however, those that have lighter shades or colours exhibit a poor resistance to light and laundering. When sulphur dyes are applied correctly they give good performance. The application of sulphur dyes is similar to that of vat dyes, as they must be made soluble before being absorbed by the fibres.

Mordant or Metallised Dyes

Mordant or chrome dyes often called metallised dyes have many properties in common with acid dyes. They are effective on the same types of fibres and the actual type of dyestuff is an acid dye. The major difference is that a metal is added to the dye molecule. The metal may be added during the process or just before the application of dye to the textile. This metal reacts with the dye to form relatively insoluble dyestuffs with improved wet colourfastness and lightfastness.

The metal most often used is chromium, which produces the chrome dyes (Joseph, 1986). Other metals may include cobalt, aluminium, tin and nickel, copper also serves as a mordant in some acid dyeing of acrylic fibres. Metallised dyes usually have good colourfastness to dry cleaning. For mordant dyes to be fast on cotton or cellulose fibres, pigment dyes are added to mordant dyes during the application of the dye.

Pigment Dyes

According to Joseph (1988), pigments are technically not dyes. This is because they do not dissolve or are completely insoluble in water or solvents typically used for dyeing. However, they may be added to the fibre-forming material before spinning. Pigment colours are made from both organic and inorganic compounds. In addition to being insoluble water, pigments have no affinity for fibre. In order to fix them to fabric, some type of adhesive, resin or bonding agent must be employed. The colours produced are relatively permanent, except that as the resin or bonding agent wears away, the colour will also disappear.

Mild abrasion may sometimes erode some of the colour. Thus, fabrics pigmented in this manner often exhibit poor crocking resistance. Sunlight may also darken the binder and cause colour changes. Sometimes the dyes hinder the soluble in dry-cleaning solvents in this case the colour is not fast to dry-cleaning (Smith & Block, 1982). Pigments can be attached to textile surfaces as part of a printing process if they are securely affixed by means of some type of bonding agent (Joseph, 1986).

Methods of Dye Application

A cloth may be coloured and patterned by dyeing or printing techniques. Generally, dying yield deeper shades and give more colourfast materials, while printing provides a greater variation of patterns (Smith & Block 1982). Clothes may be dyed in the fibre form, as yarn or after the dye has been knitted or woven. Printing however is done generally on the finished cloth although some techniques allow for the printing of yarn before cloth manufacture.

Dyeing Techniques

Solution or Dope Dyeing or Mass Pigmentation: Bien, Stawitz and Wunderlich (2005) and Joseph (1986) described this method of dyeing as a process through which colour is added to the solution before it is passed through the spinnerets to manufacture man-made fibres. They confirmed that this mode of application of dyes produces even and uniform colouration. The colour becomes an integral part of the fibre since it is fixed throughout the fibre.

Fibre or Stock Dyeing: As reported by Bien et al. (2005), fibre or stock dyeing is more difficult to handle and more expensive than the other method and yet the results are likely to be quite uniform. Joseph (1986) observed that when raw fibre stocks are dyed under atmosphere pressure, it allows an in-depth penetration of the dye into the fibre. Consequently, there is uniformity in colouration and improvement colourfastness.

Yarn Dyeing: In this method, yarns are dyed in skein or cake forms as described by Bien et al. (2005). They noted that this method tends to create a problem of having a uniform dyeing because the dye solution cannot penetrate through to the yarns in the innermost sections. It, however, permits the use of various coloured yarns in one fabric.

Piece Dyeing: Joseph (1986) also observed that piece dyeing in comparatively the easiest and most economical method. It also offers a choice of dyeing in a liquid dye-bath or applying a pigment past. Gawthorpe (1966) in her observations found that dyes applied to fibres and yarns are more likely to be faster than those applied to the fabric because in the former, the dyes can be absorbed more easily.

Printing Techniques

The printing of fabrics represent an important part of the textiles industry. It is interesting to note that the consumer often brings printed good on impulse because a particular pattern, design or colour combination appeals to him or her (Wingate & Mohler, 1984). Printing, however, allows the artist to achieve complete flexibility in colour and pattern. The major printing processes are direct, resist and transfer printing. There are a number of handicraft techniques.

Direct Printing: The earliest method of printing fabrics was by carving a design on a wooden block, inking the block and transferring the design to the fabric. Direct printing methods include roller printing and block printing which are common. Direct methods may also be involved in duplex and photographic printing. In roller printing, seamless metal cylinders (usually copper) are carefully engraved, each with a portion of the pattern to be printed in each colour. The portions of the rollers that will not take colour are covered with a chemically resistant coating and the uncovered portions are etched away. The resist is then removed. The rollers are made more durable by the application of a chrome coating (Smith & Block, 1982).

The design is separated into its individual colours, a roller being used for each colour in the des ign. Thus the colour rolls are arranged around the circumference of the central cylinder of the printing machine. Each colour roll is partly immersed in a trough of dye paste; each has a metal blade which scrapes from the surface of the roll. The cloth passes around the padded central cylinder and is pressed against each of the engraved rollers in turn. The dye paste is transferred from the etched regions of the roll into the cloth and successive additions of colour from the pattern. Screen-printing and roller printing are the main methods used in the printing of metallic prints.

Another direct method of printing is the block printing. Block printing is primarily considered as a handicraft (Joseph, 1986). Here each block prints only one colour, so a block is made for each colour in situations where the cloth or design desires several colours. In block printing, the block which have the design engraved on is dipped in a printing paste or dye so that only the raised portions picks up the colour and then pressed unto the fabric surface with sufficient pressure to force the colour into the fabric. The fabric is then left to dry.

Resist Printing: Dyeing is believed to be one of the oldest methods of applying design to cloth. The basic principle of resist printing, according to Joseph (1986), is to protect areas of the fabric that are not to be coloured so that dye cannot penetrate at those protected locations. The basis of protection may be paper or metal coy rings, chemicals painted onto the fabric or wax coatings painted onto the fabric. The protective material is called a resist.

Wingate and Mohler (1984) described screen-printing as the printing of a fabric that is first stretched on a padded table before the printing is done. A printing screen made of silk, nylon or metal stretched on a frame is placed on the fabric. The parts of the pattern on the screen that are not to take the print are covered with enamel or certain paints to resist the printing paste. The printing paste is poured on the screen and pushed through the pattern portion with a wooden or rubber paddle called squeegee. When one section of the pattern has been finished, the frame is moved to the next section and so on until the entire length has been finished. This method is time consuming; however, due to technological advances there has been a mechanised method or kind of screen printing, which prints several yards of fabric within few minutes. Here the fabric moves along a table and the automatic application of the screens is electrically controlled and automatic squeegee operates electrically. The mechanised method reduces cost appreciably for large batches.

Transfer Printing: Transfer printing is considered to be the newest and fastest growing printing method, and is based on the productivity of some dispersed dyes to sublime when heated (Smith & Block, 1982). The process of transfer printing involves the transfer of colour from one surface, usually paper to a second surface, the textile fabric and as many colours as desired may be used, and any pattern may be reproduced (Joseph, 1986).

Transfer printing however involves three basic methods, which are vapour phase transfer, wet transfer sometimes called migration printing and melt transfer. This process is a competitor to both direct roller and rotary screen-printing. However, its use has not grown as predicted and there appears to be no attempt to replace either direct or rotary screen printing methods with transfer methods except for specialised uses (Joseph, 1988).

Historical Background of Soaps

Soaps are an ancient surfactant known since the dawn of civilisation. Although the oldest synthetic surfactant, sulphonated castor oil or turkey red oil, was produced over a century ago, synthetic surfactants based upon either fats or petroleum have been developed industrially only during the past four decades. Soap has retained its dominance as the active surfactant ingredient in toilet soaps. Spitz (2004) attributed the invention of soap to the Gaul who used it to dye their hair red. It was made from beech wood ash and tallow from goats in two forms – soft and hard. There is as yet no conclusive evidence that any other cleansing agent was used for bathing. Among the Romans and Greek and in the Northern countries, the stem bath was more popular in later times, just as it is today, with the cleansing action aided by beating the body with bundles of twigs of the beach or oak trees.

In pre-Christian and early Christian times, putrid urine was much used as a cleanser. Its effectiveness results from its content or ammonium carbonate which reacts with fats and soils in wool to produce a kind of soap by the process of saponification (Brooks, 1950). Jordan, Dolce and Osborne (1958) advocated for the use of soap as a medicine to treat skin diseases. They distinguished between two types of soap, made by the Gaul and Germans, the lustre’s being more preferable. Later on, pomade manufactured in the German town of Mattium called “Mattain Balls”, came into general use with the affluent of Roman woman (Jordan, Dolce & Osborne, 1958). Simple detergents or soaps commonly used in ancient Babylonia were alkalis clays and earths or resins; with the first predominating alkaline substances were generally procured from wood or plant ash although it is possible that a very small amount was obtained from other sources.

A “salt”, possibly soda and another alkali from plants, for washing the hands in a religious ceremony was used. Alum was also used to wash clothing and is mentioned as a “detergent”. Although the saponins are of widespread occurrence, there is no concrete evidence that aqueous extracts of plants were made for cleansing purposes. This is in spite of the fact that aqueous extraction was well known and had been brought to a high perfection in perfume manufacturing. In regard to alkaline detergents, the evidence is now complete that soda and potash were used from plant and wood ash as the most common washing substances in the household, for the cleansing of both clothes and the body. Furthermore, soap plants are found in great abundance in the Near East. The soap worth is a very common Soapless shrub Salsola kali the soda plant grows near the Dead Sea today and is also common in Egypt (Cavitch, 1994).

In modern times the operations which resemble those probably used long ago include the slow combustion or incineration of the dried plant parts, then a leaching or washing of the sides of the vessel and then calcinations of the substances. For the common household chores the ash was probably stirred in water and the solution filtered to remove the insoluble impurities before using. Soap is not the traditional soap that has been used over the ages. The development of detergent worked well for the military, which needed cleaning products that could work in sea water and cold water. By 1930, detergent almost replaced real soap for laundry, dish and household cleaning products (Cavitch, 1994).

Today, soap is primarily a detergent made from petroleum-based materials. There are five general categories of soap: personal care, laundry, dish, household and automotive care. Manufacturers of soap and detergent based cleansing products are constantly developing new products to one that is efficient, easy and safe for the use of the consumer.

Soaps and Detergents

Soap and detergent manufacturing consists of a broad range of processing and packaging operations. The size and complexity of these operations vary from small plants employing a few people to those with several hundred workers. Products range from large-volume types like laundry detergents that are used on a regular basis to lower-volume specialties for less frequent cleaning needs. Soap is a solid, liquid or powdered preparation that is made by potassium or sodium hydroxide reacting with animal or vegetable oils (Hopkins, 2010). Soaps are usually used with water and may contain scents/perfumes and other additional ingredients. Chandler's Soaps (2010) technically defined soap as the alkali salt of a fatty acid. It is the product that results from the reaction of a fatty acid and a strong base (alkali).

According to Katz (2000), a soap molecule consists of a long hydrocarbon chain (composed of carbons and hydrogen's) with a carboxylic acid group on one end which is ionic bonded to a metal ion, usually a sodium or potassium. The hydrocarbon end is nonpolar and is soluble in nonpolar substances (such as fats and oils), and the ionic end (the salt of a carboxylic acid) is soluble in water. Ohpardt (2003) defined soap as a mixture of sodium salts of various naturally occurring fatty acids. Air bubbles added to a molten soap decreases the density of the soap and thus it floats on water. However, if the fatty acid salt has potassium rather than sodium, a softer lather is the result.

Ameyibor and Wiredu (1991) reported that the structure of soap is made up of a long chain of non-polar hydrocarbon tail and ionic polar end. The non-polar hydrocarbon tail [CH_3 (CH_2) n; in which “n” is usually large] is insoluble in water, but soluble in oils and grease which are organic substances whiles the tail end is the hydrophobic end. The ionic head (-COO-Nat) is soluble in water but does not dissolve in organic substances such as oil and grease. The head is the hydrophilic end because of its ability to react with water (Ohpardt, 2003).

According to Ameyibor and Wiredu (1991), soap is a very simple thing which people living in primitive conditions could easily make in an elementary form. Sanders (2002) reported that an alkali can be combined chemically with fat to form soap. The type of fatty acid and length of the carbon chain determines the unique properties of various soaps. Tallow or animal fats give primarily sodium stearate (18 carbons) a very hard, insoluble soap. Fatty acids with longer chains are even more insoluble. As a matter of fact, zinc stearate is used in talcum powders because it is water repellent (Ohpardt, 2003).

Coconut oil is a source of lauric acid (12 carbons) which can be made into sodium laurate. This soap is very soluble and will lather easily even in sea water. Fatty acids with only 10 or fewer carbons are not used in soaps because they irritate the skin and have objectionable odours. Soaps can be made in liquid, powder or flakes form. Examples of traditional soaps in Ghana are “Don’t touch me” soap, “Alata” soap, “Azumah blow” soap, “Amonkye” soap, among others, while standard soaps specified by the Ghana Standards Authority include Key soap, Duck washing soap, Guardian soap, So-kiln soap, Geisha soap, Brillant soap and Lux soap.

Soaps differ from detergents in that they are made from natural fats and oils by basic hydrolysis whereas soapless detergents are manufactured in large quantities from petrochemicals (Ameyibor & Wiredu, 1991). In spite of these differences in origin and preparation, soaps and detergents are similar in function before the two aids in the cleansing action of water (Henney & Byett, 1968). Henney and Byett defined the term “soap” as a particular type of detergent in which the water-solubilised group is carboxylates and the positive ion is usually sodium or potassium. The largest soap market is bar soap used for personal bathing.

Synthetic detergents replaced soap powders for home laundering in the late 1940s, because the carboxylate ions of the soap react with the calcium and magnesium ions in the natural hard water to form insoluble materials called lime soap. Some commercial laundries that have soft water continue to use soap powders. Metallic soaps are alkali-earth or heavy-metal long-chain carboxylate that are insoluble in water but soluble in nonaqueous solvents.

They are used as additives in lubricating oils, greases, rust inhibitors, and jellied fuels.

Henney and Byett (1968) were of the view that soap has been known since the time of Romans. Ehrenkranz and Inman (1966) defined soap as a cleaning agent usually made by the action of alkali and fatty acids. Henney and Byett contended that fats and oils used for soap may be of animal or vegetable origin while alkalis used are generally caustic soda. Bratton (1975) mentioned that different qualities of soaps can be made from the different kinds of fat such as tallow, beef fats, olive oil, palm oil and plan kernel oil. All soaps are alkali but when soaps are made with good balance between lye and fat, the soap is said to be neutral. Bratton again stated that mild soaps are either alkaline or acidic.

Soaps break the surface tension of water so that the soap can spread better and cover or penetrate surfaces being cleaned. Soap is an excellent cleanser in soft water but it has several defects. Leena (1972) explained that soap reacts with calcium and magnesium ions in hard water to form soap scums which are sticky, gel-like masses that deposit on fabrics or washing equipment. This does not only reduce the soap concentration but also adds to the insoluble soil problem. Brady, Russell and Holum (2000) contended that when scum is formed by soap on the surface of fabrics, soap is wasted in forming the precipitate. To compensate for this, more soap must be added before washing can take place. The precipitate formed tends to be re-deposited on the fabric as soap scum.

In modern soap making, some substances known as builders are added to the mixture to improve its cleaning power (Gitobu, 1988). Brady et al.

(2000) described builders as an alkaline substance such as sodium tripolyphosphate (STD), which aid in softening hard water and promoting the cleaning action by combining grease on badly soiled clothes. Henney and Byett (1968) defined detergent as a substance which aids in the removal of dirt or soil. A colloidal chemistry studies conducted over the past half century have shown that detergents, or substances that help cleaning through surface activity principles, may be divided into three main groups according to their behaviour in an electric cell. These are, in order of importance in cleaning, anion, non-ionic, and cationic detergent. Brady et al. (2000) added a fourth type known as ampholytic surfactant which can exhibit both anionic and cationic behaviours.

Leena (1972) was of the view that anionic types of detergents are the most widely used in cleaning and consist structurally of a moderately long hydrophobic carbon atom chain joined to a hydrophilic group bearing a strong positive charge. Two of these ionic compounds, according to Leena, are soaps and synthetic detergents which are nowadays referred to as detergents. The term “synthetic detergent products” applies broadly to cleaning and laundering compounds containing surface-active (surfactant) compounds along with other ingredients. Heavy-duty powders and liquids for home and commercial laundry detergent comprise 60 to 65% of the U. S. A. soap and detergent market and were estimated at 2.6 megagrams (Mg) (2.86 million tons) in 1990.

Until the early 1970s, almost all laundry detergents sold in the U. S. A. were heavy-duty powders. Liquid detergents were introduced to utilised sodium citrate and sodium silicate. Mukerjee and Mysels (1971) reported that the liquid detergents offer superior performance and solubility at a slightly increased cost while heavy-duty liquids now account for 40% of the laundry detergents sold in the U. S., up from 15% in 1978. As a result, 50% of the sprays drying facilities for laundry granule production have closed since 1970. Some current trends, including the introduction of super concentrated powder detergents, will probably lead to an increase in spray drying operations at some facilities. Manufacturers are also developing more biodegradable surfactants from natural oils.

According to Moller and le Maire (1993), detergents are amphipathic molecules that contain both polar and hydrophobic groups. These molecules contain a polar group (head) at the end of a long hydrophobic carbon chain (tail). In contrast to purely polar or non-polar molecules, amphipathic molecules exhibit unique properties in water. Their polar group forms hydrogen bonds with water molecules, while the hydrocarbon chains aggregate due to hydrophobic interactions. These properties allow detergents to be soluble in water. In aqueous solutions, they form organised spherical structures called micelles, which contains several detergent molecules. Following their amphipathic nature, detergents are able to solubilised hydrophobic compounds in water.

Incidentally, one of the methods used to determine the critical micelle concentration (CMC) relies on the ability of detergents to solubilise a hydrophobic dye. Detergents are also known as surfactants because they decrease the surface tension of water. Many detergents are of sodium salts of sulphuric acid and the principal advantage they have over soaps is that their cleaning power is not affected by hard water (Oxford Illustrated

Encyclopaedia of Invention and Technology, 1992). According to Henney and Byett (1968), detergents have been developed in search for cleansers that are unaffected by hardness of water. Detergents were first used in 1931 in the dye industry but later produced to overcome the hardness problem first for shampoos and later for all purpose laundry and household cleansers. Henney and Byett indicated that detergents are effective cleansers even in cold water, sea water or when used in an acid solution.

Like soaps, detergents have certain substances added to then to make washing more effective. An anti-redeposition agent, usually carboxyl methyl cellulose, is included to hold the soil in suspension in the wash water during the washing process (Ehrenkranz & Inman, 1966). They went on to say that, a corrosion inhibitor usually sodium silicate may be added to protect metal parts of the washer from corrosion. They further reported that a florescent dye or optical bleach otherwise known as brightener is usually included. Florescent dyes make cloths appear brighter by converting invisible ultra violet radiation to visible light so that yellowness is masked and light reflectance stains, especially those of protein origin.

Lee, Prince and Robertson (1965), however, cautioned that soap and detergents are antagonistic and therefore should not be used in combination otherwise subs begin to disappear and cleaning power decreases. Despite the differences in the qualities of soaps and detergents, Peet, Picket, Arnold and Wolf (1975) outlined some common characteristics that make soaps and detergents acceptable cleaning agents. Soaps and detergents aid in the separation of soil from fabric, wet the soil in the fabric, and hold the soil in suspension for the removal by extraction and rinsing. In addition, they reduce the surface tension of wear by allowing it to spread out in a film and penetrate the fabric.

Detergents are essential to the cleaning of textile fabrics, both in processing, and for laundering after wear. Detergents are surface active chemicals that have the ability to emulsify, wet, suspend and remove soil matter from textile materials. They are formulated to have particular performance characteristics to meet a specific customer's end user requirements, and formulations that can be made to meet a specific price point. Detergent systems used in textile processing are significantly different to those used within the home environment (Stalmans & Guhl, 2003).

Components of Soaps

Soaps are water-soluble sodium or potassium salts of fatty acids (Sanders, 2002). Soaps are generally produced with natural products (soap and lye) and require very less energy in the manufacturing process. They are produced with fats and oils or their fatty acids by treating them chemically with a strong alkali. The fatty acids come from oils and fats; the strong alkali base is sodium hydroxide, also known as lye (for hard soaps) or potassium hydroxide, also known as potash (for soft soaps). The fats and oils include palm, castor, coconut, or olive oils, and retain the natural glycerine, rather removing it and selling it for profit, which bulk manufacturers generally do. The composition of the fats and oils and alkalis is as follows:

Fats and Oils

Chandler's Soap (2010) distinguished between oils and fats. According to Chandler's Soap, there is no sharp distinction between fats and oils. Oil commonly means a liquid which at ordinary temperature will flow as a slippery, lubricating, fairly thick fluid. Fat normally implies a greasy, solid substance slippery to the touch. It is necessary to differentiate the oils and fats used in the manufacture of soap. The fats and oils used in soap-making come from animal or plant sources.

Ohpardt (2003) indicated that each fat or oil is made up of a distinctive mixture of several different triglycerides. Hydrocarbon (petroleum-based) oils or paraffins, while included in the general term oil, do not contain fatty acids and cannot be used to make traditional soap. Animal- and vegetable-based oils and fats do contain the necessary fatty acids, in the form of triglycerides.

Fatty Acids

Fatty acids are the components of fats and oils that are used in making soap. They are weak acids composed of two parts – A carboxylic acid group consisting of one hydrogen (H) atom, two oxygen (O) atoms, and one carbon (C) atom, plus a hydrocarbon chain attached to the carboxylic acid group. Generally, it is made up of a long straight chain of carbon (C) atoms each carrying two hydrogen (H) atoms. According to Chandler's Soap (2010), a fatty acid can be saturated or unsaturated. In a saturated fatty acid, the carbon atoms are bonded with single bonds; they share one set of electrons. As a result, saturated fatty acids have two hydrogen atoms for each carbon atom. An example is Palmitic Acid. In an unsaturated fatty acid, there is at least one double bond where one set of carbon atoms is bonded by sharing two sets of electrons, instead of each being connected to a hydrogen atom. Oleic Acid is an example of an unsaturated fatty acid.

Alkali

An alkali is a soluble salt of an alkali metal like sodium or potassium. Originally, Cavitch (1994) noted that the alkalis used in soap-making were obtained from the ashes of plants, but they are now made commercially. Today, the term alkali describes a substance that chemically is a base (the opposite of an acid) and that reacts with and neutralises an acid. The common alkalis used in soap-making are sodium hydroxide (NaOH), also called caustic soda; and potassium hydroxide (KOH), and also called caustic potash. Alkalis raise the pH of the laundry wash water, which assists in breaking up oily and acidic soil components. However, since high pH can also damage fabrics the pH of laundry detergents is carefully controlled.

Builders

Builders enhance or maintain the cleaning efficiency of the surfactant. The primary function of builders is to reduce water hardness (Hopkins, 2010). This is done either by sequestration or chelation (holding hardness minerals in solution), by precipitation (forming an insoluble substance), or by ion exchange (trading electrically charged particles). Various types of builders are used to soften water, to help disperse soils and prevent their re-deposition out of solution, and to provide alkalinity, which assists the dissolving of oil-based soils. Complex phosphates and sodium citrate are common sequestering builders. Sodium carbonate and sodium silicate are precipitating builders. Sodium aluminosilicate (zeolite) is an ion exchange builder. Builders can also supply and maintain alkalinity, which assists cleaning, especially of acid soils; help keep removed soil from re-depositing during washing; and emulsify oily and greasy soils.

Triglycerides

In a triglyceride molecule, carboxyl group ends of three fatty acid molecules are attached to one molecule of glycerine. There are many types of triglycerides with each type consisting of its own particular combination of fatty acids (Chandler's Soaps, 2010). The actual physical characteristics of the oil depend upon which fatty acids have attached to the glycerol and whether they are connected to the top, middle or bottom of the glycerol molecule. If primarily unsaturated fatty acids are contained in the triglyceride, then the oil is considered to be an unsaturated fat. The type of fatty acids also determines whether the triglyceride is solid or liquid at room temperature, how thick it is, and the nutritional value.

Fragrance

Fragrances do more than giving laundry a pleasant smell. They neutralise the inherent odour of the detergent chemicals, and also of the soils in the laundry wash. They can also enhance mood and help create pleasant associations with 'doing the laundry'. They are chemicals with an odour that is detectable by humans. The human nose contains hundreds of olfactory receptors to which odour molecules can bind. Just like a key in a lock, certain odour molecules will fit into certain receptors if they have the right shape. This is called "molecular recognition". Therefore, odour is related to the shape and structure of the chemical molecules.

Optical Brighteners

Optical brighteners enhance the light reflected from the fabric surface and can make fabrics appear whiter and brighter, helping to keep them looking newer for longer. Optical brighteners mask the appearance of an undesirable colour, such as the yellowing of fabric that occurs naturally over time. They do this by introducing a complementary colour. Different colours exist because light can have many different wavelengths, depending on the nature of the substance that the light is being emitted or reflected from. The colour that is observed comes from a combination of all the wavelengths of light that reach the eye (Tyebkham, 2002).

Humans can only see a small fraction of all the wavelengths of light that exist, known as the visible spectrum; white is a combination of all the wavelengths in the visible spectrum. Just beyond the visible spectrum lies the ultraviolet region. Optical brighteners attach to fabrics, absorb invisible ultraviolet light and convert it to visible blue-violet light. The blue light that is emitted interacts with the yellow light emitted by the fabric, giving an overall appearance of whiteness.

In summary, soap is produced by the saponification (hydrolysis) of a triglyceride (fat or oil) as shown in Figure 3. In this process the triglyceride is reacted with a strong base such as sodium or potassium hydroxide to produce glycerol and fatty acid salts. The salt of the fatty acid is called soap.

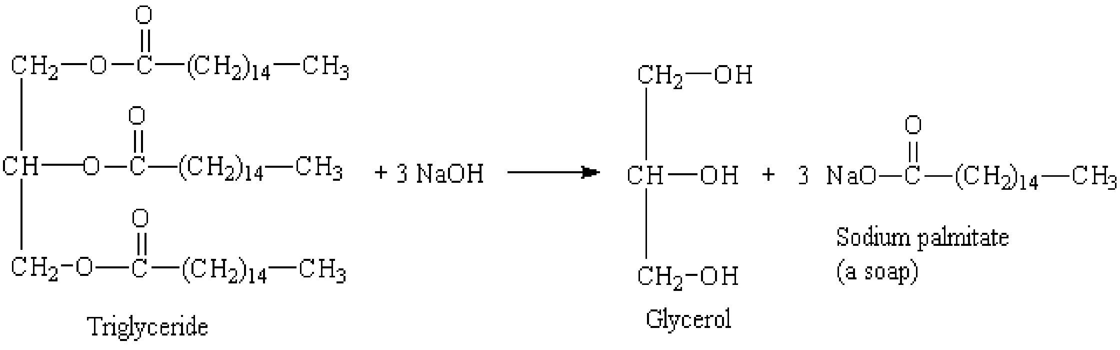

Figure 3. Saponification of a triglyceride with sodium hydroxide to give soap and glycerine (glycerol)
Source: Sanders (2002)

Cleaning Action of Soaps and Detergents

Detergents and soaps are used for cleaning because pure water cannot remove oily or organic soiling by acting as an emulsifier (Lohman, 2002). Water alone is not able to penetrate grease or oil because they are of opposite polarity. Basically, soaps allow oil and water to mix so that oily grime can be removed during rinsing. Detergents were developed in response to the shortage of the animal and vegetable fats used to make soap during World War I and World War II. Detergents are primarily surfactants, which could be produced easily from petrochemicals (Tyebkhan, 2002). Surfactants lower the surface tension of water, essentially making it wetter so that it is less likely to stick to itself and more likely to interact with oil and grease. Modern detergents contain more than surfactants.

Cleaning products may contain enzymes to degrade protein-based stains, bleaches to de-colour stains and add power to cleaning agents, and blue dyes to counter yellowing. Like soaps, detergents have hydrophobic or water-hating molecular chains and hydrophilic or water-loving components (Sanders, 2002). The hydrophobic hydrocarbons are repelled by water, but are attracted to oil and grease. The hydrophilic end of the same molecule means that one end of the molecule will be attracted to water, while the other side is binding to oil. Neither detergents nor soaps accomplish anything except binding to the soil until some mechanical energy or agitation is added into the equation.

According to Ohpardt (2003), the cleansing action of soap is determined by its polar and non-polar structures in conjunction with an application of solubility principles. The long hydrocarbon chain is non-polar and hydrophobic (repelled by water). The “salt” end of the soap molecule is ionic and hydrophilic (water soluble). When soap is added to water, the ionic-salt end of the molecule is attracted to water and dissolved in it. The non-polar hydrocarbon end of the soap molecule is repelled by water. A drop or two of soap in water forms a monolayer on the water surface as shown in the graphics on the left. The soap molecules “stand up” on the surface as the polar carboxyl salt end is attracted to the polar water. The non-polar hydrocarbon tails are repelled by the water, which makes them appear to stand up.

When used for cleaning, soap serves as a surfactant in conjunction with water. The cleaning action of this mixture is attributed to the action of micelles, tiny spheres coated on the outside with polar hydrophilic (water loving) groups, encasing a lipophilic (fat loving) pocket that can surround the grease particles, causing them to disperse in water (Willcox, 2000). Swishing the soapy water around allows the soap or detergent to pull the grime away from clothes or dishes and into the larger pool of rinse water. Rinsing washes the detergent and soil away. Warm or hot water melts fats and oils so that it is easier for the soap or detergent to dissolve the soil and pull it away into the rinse water.

Detergents are similar to soap, but they are less likely to form films (soap scum) and are not as affected by the presence of minerals in water (hard water). Modern detergents may be made from petrochemicals or from oleochemicals derived from plants and animals. Alkalis and oxidising agents are also chemicals found in detergents (Smulders et al., 2003).

Lee et al. (1965) observed that greasy dirt is often difficult to remove from fabrics or surfaces by the use of water alone. A surface active agent, for example, soap or detergent is necessary to break the surface tension of water and improving its cleaning power. Henney and Byett (1968) reported that when soaps or detergents come into contact with water, their first function is to lower the surface tension. These changes in surface tension enable the water to spread out and therefore wetting the fabric easily as well as penetrating between the fabrics and the particles of dirt.

Ling (1972) supported the idea that soap and detergent solution emulsifies any grease or oil present and the insoluble particles of dirt are wetted and held in suspension. This mechanical action aids in separating the dirt from the fabric. In addition, Henney and Byett (1968) believed that the efficiency of the cleaning action is influenced by the nature of the detergent, the presence of other ingredients or builders, the temperature of water used, washing time, mechanical action and also water hardness.

De Bonneville (1998) concluded that in order to understand the cleaning action of detergents, it is appropriate to consider the mode of action of detergents in the laundry process. Mechanical action also plays an important part in the cleaning process, as it facilitates the removal of solid particles of dirt, which must then be suspended within the solvent detergent system. Water alone is incapable of removing dirt, oils and fats; neither is water a good wetting agent for textile materials. Oils and fats are non-polar and are not attracted to water.

History, Benefits and Demand of Naturally-coloured Cotton Fabrics

Naturally-coloured cotton is a naturally pigmented fibre that grows in shades of green and brown. Historical records report of the existence of brown with pink and lavender tints. The natural colour is due to the plant’s inherent genetic properties. Shades of coloured cotton can vary over seasons and geographic location due to climate and soil variations. Naturally-coloured cottons, while only available on the commercial market for about 10 years, have been cultivated and used in native textile products by indigenous populations of the Americans for centuries (Apodaca, 1993; Backe, 1994; Boone & Katz, 1997; Vreeland, 1987, 1993, 1999). As a result of low yields or the inability of the fibre to be machine spun, and the availability of inexpensive dye-stuffs, Katz (2000) indicated that naturally-coloured cottons have not been utilised for commercial textile production.

In 1982, Sally Fox, a plant breeder now based in Wickenburg, Arizona, began a breeding and selection programme to improve the length and quality of naturally-coloured cotton (Fox, 1987). Dyeing can be one of the most costly steps in fabric finishing. It is estimated that the elimination of dyeing can save up to one-half of the manufacturing costs and disposal of toxic dye waste (Apodaca, 1993; Brookhart, 1991). Naturally-coloured cottons do not fade in laundering as it is typical of most conventionally dyed cottons. According to Dickerson, Lane and Rodriguez (1996) and Williams (1994), the colour of naturally-coloured cottons becomes stronger and more intense after laundering.

Eventually, the colours may start to return to their original hue (Apodaca, 1993; Dickerson et al., 1996) whiles some naturally coloured cotton darkens with exposure to light (Williams, 1994; Dickerson et al.). A study by Ferguson (1999) suggested that in the presence of light and wear, the molecules in the green cotton orient to reflect less light and produce a lighter-whiter appearance. Fergusson opined that during laundering the molecules reorient with the soap or detergent to become smoother, causing the colour to appear brighter and more intense because of optical brightness in most of these soaps and detergents.

Naturally-coloured cottons yield less per acre, but growers are paid higher prices for their harvest. In 1996, world market prices for naturally-coloured cotton ranged from $1.80 to $5.00 per pound compared to $.75 to $1.15 per pound for conventional white cottons (Vreeland, 1993). Growers of naturally-coloured cotton should experience a greater profit margin with very few production variations over conventional white cotton. Growers of naturally-coloured cotton may find less need for pesticides. Coloured cottons have many insect and disease-resistant qualities and are drought and salt tolerant (Fox, 1987; Lee, 1996; Vreeland, 1993). Coloured cottons have been grown successfully with organic farming methods.

The majority of naturally-coloured cotton varieties are of lesser quality (strength, length, micronaire, etc.) than most conventional cottons and are presently only available in a limited range of colours. In 1993, The San Joaquin Valley Cotton Board in California turned down requests to allow commercial planting of coloured cotton within its jurisdiction. The rationale for this decision was the reluctance to approve growing a cotton variety inferior in quality to the acala and Pima varieties already being grown in California.

BC Cotton Inc., operating an active breeding nursery in California and one in Mexico during the winter months since 1988, has experienced extremely rapid strides in improving the quality of coloured cotton. The result of this extensive and accelerated breeding and selection programme has been a coloured fibre (mocha) equal in quality to the San Joaquin Valley Cotton Board's acala standard. In addition, the staple lengths of all colours produced by BC Cotton Inc. have been improved. According to Johnson (1993), breakthrough reports in 1997 resulted in continued quality and colour improvement.

Even though breeders have improved the properties of naturally-coloured cotton, in comparison to conventional white cotton, naturally-coloured cotton fibres are still shorter and weaker. These composite yarns are stronger while still retaining the softness and appearance of coloured cotton yarns (Lee, 1996). It is generally known that naturally-white cottons vary in hues of yellowness depending on the growing region and variety. However, for dyeing purposes, a consistent white is necessary. In some areas, restrictions on delinting and ginning of coloured cotton have been imposed as a result of some contamination. Coloured cotton fields need to be located some distance away from the white cotton to avoid cross-pollination. Ginning can take place at gins where seeds are crushed and not saved for planting (Johnson, 1993).

Coloured cotton breeder by Sally Fox has encouraged legislations in states growing coloured cotton to help guard against contamination and to protect both the conventional and coloured cotton industries (Johnson, 1993). Arizona, where Fox is located, has passed regulations restricting the use of machinery, gins, and the location of coloured cotton fields (Fox, 1987). In Arizona, machinery used to pick coloured cotton is not allowed in "seed-saving" white cotton fields, and gins that have processed coloured cotton may not gin seed-saving white cotton for one year. Certain distances must also be maintained between coloured and white cotton fields.

The natural trend among consumers and the environmentally conscious social climate of the early 1990s helped to create an initial demand and niche market for naturally-coloured cottons, organic fibres and other environmentally friendly textile products. In 1992, an estimated 4,000 acres of naturally-coloured cotton was grown in the United States. This has declined due to limited market demand. The eco-fashion market peaked in 1993 – 1994 and by 1995, many retailers had withdrawn from the market (Katz, 2000). Natural Cotton Colours, Inc. has been experiencing financial difficulties (Fox, 1987; Miller, 1998). Sally Fox of Natural Cotton Colours, Inc. has attributed the decline to the bottleneck created by sporadic yarn production.

According to Fox (1987), naturally-coloured cotton products sell out in record fashion, but reorders have not been possible because of the unavailability of yarn. Fox believes that the primary issue is the possible contamination of white cotton lines in the manufacturing process. Mills have dealt with the problem in a variety of ways, but it has made the production of coloured cotton yarns and fabrics problematic. It is hoped that the recent study of contamination will alleviate some of concerns relative to contamination for yarn producers (Ethridge, Gustavo & William, 1997).

Naturally-coloured cottons have an extremely soft hand or feel. This, combined with their unique non-fading and environmentally friendly properties, has helped to assure their niche market. Coloured cotton’s future depends on continued improvement of fibre quality and development of appropriate manufacturing procedures (Lee, 1996).

Effect of Laundry on Naturally-coloured Cotton

The great appeal of textiles lies in their colours and the way that colour is used to create patterned effects. Colour is applied by the process of dyeing, which in its simplest form involves the immersion of a fabric in a solution of a dyestuff in water. Patterned effects are obtained by selectively applying dyes to fabric, for example by roller printing. Initial research studies have determined that naturally-coloured cottons have both unique and desirable qualities beneficial to the consumer and the environment (Tilocca, Borzone, Carosio & Durante, 2002).

Van Zandt (1994) tested coloured cottons for flame resistance and found coloured cotton (green) by Sally Fox and Coyote (brown) to be suitable for upholstery in motor vehicles and airplanes. Williams (1994) evaluated resistance to colour change in fabrics of Sally Fox and Coyote. Findings supported reports that laundering intensified the colour and that green is less stable than brown colours. When the effects of laundering, stains and stain removal products were studied, Williams (1994) concluded that the number of care cycles, water temperature, and water hardness affect colour change. Ammonia and chlorine bleach used as a stain removal pre-treatment greatly affected colour. Therefore, care products should be pretested before using on naturally-coloured cotton fabrics.

Dickerson et al. (1996) studied the performance of knit fabrics constructed with naturally-coloured (BC Cotton brown, green and red) and white Pima fibres. All the fabrics were laundered 20 times and evaluated at designated intervals for abrasion resistance, bursting strength, colour difference after laundering, colourfastness to light, consumer acceptance of colour change, dimensional stability, oxygen index, and pilling resistance. Naturally-coloured cotton fabrics compared favourably with the white pima cotton fabric in abrasion resistance. Weight loss due to abrasion was minimal for all fabrics tested.

The white Pima had significantly higher bursting strength than all naturally-coloured cotton fabrics in the study. Blending the coloured cotton with white Pima increased the bursting strength of naturally-coloured cotton fabrics. Instrumental colour difference measurements were the greatest after five laundry periods with minimal subsequent changes occurring at 10, 15, and 20 laundry periods. All naturally-coloured cotton fabrics became darker after laundering, while the white Pima got lighter (less yellow). Of the coloured cotton fabrics tested, the green fabrics had the highest change in colour values whilst the brown had the lowest change in colour values.

Colour change was also evaluated by a consumer panel. The panel rated the white Pima and brown fabrics as acceptable for wear. All blends were rated higher than the corresponding 100% coloured fabrics. The red and green fabrics were not acceptable to the panel. The naturally-coloured red and brown fabrics had excellent light fastness and received higher Grey Scale ratings than either the white Pima or the green naturally-coloured fabrics. The red was virtually unchanged, brown slightly lighter, white significantly lighter and green turned to tan. All fabrics had considerable dimensional change after laundering, showing an increase in the wale direction and a decrease in the course.

Most changes occurred at the first laundering period. Blending the coloured cotton with white Pima did not always result in less dimensional change. All naturally-coloured cotton fabrics evaluated had higher oxygen index values than white Pima, with red naturally-coloured cotton fabric having the highest oxygen index value of the fabrics studied. Mean ratings for pilling resistance improved after 20 launderings. Both brown 100% and white Pima had the highest rating after 20 launderings.

Standardisation of Soaps and Performance of Cotton Textile Fabrics

Standardisation refers to the process of adopting the same procedures or methods in order to achieve uniformity or comparable results (Henning, 1998). Hallstrom (1998) identified two basic kinds of standards which are technical standards and procedure standards. Technical standards provide information about how something should be constructed. Procedure standards look at the method by which something is constructed. Henning emphasised that knowledge about the effect of various ingredient and records or documentation on the procedure and the quantity of each ingredient used in manufacturing is essential in establishing standardisation.

According to Stalmans and Guhl (2003), standardisation in the manufacturing of soaps affects the strength, colour and elongation of cotton fabric during washing. The standardisation is in terms of the quantity of raw materials used, the equipment used as well as the processes involved. Standardisation in soap manufacturing therefore includes acquiring measurement standards and test measures in temperature-control, comparator balances, volume or quantity of raw materials, master metres, a water meter test rig, testing equipment, and test products directly used in verifications.

However, Atkins (2003) indicated that large factories use standardised processes in the usage of uniform quantity of ingredients, time for mixing, temperature control, etc. in their soap production. Such factories develop their products on the basis of sound scientific research and technological data, which conform to International Standards Board’s specification as well as international standards. On the contrary, the small-scale soap producers use non-standardised processes in their soap manufacturing. The difference in the manufacturing processes of the soaps is likely to have different effects on cotton fabrics when subject to washing.

Olatunji (2004) asserted that excess quantity of caustic alkali in soap preparation leaves unreacted caustic soda on the soap. And as a result of these, high levels of total free caustic alkali in soap which increases the pH of the laundry washes water and has the advantage of increasing washing efficiency because it assists in breaking up oily and acidic soiled components of fabrics (Anderson, 1999). However, while high pH of laundry water improves cleaning effectiveness, it can also result in fabric discoloration and reduction in fabric tensile strength (Anderson, 1999).

Atkins (2003) found that most small-scale soap manufacturers do not take into consideration the quality and quantity of raw materials, oils and alkalis needed for the soap preparation. They developed their own methods of making the soap as well as selecting of raw materials for the preparation of these soaps in sincere ignorance, without thinking of safety measures which can compromise the quality of the soaps produced. These consequently, result in either too much alkali or too much oils or fats being used during the soap preparation. Moreover, most of these small-scale soap producers do not seem to have any means of checking the quality of their products, which result in undesirable effects such as fading, peeling and loss of strength on the fabrics over a period of time.

Effect of Soaps on Colour Fastness of Dyed-cotton Textile Fabrics

Colour is a vital constituent and is probably one of the first characteristics perceived by the senses. Cannon and Cannon (1994) defined colour as a visible light, a phase of electromagnetic radiation, which enables one to see colour as a result of the reflection of light, rays. They asserted that colour is a measure of how well the dye is attached to fabric. According to Henney and Byett (1968), colours may be affected by long emersion in water, heat, and contact with strong alkaline solutions, environmental factors and friction.

Kao (1981) also observed that when a coloured textile is washed, the colour may be weakened through loss of dye and some of these dyes may be re-deposited on other articles that are being washed at the same time or at different parts of the same articles. Modern dyes and printed cotton are generally of fast dyes. However, certain precautions should be observed throughout the treatment and care of these items so that colours do not become dulled by repeated washing.

Bhardwaj and Mehta and (2006) explained that as the apparels made from African prints go through their cycle of use, they are exposed to conditions in wear and care such as laundry and laundry aids which can influence their overall performance. Ling (1972) commented that the aim of washing is to remove dirt from dirty garments or articles. Water is an excellent solvent and as a result, it will be able to dissolve water soluble matter and release dirt particles. However, in the absence of a suspending agent, such as soap or detergent, the particles are likely to aggregate. Bratton (1975) suggested that to be able to achieved high standards of washing, soaps must be used to increase the cleaning action of water. Sufficient amounts of detergent will have to be used to increase the wetting power of water. Detergents used should be able to give good lather, but not used up too quickly for friction washing (Henney & Byett, 1968).

According to Ling (1972), when a detergent is used for washing fabrics, the quantity of lather is an indication of the amount of detergent still present in solution, and too much of lather can be a nuisance and can impede the washing action. Apart from this, Ehrenkranz and Inman (1966) stated that excess detergent may produce seemingly cleaner clothes, but if it is not free from all traces of detergent used to wash the fabrics, it makes them stiff and harsh. Such fabrics may scorch more easily when ironed. Consequently, Gitobu (1988) suggested that washed fabrics must be rinsed thoroughly so that detergents that contain too much alkali or other chemicals do not tend to harm fabric colours and fabric finishes.

Joseph (1972) also suggested that improper care procedures used for washing coloured cotton fabrics can harm them. Henney and Byett (1968) and Joseph (1988) asserted that when printed or dyed fabrics are either immersed in water for a very long time, exposure to heat treatment or strong alkaline solutions or any harsh treatment like rubbing or friction method of washing, colours may be affected. Henney and Byett again stated that while small amounts of alkali have little effect on cotton fibres, it may affect the colour of dyed cotton.

Bratton (1975) indicated that the method of washing interferes with good cleaning action when there is too little detergent or soap. Sufficient detergent or soap is therefore needed to increase the wetting power of water. To achieve high standard washing and prevent problems during washing, there must be enough soap or detergent. On the other hand, Ehrenkranz and Inman (1965) observed that excess soap may produce seemingly cleaner clothes but if the detergent is not free rinsing, some will be left in the washing clothes and the clothes will feel stiff or harsh. Moreover, articles containing detergent should be will rinse to prevent them from scorching when ironed.

Gitobu (1988) emphasised that when detergents or soaps contain too much alkali or other chemicals, they tend to harm the fabric. Soaps and detergents have been made to suit all types of fabrics and may not have any negative effect on cotton. However, Joseph (1981) observed that some colours and fabric finishes may be damaged by some detergent and laundry aids. It is therefore important for consumers to read labels carefully and adhere to suggested and recommended care procedures.

Mohamed and Ulrich (1982) found that after repeated launderings, fabric’s surfaces deteriorate due to normal abrasion in the laundry and drying machines. Laundering with no detergent causes more abrasive damage than laundering with detergent in the form of fibre fractures and horizontal breaks along the fibres. The fabric’s surface deterioration would result in a decrease in appearance after laundering observations.

Chen (1999) observed that after repeated launderings the green and brown naturally-coloured cottons, crystallite area was similar or slightly larger compared to the crystallite area of the unwashed cottons. Chen concluded that an increase in the fibre moisture content after laundering could also cause an increase in the crystallite size that would result in an increase in colour change. Day and Kimmel (2001) found in their evaluation of naturally-coloured cotton an increase in colour intensity after laundering. Dickerson et al. (1996) found that instrumental colour differences were greatest after five laundry cycles with minimal differences between the tenth, fifteenth, and twentieth laundry cycles. Reinforcing their results was the Gulf Coast Section's project (2002) where samples reported change in colour after the first washing, but showed greater changes in accelerated laundering tests.

Colour Fastness Relating to Colour Change and its Significance on Textiles

In the assessment of colourfastness of a particular textile, the change that occurs may be a change in depth of colour, a change in hue, a change in brightness or a combination of these. Regardless of the character of change, the assessment is based upon the magnitude of the visual contrast between the specimens of the original material (International Standards Organisation [ISO], 1987). All colour changes that occur in a test are evaluated by reference to others for staining where there is a transfer of dye from one fabric to another (Kao, 1981).

Colour plays a very important role in the selection of fabrics. Ling (1972) confirmed this by stating that when people select a textile for either clothing or furnishing, the most important factor that affects the choice is often the colour of the fabric. Joseph (1981) classified colour as the visual sensation resulting from the reflectance of certain visual light rays that affect consumers' choice is often the colour of the fabric. Joseph went on to say that colour as the visual sensation resulting from reflectance of certain visible light rays may strike the retina and stimulate cells in nerves of the eye. She pointed out that the nerves send messages to the brain which in turn produces the sensation of a specific hue.

Ling (1972) supported the idea that the objects that look coloured do so because they absorb some wavelengths of light and reflect others. Anin (1974) reported that in the range of visual wavelength, the eye can distinguish 125 different lines which are usually grouped and commonly called the violets, blues, green, yellow, oranges, and the reds. Brookhart (1991) asserted that colour selection dominates the interior world. The first response by the ultimate consumer is to colour before appraisal of design and price can finally be considered.

Johnson (1993) reported that personal experience and much sophisticated and widely acknowledged research confirmed that nothing is more important to designers and manufacturers of all products from apparel to carpet than colour. Fianu and Adams (1998) also found out that washing per se and sunlight cause the colour of Real Wax, Real Java, and Batik fabrics to fade and suggested that they are dried in the shade.

FabricLink (2006) also pointed out that are several reasons why clothes lose their brightness. Common reasons include the use of too much/too little detergent, use of too large of washer loads, inadequate rinsing, and using the wrong water temperature. FabricLink reported that if the washer is too full, there's more rubbing or abrasion on the clothes, which dulls the colours of the fabric. Many clothes have optical brighteners or fluorescent whitening agents applied, which help to brighten colours. Unfortunately, nothing can be done, if the fluorescent whitening agents are damaged by sunlight, bleach, or age.

Soap and Tensile Strength and Elongation of Cotton Fabrics

Performance of cotton fabrics in warp and weft directions are seen in washing, wetting and drying processes. According to FabricLink (2006), warp threads are long threads that are stretched on the loom and secured. They become the fabric's lengthwise grain, the threads that are continuous along the length of your yardage as it comes off the bolt. In all woven fabrics, this is the set of yarn running lengthwise – machine direction – parallel to the selvage and interwoven with the filling. It is the set of yarns wound together on a beam for the purpose of weaving or warp knitting. Weft threads are woven back and forth, perpendicular to the warp threads and along their entire length. These weft threads make up the fabric’s crosswise grain. They are the filling yarns that run perpendicular to the warp yarns. The warp (vertical) and weft (horizontal) is the fabric’s weave. All fabrics are made in this way.

FabricLink (2006) again defined the tensile strength of a fabric as the strength shown by a fibre, yarn, or fabric to resist breaking under pressure. It is the actual number of pounds of resistance that a fabric will give before the material is broken on the testing machine. Researchers in the area of clothing and textiles have recognised the fact that processes garments go through during care, especially laundry, affect their performance and so have taken steps to identify the effects of some conditions such as sunlight and washing.

For example, Realff, Boyce and Backer (1997) reported that sunlight and washing may have influence on the tensile strength of the fabric, fineness of the fabric, number of ends and picks per unit length, and weave design.

Willcox (2000) found that whether a material is brittle or ductile could be a subjective guess, and often depends on temperature, strain levels, and other environmental conditions. However, a five percent elongation criterion at break is a reasonable dividing line. Materials with a larger elongation can be considered ductile and those with a lower value brittle.

Cano-Glu, Geultelin and Yeukselo-Glu (2004) found that at the end of five times washing, fabrics in both weft and warp directions exhibited less tensile strength values, especially this can be seen clearly on the weft direction of the breaking strengths. Particularly, end of the 15 times of ultrasound washing has higher breaking strength in weft direction than the other washings. In all ultrasound washing processes, breaking strength in warp direction has given higher results than the untreated fabrics. However, on the weft direction of ultrasound washing process, only the 25 washing is less than that of the conventional washing process. Additionally, there is no clear difference before and after the washings in breaking strength of weft direction of the fabrics apart from the 25 washing.

In the washing of ultrasound technique, the reason for having higher tenacity values in both weft and warp directions of the fabrics, may be that the yarns used in blended fabrics do have normal twist structures. The other fabrics did not show same trend due to the intermingled structure within the yarns that they consist of. In ultrasound washing processes of fabrics, as the number of washing increases no much difference observed between the breaking strength in weft directions and untreated fabrics. In the conventional washing processes of the fabrics, as the number of washing increases there has been a little decrease in the breaking strength in weft directions. It has been also determined that there is not much difference between the two washing processes on the breaking strength in warp directions of the fabrics.

Jucienė, Dobilaitė and Kazlauskaitė (2006) reported on the influence of washing on denim, a cotton fabric. The tensile characteristics of the specimens were measured using universal testing machine ZWICK/Z-005. All experiments were carried out in standard atmosphere for testing according to the standard ISO-139. The specimens used for tensile investigation were cut in the warp and weft. The determination of breaking force and elongation at break was obtained following the standard LST ISO 13934-1.

Their results of elongation demonstrated that even in the initial phase of tensile in the weft threads, fabric treated with different washing ways features higher elongation, whereas in the warp influence of washing was not so significant. After washing, elongation in the weft increased almost twice in some cases, whereas elongation in the warp was negligible. That is, in all the cases, breaking elongation increased, but in the warp, it increased less and in the weft, it increased more.

In Ghana, Fianu, Sallah and Ayertey (2005) researched into the effect of sunlight and drying methods on the colour and strength of wax printed fabrics. Fianu et al. revealed that sunlight causes loss of strength in Real Wax printed fabrics from GTP with laundered specimens losing more strength in the sun than in the shade.

Summary of the Chapter

Colour, tensile strength and elongation are vital constituents of cotton textile fabrics. The review of literature showed that the properties of fibre play a major role in the performance of the fibre. The properties (colourfastness, tensile strength and elongation) of fibre are affected when the fabric is immersed in water for a very long time, exposed to heat treatment, and contacted with strong alkaline solutions, environmental factors, and rubbing or friction method of washing. Thus, the properties of fibre are affected when soap is used in washing the fabric. The literature review indicated that the effect on the fabric depends on the standardisation in the manufacturing of soaps.

Standardisation of soap is in terms of the quantity of raw materials used, the equipment used as well as the processes involved. That is, the differences between standardised and non-standardised soaps are caused by the differences in the input methods during preparation in terms of their uniformity in combining the ingredients used in making soaps. The differences in the input methods in soap making are likely to result in different properties and chemical compositions of soaps. The output of any process is a function of the combination of the various inputs used, and the reactions among the various inputs. The literature revealed that the applications of standardised and non-standardised soaps of different chemical compositions are likely to have different effects on textile fabrics. The study therefore examined the effect of soaps on the performance of some printed cotton fabrics.

CHAPTER THREE

METHODOLOGY

The purpose of this study was to investigate the effects of two locally manufactured soaps on colour, strength and elongation of Ghanaian printed cotton fabrics after three washing cycles. The experimental work was carried out in the textile laboratory of the Ghana Standards Authority and the appropriate standard methods were used.

This chapter describes the methods that were employed for the study. It explains how the investigations were carried out, why particular methods and techniques were employed. It presents the research designs, materials, sampling and sampling procedure. The chapter also provides an account of the materials and procedures that were used for the study as well as information on how data were analysed.

Research Design

This study is a quantitative experimental study because it investigated the effects of two locally-manufactured soaps on the strength, colour and elongation of some selected Ghanaian cotton prints after three washing cycles. The experimental type of research was chosen for this study to thoroughly examine the variables involved. A two by two by three (2 × 2 × 3) factorial design was employed for the study. This involved two brands of locally-manufactured soaps (key soap and “Azumah blow soap”), two Ghanaian cotton prints (Akosombo Textile print and Tex Style Ghana Limited Real wax print formally (Ghana Textiles Print) and three washing cycles.

According to Ary, Jacobs and Razavieh (2002), a factorial design is an experimental design that investigates two or more independent variables at the same time in order to study their effects singly and in interaction with each other. Ary et al. further stated that in a factorial design, the researcher manipulates two or more variables simultaneously in order to study the independent effect of each variable on the dependent variables as well as the effects caused by the interactions among the several variables. The three independent variables in this study were two locally-manufactured soaps, two samples of Ghanaian printed fabrics and three washing cycles. They were manipulated by combining them to evaluate their effects singly and in combination on the dependent variables such as degree of colour change, tensile strength and elongation at break.

Materials

Twelve yards (six yards ATL and six yards GTP) of real wax fabric from Tex styles Ghana Limited and Akosombo Textiles Limited were bought from the market as the two textile companies are perceived to produce good quality African prints in Ghana. The researcher measured the lengths of the two fabrics to make sure that they were both exactly six yards each. The aim was to ensure equivalence in measurements as well as equal number of specimens. A total of 390 specimens were obtained from the two fabrics (195 each from each fabric). Two different brands of soaps which are key soap (standardised soap) produced by Uniliver Ghana Limited, and Azumah blow soap (non-standardised soap) produced by a small-scale manufacturer, were purchased from the market. These two brands of soaps were chosen because they are the most common laundry products, least expensive and are mostly available in the Ghanaian market.

Sample and Sampling Procedure

The strip test method was employed for this study. Out of the 12 yards of Tex Styles Ghana Limited Real wax fabric and Akosombo Textile printed fabric bought, a total number of 390 specimens were obtained for the experiments. According to Krejcie and Morgan (1970), a population of 398 requires a sample size of 196 to ensure representativeness. However, 190 specimens were sampled for easy distribution of the specimens among the various experiments conducted. The sample size was with an error margin of five percent. Stratified sampling was used to sample the 190 specimens from the two fabrics. Thus, the total specimen of 390 was stratified into two (GTP and ATL). Ninety-five specimens were randomly sampled from each stratum. Eighty of the specimens were used for tensile strength testing. The details are shown in Table 1

Table 1: Specimens for Testing Tensile Strength of Fabrics

Soap type	Fabric type	Yarn direction	30mins washing	60mins washing	90mins washing	Control	Total
Azumah blow	GTP	Warp	5	5	5	5	20
	ATL	Weft	5	5	5	5	20
Key soap	GTP	Warp	5	5	5	5	20
	ATL	Weft	5	5	5	5	20

Eighty specimens were used for colourfastness testing. Table 2 presents the results.

Table 2: Specimens for Testing Colourfastness of Fabrics

Soap type	Fabric type	Yarn direction	30mins washing	60mins washing	90mins washing	Control	Total
Azumah blow	GTP	Warp	5	5	5	5	20
	ATL	Weft	5	5	5	5	20
Key soap	GTP	Warp	5	5	5	5	20
	ATL	Weft	5	5	5	5	20

Thirty specimens were used for testing for the physical properties (weave type, thread count and weight) of the fabrics. The details are presented in Table 3.

Table 3: Specimens for Testing Physical Properties of Fabrics

Fabric type	Fabric weight	Fabric weave	Thread count	Total
GTP	5	5	5	15
ATL	5	5	5	15

In the random sampling process, the specimens were first numbered. The numbers were replicated on pieces of papers and folded into a bowl. The papers were shuffled after which draws were made without replacement. The numbers were recorded and their corresponding specimens were selected. This was to give the specimens fair chance to be selected for the tests. This process was used to select specimens for all the tests (Table 4).

All samples for investigations were conditioned at 20 ± 2^{o}C with a relative humidity of 65% for 24 hours in a relaxed state as indicated by international standard 13935-1 in ISO (1999) (E). All the procedures in this text were carried out according to the standard test methods employed by the Ghana Standards Authority in carrying out the tests stated.

Table 4: Random Sampling of Specimens in the Warp (WP) and Weft (WF) Directions of the Fabrics

WP	WF	WP	WF	WP	WF	WP	WF	WP	WF
WF	WP	WF	WP	WF	WP	WF	WP	WF	WP
WP	WF	WP	WF	WP	WF	WP	WF	WP	WF
WF	WP	WF	WP	WF	WP	WF	WP	WF	WP
WP	WF	WP	WF	WP	WF	WP	WF	WP	WF
WF	WP	WF	WP	WF	WP	WF	WP	WF	WP
WP	WF	WP	WF	WP	WF	WP	WF	WP	WF
WF	WP	WF	WP	WF	WP	WF	WP	WF	WP
WP	WF	WP	WF	WP	WF	WP	WF	WP	WF

Preparation of Specimens

Specimens were taken through a number of processes to prepare them for the experiments. These include the following:

Tensile Strength and Elongation at Break of Fabric

Fabrics were cut into samples in both warp and weft directions in the size of 30cm × 7cm. The 30cm × 7cm samples were frayed at both sides in their lengthwise directions to achieve 30cm × 5cm required for testing. Tensile strength and elongation at break were tested after the specimens had been washed.

Fabric Weight, Count and Weave

Ten specimens, which were cut using the sample cutter, were used to determine the weight of the fabric (5 specimens from each fabric types). The area of each of the cut piece for testing for fabric weight was 0.015m^2. A total of 10 specimens were used in testing for thread count (5 in the warp direction from both fabric types and 5 in the weft direction for both fabric types) and 5 specimens each from each fabric type was used in testing for fabric weave.

Fabrics for Testing Colourfastness

Fabric were cut into samples from both fabric types in the size of 5cm × 10cm. Out of the 190 samples, 80 specimens were used to test for colourfastness (5 in the warp directions from each fabric type and 5 in the weft direction from each fabric type) and the degree of colour change was examined after 3 washing cycles.

Analyses of Soaps

Soap analysis was carried out immediately after production and then three months after production.

1. Total Fatty Matter (TFM): A sample of the scrapped soap (10 g) was put into a 250 em3 beaker. 100 cm3 of water was added and the mixture was heated on a water bath until the soap melted. 10 em3 of 20% H2SO4was added with continued stirring then 5 g of candle wax and heating was continued until the wax melted. The whole content was allowed to cool to room temperature. The TFM was then calculated.
2. Total Free Alkali (TFA): 10g of soap samples were digested in freshly boiled ethanol (200ml) on steam bath until the soap sample was dissolved. The solution was heated to boiling and then filtered with standard 0.1m sulphuric acid to phenolphthalein and point. The total free alkali is calculated as potassium oxide using the relationship weight (g) of TFA = molarity of acid formula weight of oxide X volume of acid used (liters).
3. Free Caustic Alkali (FCA): 10g of soap were dissolved in 100ml of neutralized ethanol over steam bath and 10ml of barium chloride added to

the hot solution. The soap sample is filtrated with0.1m sulphuric acid using phenolphthalein indicator. The amount of free caustic alkali in the soap is calculated using the relationship as; FCA = molarity of acid X formula weight of barium chloride X volume of acid used (liters).

4. Chloride matter: Mother liquor was prepared by diluting 2 ml of spent lye with 250ml of deionized water in a flask. To an aliquot of 10 ml were added 50ml and few drops of 10% potassium chromate solution as indicator, and the solution obtained was titrated with 0.1 N silver nitrate solution to the endpoint. The percentage of NaCl present in the spent lye is calculated using Equation: NaCl (%) = V ×5.85 [10]. V is the volume of the 0.1 N silver nitrate solutions at the endpoint.
5. Insoluble in ethanol: This was found by running alcohol of the 10ml strength from a burette into 20ml volume of the oil with constant agitation. The solution was allowed to settle until the oil forms a clear solution with the alcohol. Having noted the quantity of alcohol added, 5ml alcohol was added. The opalescence or cloudiness was used to estimate the proportion of insoluble in ethanol.
6. Lather volume: The soap produced was used to form lather in water and the time taken for the foam-to collapse was determined using a stopwatch. The hand feel hardness was determined relatively to each other.

Instruments

The experimental work was carried out in the textile laboratory of the Ghana Standards Authority. The standard Launder-Ometer (Gyrowash 315) was used in washing the specimens. A tensile testing machine (Hounsfield H5K-5) was used in testing the tensile strength and elongation at break of the specimens and a magnifying glass was used in determining the weave of the fabric as well as the thread count. Weighing balance (Adams equipment) was used in determining the weight of the fabrics before washing.

A pair of scissors was used in cutting specimens and a sample cutter was used in cutting specimens for weighing. A geometric grey scale was used to evaluate the colour change of the specimens. These instruments are used by the Ghana Standards Authority (GSA) in testing for approval of textile prints and so deemed reliable for use. Refer to Appendices for the pictures of the instruments used for the study.

Data Collection Procedure

The primary data for the study were collected through the following procedures:

Labelling of Specimens

The labelling of specimens was done based on the direction of the specimen (warp, weft) and the number of washes the specimen had. For fabric type, all GTP samples were labelled ‘A’ and all ATL samples were labelled ‘B’. Key soap solution was labelled ‘C’ and Azumah blow soap solution was labelled ‘D’. All warp samples were labelled ‘WP’ and weft samples were labelled ‘WF’. Specimens which were washed once were labelled 1, those washed twice were labelled 2 and those washed thrice were labelled 3. Specimens for testing colourfastness were labelled Q, Q1, Q2 and Q3 for GTP samples and G, G1, G2 and G3 for ATL samples. Specimen for testing tensile strength, and elongation at break were labelled as WP, WP1, WP2 and WP3 for warp, WF, WF1, WF2 and WF3 for weft, with WP and WF representing samples that were not washed (control). The labelling for the weft and warp specimens is presented in Table 5.

Table 5: Labelling of Warp and Weft Specimen for Testing Colourfastness, Tensile Strength and Elongation of Fabric

Fabric strength and elongation at break	Number of washing cycles
WF	0
WF1	1
WF2	2
WF3	3
WP	0
WP1	1
WP2	2
WP3	3
Colourfastness	
Q	0
Q1	1
Q2	2
Q3	3
G	0
G1	1
G2	2
G3	3

Preparation of Soap Solution

A stock solution of key and ‘Azumah blow’ soaps, proprietary soaps used by Ghanaians for washing clothes were prepared for washing the test specimens. The amount of soap solution used was obtained based on the weight of the specimens. It was noted that 1g of specimen takes 50ml of soap; 1l of water takes 5g of soap, and 1kg of sodium carbonate. For this study, three specimens weighed 7.6967g. In one round of washing, eight calester cylinders were used with each cylinder taking three specimens. The stock solution was therefore obtained by dissolving 20g of key and Azumah blow soaps and 8g of Sodium carbonate in 4l of water for each soap solution. The four litters of soap solution from each soap type were enough to wash 18 specimens for all the three washing cycles, with each calester cylinder taking 400ml of soap solution.

Washing of Specimens

The specimens to be washed were subjected to washing in the Standard Launder-Ometer (Gyrowash 315) with a solution made from key soap and “Azumah blow”. According to the standard test methods employed by the Ghana Standards Authority, the washing was done at 60^oC temperature for 30, 60 and 90 minutes, respectively after which the washed specimens were removed from the washing machine and rinsed in clean water and dried on a drying rack under an experimental condition for 12 hours. The same procedures were repeated for the 60 and 90 minutes washing cycles. The washed specimens were taken off the drying rack immediately they dried, after which the specimens were tested for tensile strength, elongation at break and colour fastness.

Weighing of Fabric, Testing for Fabric Weave and Thread Count

The three samples from each fabric types were placed on the weighing balance (Adams equipment), one at a time and their readings recorded separately for each fabric type. With the help of a magnifying glass, the fabric’s weave and thread count were determined. For thread count, the number of threads in the warp and the weft directions of the two fabric types were counted separately for five times (5 in the warp and 5 in the weft direction for each fabric type) and recorded.

Testing for Tensile Strength and Elongation at Break

The tensile strength testing machine was used for carrying out the testing for tensile strength and elongation at break for the fabrics. The gauge length of the tensile testing machine was set at 200mm ± 1mm and the rate of extension or the speed was set at 100mm/minute. The force at break and the extension at break of fabric were recorded for each specimen in both the warp and the weft directions for each fabric type after each cycle of washing as well as the unwashed specimens which served as control. Maximum forces at rupture and extension at break were recorded in Newton. The experimental procedures were carried out with the assistance of the technicians at the Ghana Standards Authority textile laboratory.

Testing for Colour Change

The geometric grey scale was used to evaluate the change in colour in 12 treated specimens from each fabric type as well as each soap wash. To do the visual assessment test, the control specimens and a treated test piece from each washing cycle was placed side by side (without leaving any space between them) in the same plane and orientation under florescent light system. The colour difference values were computed between the treated specimens and the control specimens. The difference in shade or colour was described in terms of the magnitude and the degrees of contrast provided by the grey scale values. This was done for all the treated samples from each fabric type, each yarn directions, soap type as well as duration of washing cycle.

Data Analysis

The data was analysed by the use of the Statistical Product and Service Solution (SPSS) version 17. Readings were recorded for each of the tests identified for both washed and unwashed specimens. Continuous or Interval data was generated which allowed quantitative analysis to be carried out. The statistical tool that was used in the analysis of the data was descriptive statistics such as mean and standard deviation. The descriptive statistics were used to describe the structural and performance attributes of the fabric which are fabric weave, thread count, fabric weight, colour, tensile strength, and elongation of the fabrics. A one-way analysis of variance (ANOVA) was used to test for significance differences in the performance (colour fastness, tensile strength and elongation at break) between the two fabrics after undergoing three washing cycles in both soap solutions.

CHAPTER FOUR

RESULTS AND DISCUSSION

The purpose of this study was to investigate the effects of two locally manufactured soaps (standardised and non-standardised) on the colour, tensile strength and elongation of Ghanaian printed cotton fabrics. In this chapter, data obtained from the study are analysed and discussed. Readings were recorded for each of the tests identified from washed and unwashed specimens. The Statistical Package and Service Solution (SPSS) for Windows version 17 was employed in analysing the data for the study. Means and standard deviations were used to report the details of selected structural and changing attributes of the fabrics and in answering the research questions. Inferential statistics (Analysis of variance and Independent t-test at 0.05 alpha levels) were used in testing the hypotheses.

This chapter is organised under the following headings:

1. Basic chemical characteristics of soaps
2. Effect of Soap on colour fastness of cotton textiles fabrics
3. Structural and changing attributes of fabrics
4. Deformation of the specimens
5. Effect of soap on tensile strength and elongation at break of GTP and ATL fabrics

Basic Chemical Characteristics of Soaps

According to Deshwal and Khambra (2006), the chemical properties of soaps are the major influence of colour fastness in fabrics as they undergo washing. Similarly, the chemical characteristics of soaps affect the tenacity, weight and bending length of fabrics among others. The implication is that different chemical characteristics of soaps are likely to have different impacts on textile fabrics. The study therefore examined the chemical properties of both key soap and Azumah blow soap, and how their properties were likely to affect the performance of the fabrics.

Chemical Properties of Key Soaps

The basic chemical characteristics of key soap, locally-produced (standardised) laundry soap, were determined to explain its effect on GTP and ATL cotton fabrics. The key soap parameters were: Net Weight (g), free caustic alkali (NaOH) (%), lather volume (ml), total fatty matter (%) and matter insoluble in ethanol (%). The determinations of these parameters were the most common operations in the analysis of commercial soaps. The mean values were obtained from the Ghana Standards Authority, Accra, and are presented in Table 6.

The mean values for key soap parameters were: net weight (1073g), lather volume (222.9), total fatty matter (54.2) and insoluble in ethanol (9.1). The basic chemical characteristics of key soap met all the standard specifications of laundry soap. The implication is that key soap is likely to have a minimal deteriorating effect on fabrics during washing.

Table 6: Basic Chemical Characteristics of Key Laundry Soap (Type 1)

Parameters	Mean value	Standard Specification for Type 1 Laundry Soap by GSA (GS 167: 2006)
Net weight	1073.0	1200.0 (declared)
Free Caustic Alkali (%)	0.0	0.1 (max)
Total Free alkali (%)	0.0	0.3 (max)
Lather Volume (ml)	222.9	200.0 (min)
Total Fatty Matter (%)	54.2	59.0 (max)
Chloride Matter (%)	0.0	1.5 (max)
Insoluble in Ethanol (%)	9.1	20.0 (max)

Basic Chemical Characteristics of Azumah Blow Soap

The basic chemical characteristics of Azumah blow (non-standardised), Type two locally-produced laundry soap, were determined to investigate its effect on GTP and ATL cotton fabrics. The Azumah blow soap parameters were: Net Weight (g), free caustic alkali (NaOH) (%), Lather volume (ml), total fatty matter (%) and matter insoluble in ethanol (%). The determinations of these parameters were the most common operations in the analysis of commercial soaps. The mean values were obtained from the Ghana Standards Authority, Accra, and are presented in Table 7.

Table 7 shows that the mean values for Azumah blow soap parameters were: net weight (341.6g), free caustic alkali (0.60), total free alkali (1.57), lather volume (183.8), total fatty matter (22.9), chloride matter (0.22) and insoluble in ethanol (38.5). The mean values of the parameters of Azumah blow soap, except for chloride matter, had values for the basic parameters far from the recommended standard specifications (GS 167: 2006).

Table 7: Basic Chemical Characteristics of Azumah Blow Soap (Type 2)

Parameters	Mean Value	Standard Specification for Type 2 Laundry Soap by GSA (GS 167: 2006)
Net weight	341.6	0
Free Caustic Alkali (%)	0.60	0.1 (max)
Total Free alkali (%)	1.57	0.3 (max)
Lather Volume (ml)	183.8	200.0 (min)
Total Fatty Matter (%)	22.9	59.0 (min)
Chloride Matter (%)	0.22	1.5 (max)
Insoluble in Ethanol (%)	38.5	20.0 (max)

The massive deviation of the Azumah blow soap from the recommended standard specifications of laundry soaps could be attributed to the non-standardised process in its preparation, scale of production and technology used. The informal nature in the manufacturing of Azumah blow soap and lack of quality control do not allow for standard assessment of its specifications to meet the (GS 167: 2006) standard. For example, the high content of alkalis (free caustic and total free) is likely to be cause of excessive colour bleeding during washing (GS 167: 2006).

The values of the basic chemical characteristics (parameters) of key and Azumah blow soaps varied from each other. The implication is that both soaps are likely to have different impacts on the test cotton fabrics (GTP and ATL). In other words differences in the attributives of the two test fabrics are likely to be caused by the differences in the chemical properties of the two soaps. According to Atkins (2003), small scale soap producers develop their own methods of making the soap as well as selecting raw materials in sincere ignorance, without thinking of safety measures which can compromise the quality of the soaps produced. Such methods of production mostly result in either too much alkali or too much oils or fats being used during the soap preparation. Atkins concluded that the difference in the manufacturing processes of the soaps is likely to have different effects on cotton fabrics when subjected to washing.

Effect of Soaps on the Colour Fastness of Cotton Textile Fabrics

Colour fastness has been identified in research as the major problem for consumers (Dittoe, 1974). Mokhtari, Nouri and Sarli (2011) defined colour fastness as the extent to which a textile fabric is able to pose resistance against washing, bright light exposition and gas or by rubbing in maintaining its dye. Mokhtari et al. (2011) argued that colour fastness of dyed cotton textiles may be affected by long emersion in water, heat and contact with strong alkaline solutions.

The extent of colour bleeding in dyed cotton fabrics however may either be caused by the chemical properties of the soap (such as sodium hydroxide and calcium hydroxide) or the attributes of the fabrics in terms of the thickness of the yarns, weight and thread counts (Deshwal & Khambra, 2006). Consequently, the differences in the chemical composition of the two soaps are likely to have different effects on the fabrics. Similarly, differences in the physical properties of both fabrics are likely to result into different effects depending on how each of the fabric type is able to pose resistance to the reactions caused by the soaps. The study therefore considered the effect of both soaps (key soap – standardised and Azumah blow – non-standardised) on the colour fastness of GTP and ATL fabrics.

The Grey scale was used to test for colour fastness in both fabrics. Calibration on the grey scale measures between 1 and 5 with 1 as poor colourfastness and 5 as strong colourfastness. Thus, the Grey scale is calibrated into 1, 1-2, 2, 2-3, 3, 3-4, 4, 4-5, 5. According to GS 124 (2005), a cotton fabric passes the colour fastness test when it is able to retain at least 3-4 units of its colour on the grey scale.

Effects of Key Soap (Standardised) on the Colour Fastness of Cotton Textile Fabrics

This section focuses on the assessment of the effect of key soap on the colour fastness of GTP and ATL over three washing cycles. Table 8 shows that the original colour fastness of both fabrics measured 4-5 on the grey scale. Thus both fabrics passed the ISO Grey Scale Standard for African textiles of 4-5 as stipulated by GS 124 (2005).

Table 8: Colour Fastness of GTP and ATL Fabrics after Key Soap Treatments over Three Washing Cycles

Fabric Types	Mean Colour Fastness (N) of Fabrics			Control
	30 minutes	60 minutes	90 minutes	
GTP	4	4	4	4-5
ATL	4-5	4-5	4-5	4-5

From Table 8, both fabrics passed the colour fastness test after the three times washing cycle with key soap (standardised). Both fabrics recorded a colour fastness score of more than three which is the minimum colour fastness pass score for cotton fabrics. Key soap had little effect on colour fastness in both fabrics. The minimal effect of key soap on both test fabrics can be attributed to its conformity to the standard specifications of laundry soap. ATL fabric maintained its colour fastness in all the three washing cycles at 4-5 on the Grey scale reading whereas GTP recorded a colour fastness score of four out of the original 4-5 on the Grey scale.

The differences in the performance of the two fabrics may be attributed to the differences in their properties. Joseph (1988) explained that the properties of textile fibres provide the standard reference on key aspects of fibre performance. Hearle and Morton (2008) also indicated that differences in the structural attributes of textile fabrics are likely to yield different results as they undergo the same strain test. Thus, the difference in the colour performance of the two fabrics could be attributed to the difference in weight. Heavy fabrics are able to resist colour loss more than those with less weight (Hearle & Morton, 2008). From the laboratory measurement, the mean weight of the ATL specimens was 129.9g/m^2, which was higher than the mean weight of the GTP specimens of 116.5g/m^2.

The implication is that the ATL fabrics performed better than GTP because the ATL fabric was heavier to resist colour loss through washing with key Soap than GTP. This agrees with the submission of Deshwal and Khambra (2006) that the attributes of the fabrics in terms of the thickness of the yarns and weight influence their performance when subject to stress.

Similarly, it could be deduced from the results that key soap had marginal effect on the colour fastness of the two fabrics. Thus, the ATL fabrics maintained their colour, whereas GTP lost between 0.1 and 1 unit on the Grey scale through the three washing cycles. This effect may be attributed to the chemical characteristics (inputs) and the standardised process in the preparation of key soap. From the study, the overall chemical components in key soap were within the standardised limits of laundry soap making of GSA's GS 167: 2006. According to Jeffcoate (1991), standardisation helps to achieve uniformity and certain level of quality in product manufacturing.

Effect of Azumah Blow Soap (Non-standardised) on the Colour Fastness of Cotton Textile Fabrics

This section assesses the effect of Azumah blow on the colour fastness of GTP and ATL fabrics after three washing cycles. The results are presented in Table 9.

Table 9: Variations in Colour Fastness of GTP and ATL after Azumah Blow Soap Treatment over Three Washing Cycles

Fabric	Mean Colour Fastness (N) of Fabrics			Control
Types	30 minutes	60 minutes	90 minutes	
GTP	4-5	3-4	3-4	4-5
ATL	4	4-5	4	4-5

From Table 9, GTP maintained its original colour of 4-5 after the first washing cycle (30 minutes), however, it recorded 3-4 each for colour fastness on the grey scale after the second (60 minutes) and third (90 minutes) washing cycles. ATL on the other hand had mean colour fastness of 4 after the first (30 minutes) washing cycle with Azumah blow soap, but maintained its original colour fastness of 4-5 after the second washing cycle (60 minutes) and lost between 0.1 and 1 after the third (90 minutes) washing cycle. According to the GS 124 (2005), a textile fabric passes a colour fastness test when it retains at least 3-4 units on the grey scale after it undergoes a colour fastness test. This implies both GTP and ATL fabrics passed the colour fastness test after undergoing three times washing with Azumah blow soap. The performance of both fabrics on colour fastness when washed with Azumah blow soap may be attributed to the excess stress applied on the fabric during washing. According to Rankine (1850), failure will occur in materials if the stress exceeds the normal strength of the material. The implication is that the fibre properties of the two fabrics such as the thread count and weight were able to pose enough resistance to the abrasive effect of Azumah blow soap to retain the colour.

Testing Significant Difference in Colour Fastness between GTP and ATL Cotton Fabrics after Three Washing Cycles with Key Soap and Azumah Blow Soap

This section assesses significant difference in colour fastness between GTP and ATL cotton fabrics after three washing cycles with key soap and Azumah blow soap. Thus, the section assesses whether the observed differences in colour fastness between GTP and ATL cotton fabrics through the three washing cycles were statistically significant. Table 10 represents a one-way ANOVA of colour fastness between GTP and ATL fabrics after three washing cycles with Key soap and Azumah blow soap.

Table 10: A one-way ANOVA in Colour Fastness between GTP and ATL Fabrics after Three Washing Cycles with Key Soap and Azumah Blow Soap

Soap type	Df	Mean of squares	Eta square	F	p-value
Key soap	8	3108.3	0.776	10.4	0.01*
Azumah blow soap	8	3136.1	0.777	10.5	0.01*

*Significant at p-value of 0.05

Table 10, shows that there was a difference in the mean colour fastness of GTP and ATL cotton fabrics after undergoing three washing cycles with both soaps ($p < 0.05$). This difference is statistically significant. Thus, there is a statistically significant difference between the colour fastness of GTP cotton prints and that of ATL cotton prints when washed with both key soap and Azumah blow for three washing cycles. Consequently, the null hypothesis is rejected. An Eta squared was calculated to assess the effect size of key soap and Azumah blow soap on the two fabrics. The actual difference in mean scores between the groups was 0.776 and 0.777 for key soap and Azumah blow soap respectively, indicating a significant effect Pallant (2005). This implies the both soaps have significant effect on colour lost of both GTP and ATL cotton fabrics when washed.

A comparison of colour fastness on the two fabrics for key soap (standardised) and Azumah blow soap (non-standardised) indicates that Azumah blow soap had a greater negative effect on both fabrics than key soap. This was drawn from the fact that the ATL fabric was able to maintain its original colour through the three washing cycles with key soap, whereas the GTP fabric lost between 0.1 and 1 unit on the grey scale. However with Azumah blow soap ATL fabric lost between 0.1 and 1 unit of colour on the grey scale whilst GTP fabric lost between 1.0 and 1.5 units of colour on the grey scale.

The differences in the effects of the two soaps on the fabrics may be attributed partly to the differences in the chemical composition of the soaps and the differences in the structural attributes of the two fabrics. In other words, meeting the standards of laundry soap helps to ensure certain quality, and as a result, the standardisation of key soap has helped to ensure such quality thus, less reaction with colour. According to Atkins (2003), most small-scale soap manufacturers do not take into consideration the quality and quantity of raw materials needed for the soap preparation. Similarly, such producers do not have any means of checking the quality of their products, which result in undesirable effects such as fading.

The poorer performance of the Azumah blow soap compared to the Key soap with regard to their effect on colourfastness may be attributed to the high alkaline content of the Azumah blow soap. Haghighat and Nouri (1999) and Gong and Chen (1999) reported that colour fastness of printed and dyed cotton textiles may be affected by long contact with strong alkaline solutions. Kretzschmer, Ozguney, Ozcelik and Ozerdem (2007) have also reported that high contents of alkalis in laundry soaps have effect on colour efficiency, and that the total colour difference values become lighter as the laundry cycles increases. Thus, detergents action and mechanical laundry conditions on fabrics during washing are responsible for changes observed in the fastness of fabric colour. The Azumah blow soap had a very high mean total free alkali content of 1.57% compared to the specified maximum of 0.3% and higher percentage solubility in ethanol of 38.5% compared to the 20% maximum (GS 167: 2006) that may cause most fabrics to bleach and hence its negative influence on the performance attributes as well as fabric properties of both GTP and ATL printed cotton fabrics.

Effect of Soap and Duration of Washing Cycles on the Tensile Strength of GTP and ATL Cotton Fabrics

This section considered the structural attributes of the test textile fabrics (ATL and GTP), effect of soaps and duration on the tensile strength and breaking strength of both fabrics, and deformation in the fabrics during the uniaxial test. This was necessary because the performance of any textile structure is dependent on a combination of inherent fibre properties, as well as the geometric arrangement of fibres and the yarns in the fabric. Fabric strength tests are essential to determine the durability performance of fabrics. According to Ozdil, Ozdogan and Oktem (2003), the strength of fabric depends on the thread pack, weave type and fabric weight. The quality and performance of textile materials ensure the quality of textile products and provide a basis of comparison and mutual agreement between buyers and sellers.

Structural and Performance Attributes of the Test Textile Fabrics

The properties of fabrics are critical in determining its ability to withstand a particular strain or stress. Thus, differences in the physical properties of fabrics such as size and number of yarns, and weight may cause differences in the fabric performance during uniaxial test. Accordingly, the study considered the structural attributes of the test fabrics and how their differences are likely to cause differences in their performances. The fibre characteristics considered include the thread count (warp and weft) and weight.

The fabrics were 100% indigo wax cotton prints with a plain weave of 1x1 repeat in both directions. The results of the selected structural and performance attributes of the selected fabrics are presented in Table 11.

From Table 11, the GTP fabric had higher thread count in the warp direction with mean values of 99.4 ± 9.5 SD than the weft 72.4 ± 4.7 SD. Similarly ATL fabric had a higher thread count in the warp with mean 98.8 ± 12.9 SD than the weft 96.4 ± 8.2 SD.

Table 11: Measured Attributes of the Test Fabrics (GTP and ATL)

Attributes	Number of specimens	Mean	Standard deviation
GTP thread count			
Warp	5	99.4	9.5
Weft	5	72.4	4.7
GTP fabric weight (g/m^2)	3	116.5	10.1
ATL thread count			
Warp	5	98.8	12.9
Weft	5	96.4	8.2
ATL fabric weight (g/m2)	3	129.9	7.8

The higher number of thread counts in the warp direction than the weft direction probably explains why the warp direction of fabrics is considered stronger than the weft (Suansamroeng, 1994).

The mean weight (g/m^2) of the GTP fabrics was 116.5 ± 10.1 SD, whilst that of the ATL fabrics was 129.9 ± 7.8 SD. This implies that the ATL fabrics weighed heavier than the GTP fabrics. The differences in the attributes of the two fabrics in terms of the thread counts in warp and weft direction as well as in the weight may cause differences in their performances after undergoing washing (Davis, 2004).

Effect of Soap and Duration of Washing on the Tensile Strength of Fabrics

This section considers the effect of Key soap and Azumah blow soap on the tensile strength of both fabrics after three washing cycles. One of the most important features for the characterisation of fabric quality and fabric performance is tensile properties of fabric strength. According to Davis

(2004), the tensile strength of a fabric is the strength shown by a fibre, yarn, or fabric to resist breaking under pressure. Fabric strength properties may be altered after the application of different finishing treatments such as washing with soap.

Effect of Key Soap (Standardised) on the Tensile Strength of Cotton Fabrics over Three Washing Cycles

The chemical properties of soaps are responsible in part for the observed changes in tensile strength of most textile fabrics (Atkins, 2003) and textile fabrics washed in strong alkali solution for a longer periods had their tensile strength reduced (GS 124: 2005). Table 12 shows the mean strength of GTP and ATL in warp and weft yarn direction over three washing cycles with key soap.

Table 12: Variations in the Effects of Key Soap on Tensile Strength of both GTP and ATL

Fabric type	Yarn direction	Mean tensile strength of fabrics over three washing cycles			Control
		30 minutes	60 minutes	90 minutes	
GTP	Warp	234.2	233	228.6	406.4
	Weft	261.8	224.8	216.8	289
ATL	Warp	364.4	331.6	224.2	500
	Weft	272.8	259.6	130.4	330.8

From Table 12, the original (control) mean strength of GTP in the warp yarn direction was 406.4, whilst that of the weft yarn direction was 289. On the other hand, the original mean strength of the ATL fabrics in the warp direction was 500, whereas that of the weft yarn directions was 330.8. Thus, the mean strength in the warp yarn direction of both fabrics is greater than the weft yarn directions. The implication is that the warp yarns are likely to pose greater resistance during uniaxial testing. The difference in the observed mean strength between the warp and weft yarn directions of the two fabrics after treating them with the soap confirmed the assertion of Cano-Glu et al. (2004) that the warp yarn direction is the stronger part of a fabric.

After the first 30 minutes of washing GTP with key soap, the mean warp strength reduced to 234.2, whilst the mean weft strength reduced to 261.8. The mean warp strength of GTP after 60 minutes washing with Key soap was 233 whereas that of the weft yarn direction was 224.8. The mean warp strength of GTP after 90 minutes of washing with key soap was 228.6 whereas the weft strength was 216.8. The implication is that as the washing duration increases, the tensile strength of GTP in both yarn directions reduces. This agrees with Rankine (1850) that the strength of materials fails or reduces as more and more stress is put on them. Thus, the strength reduces when the stress is greater than the stress holding capacity of the fabric.

Furthermore, the mean warp strength of ATL after 30 minutes of washing with key soap was 364.4, whereas the weft strength was 272.8. The mean warp strength of ATL after 60 minutes of washing with Key soap was 331.6 while the mean weft strength was 259.6. The mean warp strength of ATL after 90 minutes of washing with key soap was 224.2 whereas the mean weft strength was 130.4.

Table 12 further shows that the original mean tensile strength of ATL (500) in the warp yarns was greater than that of GTP (406.4). This could be attributed to the greater weight of the ATL fabrics than the GTP. According to Imayathamizhan and Manokhar (2008), the relation between weight and the tensile strength of a fabric has been found to be highly significant. Hearle and Morton (2008) also stated that the properties of fabrics play a significant role in their performance.

Percentage Loss of Strength in Fabrics as they Undergo Washing

This part of the study considered the percentage loss of strength in the fabrics as they underwent three washing cycles. The percentage loss of strength in fabrics is important to ascertain a clearer picture on the performance of fabrics as they undergo stress test. Figure 4 shows the percentage loss of tensile strength in both fabrics over three washing cycles with key soap.

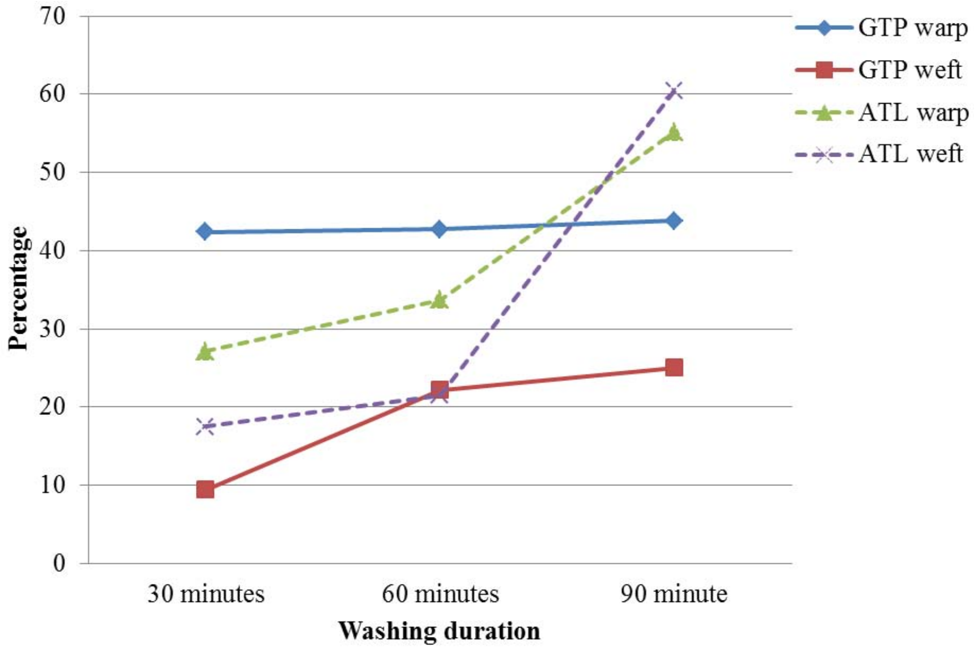

Figure 4. Percentage loss in tensile strength of GTP and ATL fabrics for both warp and weft yarn directions after three washing cycles with Key soap

Figure 4 shows that the warp strength of GTP was reduced by 42.4%, while the warp strength of ATL was reduced by 27.1% after 30 minutes of washing both fabrics with key soap. However, the weft strength of GTP after 30 minutes of washing with key soap reduced by 9.4%, whereas that of ATL reduced by 17.5%. The warp strength of GTP reduced by 42.7% after 60 minutes of washing with key soap, while that of ATL reduced by 33.7%. The weft strength of GTP reduced by 25% after 90 minutes of washing with Key soap, whereas that of ATL reduced by 60.6%. Thus, ATL had the lowest loss in strength in both directions at the second (60 minutes) washing cycle with key soap, but lost the highest strength in both directions at the third (90 minutes) washing cycle with key soap.

Figure 4 further shows that there was a relatively lesser loss of strength in the weft yarns of both fabrics than the warp yarns. This could be attributed to differences in the weave designs of the two fabrics. According to Realff et al. (1997), the weave design of fabrics may have influence on the tensile strength, fineness, number of ends and picks per unit length of fabrics.

Effect of Azumah Blow (Non-standardised) Soap on the Tensile Strength of Cotton Fabrics over Three Washing Cycles

This segment of the study examines the effect of the Azumah blow soap on the tensile strength of cotton fabrics over three washing cycles. Table 13 presents the results.

Table 13 shows that the mean warp tensile strength of ATL and GTP fabrics after 30 minutes of washing with Azumah blow soap was 402.8, whereas the mean weft tensile strength was 279.6. The mean warp tensile strength of GTP after 60 minutes washing with Azumah blow was 402.6, whilst that of the weft was 268.8.

Table 13: Variations in the Effects of Azumah Blow Soap on Tensile Strength of both GTP and ATL Fabrics after Three Washing Cycles

Fabric type	Yarn direction	Mean tensile strength /washing cycles			Control
		30 minutes	60 minutes	90 minutes	
GTP	Warp	402.8	402.6	380.8	406.4
	Weft	279.6	268.8	268.8	289
ATL	Warp	447.2	359.2	347	500
	Weft	260.2	257.8	246.8	330.8

The mean warp tensile strength of ATL after 30 minutes of washing with Azumah blow soap was 447.2, whilst that of the weft was 260.2. The mean warp tensile strength of ATL after 60 minutes of washing with Azumah blow soap was 359.2, whereas that of the weft tensile strength was 257.8.

Thus, the performance of ATL and GTP in both yarn directions during the uniaxial test indicates that the fabrics become weaker or loses much strength when the duration for washing increases. The implication is that there is an inverse relationship between washing duration with Azumah blow soap and the tensile strength in both fabrics. This agrees with the assertion of Rankine (1850) that the strength of materials fails or reduces as more and more stress is put on them.

Percentage Loss of Strength in Fabrics as they Undergo Washing

This part of the study assesses the percentage loss of strength in the two fabrics as they underwent washing. The section aims at giving a pictorial assessment of the performance of the two fabrics. Figure 5 shows the percentage loss of tensile strength in GTP and ATL fabrics over three washing cycles with Azumah blow soap.

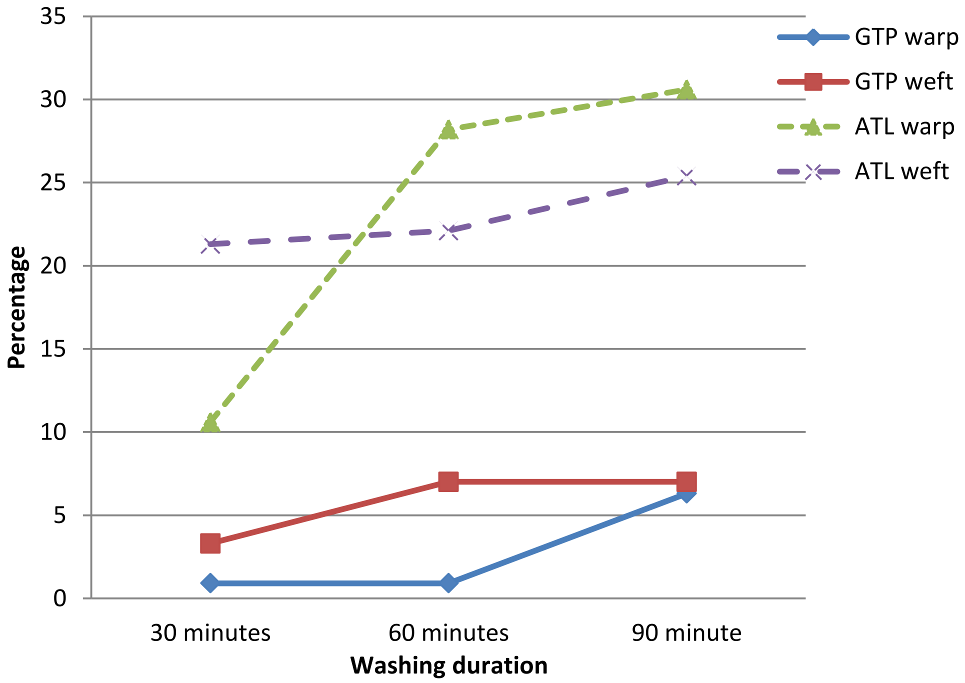

Figure 5. Percentage loss in strength of GTP and ATP fabrics over three washing cycles with Azumah blow soap

From Figure 5, the warp strength of GTP was reduced by 0.9% after 30 minutes of washing with Azumah blow soap, whereas that of ATL reduced by 10.6%. Similarly, the weft tensile strength of GTP reduced by 3.3% after 30 minutes of washing with Azumah blow soap, whilst that of ATL reduced by 21.3%. The warp strength of GTP reduced by 0.9% after 60 minutes of washing with Azumah blow soap, whereas the warp tensile strength of ATL reduced by 28.2%. After 90 minutes of washing both fabrics with Azumah blow soap, the tensile strength of GTP in weft direction reduced by seven percent, while that of ATL reduced by 25.4%. Thus, the loss of tensile strength in the ATL fabrics was higher than that of GTP at all the washing cycles. However in both fabrics, strength in the weft yarns reduced faster than that of the warp yarns after the first washing cycle.

Testing Significance Difference in Tensile Strength between GTP and ATL Cotton Fabrics after Three Washing Cycles with Key Soap and Azumah Blow Soap

This section assesses significance difference in tensile strength between GTP and ATL cotton fabrics after three washing cycle with key soap and Azumah blow soap. Thus, the section assesses whether the observed differences in tensile strength between GTP and ATL cotton fabrics through the three washing cycle were statistically significant. Table 14 presents a one-way Anova in tensile strength between GTP and ATL fabrics after three washing cycles with Key soap and Azumah blow soap.

Table 14: A one-way ANOVA in Tensile Strength between GTP and ATL Fabrics after Three Washing Cycles with Key Soap and Azumah Blow Soap

Soap type	Df	Mean of squares	F	p-value
Key soap (warp)	5	2909.4	0.7	0.58
Key soap (weft)	5	4705.2	3.2	0.2
Azumah blow soap (warp)	5	4705	3.2	0.2
Azumah blow soap (weft)	5	73.4	0.5	0.7

Significant at p-value of 0.05

The results of ANOVA presented in Table 14 shows that there was no significance difference in the change in tensile strength between GTP and ATL at the warp and weft directions after three washing cycles with key soap ($p > 0.05$) therefore the null hypothesis was not rejected.

The non-significance in the differences in tensile strength from both yarn directions between GTP and ATL cotton fabrics over three washing cycles with key soap may be attributed to the standardised nature of the soap.

This result confirmed our initial finding that key soap met all the standards of the GSA specifications for soaps as presented earlier in Table 7. This is consistent with the findings of Henning (1998) that knowledge about the effect of every ingredient on the performance of the final product as well as records or documentation on the procedure and the quantity of each ingredient used in manufacturing is essential in establishing standardisation and for soaps in particular to ensure their performance of textile products.

Similarly, there was no significant difference in the tensile strength at both warp and weft yarn directions for both GTP and ATL after all three washing cycles with Azumah blow soap ($p > 0.05$) allowing the rejection of the null hypothesis.

The study provided enough evidence to conclude that both standardised and non-standardised soaps show no significant effects on printed cotton fabrics particularly with regards to changes in the tensile strength of both yarn directions after three times washing with key soap and Azumah blow soap.

A comparison of the effects of key soap and Azumah blow soap on both fabrics types, however, revealed that Azumah blow had a greater negative effect on both fabrics than key soap after the three washing cycles. Thus, after 30 minutes of washing both fabrics with key soap, the tensile strength of GTP was reduced by 0.9% and 3.3% in warp and weft directions, respectively, whilst with Azumah blow soap, the loses were 42.4% and 9.4% respectively. Similarly, the tensile strength of ATL was reduced by 30.6% and 25.4% in warp and weft directions, respectively after 90 minutes of washing with key soap, whilst the tensile strength was reduced by 55.2% and 60.6% in warp and weft directions respectively after undergoing washing with Azumah blow soap.

The differences may be attributed to the standardised process for preparing key soap and the non-standardised process in preparing the Azumah blow soap. Thus, the Azumah blow soap did not meet most of the recommended chemical standard specifications for laundry soaps whereas key soap met all the specifications. Atkins (2003) concludes that the difference in the manufacturing processes of the soaps is likely to have different effects on cotton fabrics when subject to washing.

The results of this study are consistent with the findings of Fianu et al. (2005). In their work, they found that washing treatments caused added loss in strength of Ghanaian Real wax as their laundered specimens lost more strength than the unlaundered ones irrespective of the after laundry environmental exposure. According to Frey (2008), chemical influence on fabrics are due to oxidising bleaching agents, intensified by the presence of metal irons, such as chromium, copper, iron, alkalis and water. They went on to say that higher washing temperatures (boiling), compound and the macro-molecular linkages of diverse fibre materials provoke chemical reactions which entail a depolymerisation that weakens the fibres. Similarly, Merkel (1991) reported a tensile strength result of samples that were washed 50 times or washed and tumble-dried 50 times and compared to the tensile strength of the unwashed samples. He found out that any change in tensile strength serves as a direct indication of a change in textile structure, implicating a change in durability.

The implication is that tensile strength is an indicator for measuring durability of fabrics. Consequently, the durability of both ATL and GTP fabrics reduced as the tensile strengths reduced over the three washing cycles. This showed that the tensile strength at the end of the three washing cycles is an indication of the durability of the fabrics.

Deformation of GTP and ATL Washed Specimens

Deformation is defined as a change in the form of a material. Chan and Pang (2000) defined deformation in textile fabrics as the change in the geometrical layout of the yarns caused by inner and outer forces such as bending, torching, tension and compression. However, the extent of deformation in textile fabrics is determined by their fibre properties in terms of the type of fibre and thread counts. The present study looked at deformation in terms of fabric breaking at the jaw. According to Chang and Pang, breaking of fabrics at the jaw may either be due to the strength of the fabrics or non-treatment of the edges of the specimens. Figure 6 shows the extent of deformation in both fabrics as they underwent uniaxial testing.

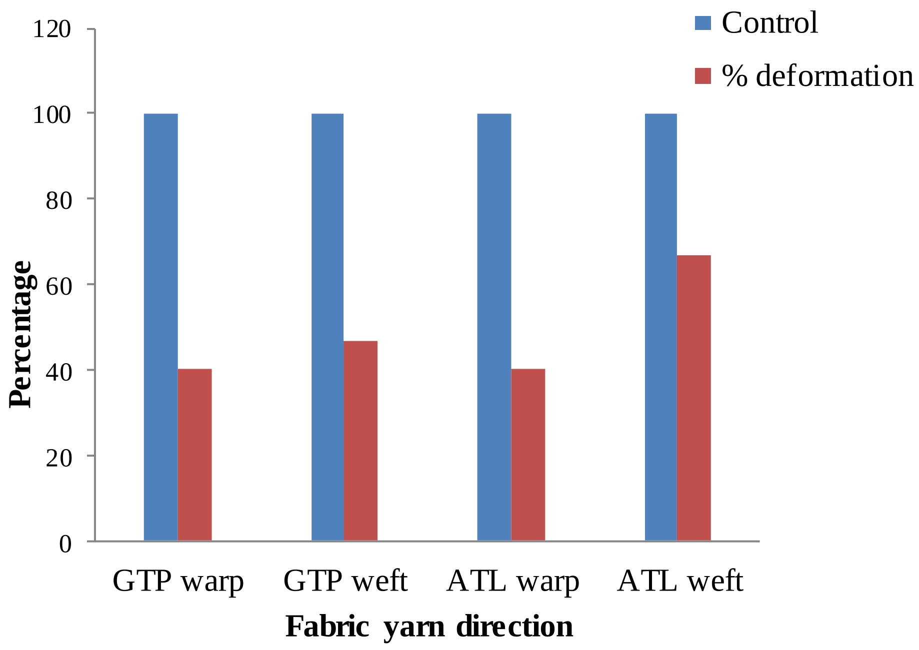

Figure 6. Percentage deformation in both GTP and ATL when washed

From Figure 6, six (40%) of the GTP fabrics that underwent uniaxial testing at the warp direction broke at the jaw, whereas 46.7% that underwent tensile strength testing in the weft direction broke at the jaw. Similarly, six (40%) of the ATL fabrics that underwent strength testing at the warp direction broke at the jaw whereas majority 10 (66.7%) that underwent tensile strength testing in the weft direction broke at the jaw.

Thus, there were more fabrics that break at the jaw in the weft direction than in the warp direction. This could be explained by the relatively more thread counts in the warp direction than in the weft direction. This confirms the submission by Joseph (1988) that the properties of a textile fibre in terms of its thread counts play a significant role in determining its strength. However, there were more fabrics that break at the jaw in ATL than GTP in the weft direction even though there were more thread counts (weft) in ATL than in GTP. This might have being caused by the non-treatment of the edges of the specimens as explained by Chang and Pang (2000).

Eighty percent of fabrics that break at the jaw in ATL fabric in the weft direction occurred during the washing with Azumah blow, whereas 71.4% of fabrics that break at the jaw in GTP in the weft direction occurred during the washing with the same soap. The implication is that the chemical properties of the Azumah blow soap have a stronger devastating impact on the weaker parts of fabrics. Similarly, 66.7% of fabrics break at the jaw in GTP at the warp direction occurred during washing with key soap, whilst 50% of fabrics that break at the jaw in ATL occurred when washing with key soap. This implies that both soaps had similar effect on the warp directions of both fabrics.

Effect of Soap and Duration of Washing Cycles on the Elongation of Cotton Fabrics

The ultimate elongation of a material is the percentage increase in length that occurs before it breaks under tension. According to Fabric Link (2006), fibre elongation (extension at break) is measured at the same time as fibre strength. It is mostly determined by genetic and environmental factors. The fibre properties of a fabric play a major role in the extent of elongation in materials when stress is applied. This segment of the study examines the effect of soap and duration of washing on the elongation of GTP and ATL cotton fabrics. It includes the extent of elongation in both fabrics over three times washing cycles with key soap and Azumah blow soap.

Effect of Key Soap (Standardised) on the Elongation of GTP and ATL Fabrics over Three Washing Cycles

This section of the study assesses the effect of key soap on the elongation at break of GTP and ATL over three washing cycles. This includes elongation in both warp and weft directions of the fabrics and have been tabulated in Table 15.

Table 15: Effects of Key Soap on Elongation of both GTP and ATL Fabrics over Three Washing Cycles

Fabric type	Yarn direction	% Fabric elongation per washing cycles 30 minutes	 60 minutes	 90 minutes
GTP	Warp	16.5	20.9	21.9
	Weft	47.2	54.8	56.3
ATL	Warp	19.5	19.7	20.5
	Weft	69.9	48.5	67.8

From Table 15, elongation in the warp yarns after 30 minutes washing with key soap was 16.5%, while elongation in the weft direction was 47.2%. The mean elongation in the warp direction of GTP was 20.9% after 60 minutes of washing with key soap whereas that of the weft direction was 54.8%. On the other hand, the mean elongation of the ATL fabrics in the warp yarns after 30 minutes of washing with key soap was 19.5%, while the mean elongation in the weft yarns was 69.9%. The mean elongation of the ATL fabrics in the warp yarns after 60 minutes of washing with key soap was 19.7%, whereas that of the weft yarns was 48.5%.

In all the washing cycles, elongation at break in the weft yarns was greater than that of the warp yarns in both fabrics. There was greater mean elongation in the weft yarn direction than the warp yarn direction in both fabrics could be attributed to the higher number of thread count in the warp directions than in the weft directions in both fabrics. In other words, the greater number of thread counts in the warp yarn direction increases its capacity to resist tension stress. This confirms the assertion of Cano-Glu et al. (2004) that the warp yarn direction is the stronger part of a fabric.

In addition, the mean elongation of GTP in both yarn directions was smaller than that of ATL after 30 minutes of washing with key soap. However, the mean elongation of GTP in both yarn directions was greater than that of the ATL fabrics after 60 minutes of washing with key soap. The mean elongation of GTP in the warp direction was greater than that of the ATL after 90 minutes of washing with key soap whereas the mean elongation of the ATL fabrics in the weft yarns was greater than that of the GTP after 90 minutes of washing with key soap.

Effect of Azumah Blow Soap (Non-standardised) on the Elongation of GTP and ATL Fabrics after Three Washing Cycles

This part of the study assesses the effect of Azumah blow soap on the elongation of GTP and ATL over three washing cycles. This includes elongation in both warp and weft yarn directions. Table 16 presents the results.

Table 16: Effects of Azumah Blow Soap on Elongation of GTP and ATL Fabrics after Three Washing Cycles

Fabric type	Yarn direction	% Fabric elongation per washing cycles		
		30 minutes	60 minutes	90 minutes
GTP	Warp	15.6	14.7	15.1
	Weft	47.0	47.5	49.8
ATL	Warp	41.2	40.3	22.9
	Weft	44.9	53.5	60.6

From Table 16, the mean elongation in the GTP fabrics at the warp yarn direction after 30 minutes of washing with Azumah blow soap was 15.6%, whilst that of the weft yarn direction was 47%. The mean elongation in GTP at the warp yarn direction after 60 minutes of washing with Azumah blow soap was 14.7%, whereas the mean elongation in the weft direction was 47.5%. The mean elongation at break of ATL in the warp yarns was 41.2% after 30 minutes of washing with Azumah blow soap, while the mean elongation in the weft yarns was 44.9%. The mean elongation of ATL in the warp yarns was 40.3% after 60 minutes of washing with Azumah blow soap, whereas that of the weft yarns was 53.5%.

The mean elongation in the weft yarns was greater than that of the warp yarns in all the washing cycles and in both fabrics. This agrees with the submission of Cano-Glu et al. (2004) that the weft yarn is the weaker part of a fabric. Furthermore, the mean elongation of GTP in the warp yarn was smaller than that of ATL over the three washing cycles with Azumah blow soap. Apart from the first washing cycle (30 minutes), the mean elongation in the weft yarns of GTP was smaller than the mean elongation in the weft yarns of ATL. The implication is that the yarns in GTP were stronger in terms of resisting elongation strain caused by washing with Azumah blow soap than the yarns in ATL. The greater strength in GTP could be attributed to the higher number of yarn counts in the warp direction of the GTP fabrics than that of the ATL fabrics. Thus, confirming the assertion by Joseph (1988) that the physical properties of fibre play a major role in the performance of fabrics.

Testing Significance Difference in elongation between GTP and ATL Cotton Fabrics after Three Washing Cycles with Key Soap and Azumah Blow Soap

This section of the study assesses significance difference in elongation between GTP and ATL cotton fabrics after three washing cycle with key soap and Azumah blow soap. This was to examine whether the observed differences in elongation between GTP and ATL cotton fabrics through the three washing cycles were statistically significant. Table 17 presents a one-way Anova in elongation between GTP and ATL fabrics after three washing cycles with key soap and Azumah blow soap.

Table 17: A one-way ANOVA in Elongation between GTP and ATL Fabrics after Three Washing Cycles with Key Soap and Azumah Blow Soap

Soap type	Df	Mean of squares	F	P-value
Key soap (warp)	5	5.5	2.6	0.2
Key soap (weft)	5	56	0.5	0.7
Azumah blow soap (warp)	5	53.8	0.2	0.8
Azumah blow soap (weft)	5	42.8	1.6	0.3

Significant at P-value of 0.05

There was no significant difference in the elongation at both warp and weft directions for both GTP and ATL after three washing cycles with Key soap ($p > 0.05$). Since there were no significant differences in elongation at the warp and weft yarn directions between GTP and ATL fabrics, it can be concluded that there is no significant difference in elongation between the two fabrics after going through three washing cycles with Key soap.

Similarly, results were obtained for Azumah blow soap at both warp weft yarn directions indicating that there is no significant difference in elongation of both GTP and ATL after three washing cycles with Azumah blow soap at ($p > 0.05$).

The implication is that the difference in the weft elongation of the two fabrics as measured in the study may be due to chance. It is therefore concluded that there is no significant difference in elongation at break between GTP and ATL fabrics after undergoing three washing cycles when treated with both soaps.

A comparison between the effect of Key soap on elongation at break in both fabrics and that of Azumah blow soap implies that key soap had a greater elongation effect on both fabrics than Azumah blow soap after the three washing cycles. Thus, key soap had a greater elongation effect in both warp and weft yarns of GTP in all the three washing cycles than Azumah blow soap. In addition, key soap relatively had a greater elongation effect on weft yarns of ATL than GTP. On the other hand, Azumah blow soap relatively had a greater elongation effect on the warp yarns of ATL than key soap. The differences in the elongation effect of the two soaps on GTP and ATL could be attributed to the differences in the chemical compositions of the two soaps as well as the differences in the manufacturing processes. Atkins (2003) concluded that the difference in the manufacturing processes of the soaps is likely to have different effects on cotton fabrics when subjected to washing.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents a summary of the entire study, conclusions on the key findings as well as suggests ways to improve the handling, durability and performance of cotton fabrics. The chapter also gives recommendations on the possible ways to reduce the effects of soaps on the performance of printed cotton fabrics.

Summary

Many Ghanaians believe that locally-made soaps have a damaging effect on the strength, colour and elongation of printed fabrics. However, many studies by several researchers have revealed different outcomes with respect to the use of soap on the performance of a fabric. Some of the studies found that the use of salt, potash and Africa black soap for washing clothes increase colour fastness during washing, whereas others indicated that the use of soap for washing causes the colour of prints to run as well as weaken the fibre contents of fabrics. The study therefore examined the effects of key soap which is a standardised locally-manufactured soap and 'Azumah blow', an non-standardised locally-manufactured soap, on the performance (colour fastness, tensile strength and elongation) of ATL and GTP cotton prints during washing.

An experimental study design was chosen for this study to thoroughly examine the variables involved. A two by two by three (2 × 2 × 3) factorial designs was employed for the study. This comprises two brands of locally-manufactured soaps (Key soap and “Azumah blow”), two Ghanaian cotton prints (Akosombo Textiles Limited print and Tex Style Ghana Limited formally Ghana Textiles Print) and three washing cycles.

The three independent variables in this study were two locally-manufactured soaps, two samples of Ghanaian printed fabrics and three washing cycles. A total number of 119 specimens were obtained from a 12 yards Tex Styles Ghana Limited Real wax and Akosombo Textile prints bought for the experiments. The specimens were selected using the simple random sampling methods. Twenty specimens served as control and 27 others were used in testing for weave, fabric strength and elongation at break, fabric weight, thread count and colourfastness. Descriptive statistics were used to describe the chemical composition of the soaps and the structural attributes of the fabrics, whereas Analysis of Variance was used to test for significant differences in the performances of the two fabrics after undergoing three washing cycles with Azumah blow soap and key soap.

Key Findings

1. The result confirms Azumah blow soap as non-standardised soap because it does not meet the standard specification of the Ghana Standards Authority’s specification of good laundry soap but key soap did conform to the standards. This differences were attributed to the differences in the manufacturing processes both soaps.
2. Generally, the study found that there were significant differences in the mean colour fastness between GTP and ATL cotton fabrics after undergoing three times washing cycles with both key and Azumah blow

soaps. Colour loss between both fabrics were highly significant as confirmed by the large eta values of 0.776 and 0.777 recorded for key soap and Azumah blow soaps respectively.

3. Azumah blow soap had a greater effect on the colour fastness of both fabrics than key soap. With key soap, ATL maintained its original colour over the three washing cycles, but GTP lost between 0.1 and 1 unit on the grey scale whilst with Azumah blow soap, ATL lost between 0.1 and 1 unit of colour on the grey scale and GTP lost between 1.0 and 1.5 units of colour on the grey scale. However, both fabrics passed the colour fastness test after undergoing three washing cycles with Azumah blow soap and key soap.
4. There were no significant differences in the tensile strength change between GTP and ATL cotton fabrics over three washing cycles with both soaps. However, Azumah blow had a greater effect on both fabrics than key soap after the three washing cycles. There was greater loss of tensile strength in both fabrics after undergoing washing with Azumah blow soap than key soap. This was attributed to the non-standardised process used in the preparation of Azumah blow soap, which resulted in the negative effect on the color and fabric attributes of GTP and ATL attributable to the high total free alkali level of 1.57% instead of the specified maximum of 0.3% (Table 4) according to GS 167: 2006. Excess quantity of caustic alkali in soap preparation leaves unreacted caustic soda on the soap (Olatunji, 2004). High levels of total free caustic alkali in soap increases the pH of the laundry washes water and has the advantage of increasing washing efficiency because it assists in breaking up oily and acidic soiled

components of fabrics (Anderson, 1999). However, while high pH of laundry water improves cleaning effectiveness, it can also result in fabric discoloration and reduction in fabric tensile strength (Anderson, 1999), as confirmed in this study.

5. There was no significance difference in elongation at break between GTP and ATL fabrics after undergoing three washing cycles with key and Azumah blow soaps. Thus, there were no significance differences between the GTP and ATL cotton fabrics in both warp and weft yarns after washing with both soaps. However, key soap had greater elongation effects on both fabrics than Azumah blow soap.

Conclusions

The study found that both soap types had significant effects on the colour fastness of GTP and ATL cotton fabrics. However, both key soap and Azumah blow soap relatively had less effect on colour fastness in the ATL fabrics than GTP. The difference in the performance of the two fabrics was attributed to the differences in the fabric properties. Similarly, Azumah blow soap had a greater effect on the colour fastness of both fabrics than key soap. This was attributed to the non-compliance of Azumah blow soap with the standard chemical specifications of laundry soap.

There were no significant differences in the tensile strength between GTP and ATL after undergoing three washing cycles with key soap and Azumah blow soap. However, Azumah blow soap had a greater effect on both fabrics than key soap after the three washing cycles. This was attributed to the non-compliance of Azumah blow soap with the standard chemical specifications of laundry soap.

From the study, there were no significant differences in the elongation at break between GTP and ATL after undergoing three washing cycles with key soap and Azumah blow soap. However, key soap had a greater elongation effect on both fabrics than Azumah blow soap after the three washing cycles.

Most Ghanaian printed fabrics tend to depreciate in quality, colour and strength over shorter period of time compared to imported fabrics (Adams, 1994), due to poor laundry care and choice of standard laundry soaps. Most locally manufactured soaps contain chemical characteristics that may damage the many attractive printed Ghanaian cotton fabrics. The choice of quality laundry soap should be considered for laundry to prevent the fast depreciation of overall quality and retain colour and strength of printed cotton fabrics particularly GTP and ATL. Non-standardised soaps such as Azumah blow as identified in this study should be avoided for washing of GTP and ATL fabrics because its chemical constituents are higher than the standards specified by the GS 71 (2006). For example, it had very high mean total free alkali of 1.57% compared to the specified maximum of 0.3% and higher percentage solubility in ethanol of 38.5% compared to the 20% maximum (GS 167: 2006) that may cause most fabrics to bleach and hence its negative influence on the performance attributes as well as fabric properties of both GTP and ATL printed cotton fabrics.

Recommendations

Based on the key findings and conclusions of the study, the following recommendations were made:

1. It is recommended that the Ghana Standards Authority and the Ministry of Trade and Industry should educate the local soap manufacturers on the

effect of each of the ingredients in soap making on the performance (colour fastness, tensile strength and elongation) and durability of fabrics. This will help to minimise the effect of locally manufactured soaps on fabrics and to improve on their durability.

2. The Ghana Standards Authority should ensure that the local soap manufacturers adhere to the standard specifications of laundry soap. This could be done by registering the locally soap manufacturers and occasionally testing their products on the market on how well their products meet the recommended chemical specifications of laundry soaps.
3. Local fabric manufacturers should also improve on the physical properties of their products (in terms of the number of yarn counts, weave count, yarn thickness and weight) to improve their resistance to chemical, mechanical and environmental strains. Thus, improvement in the physical properties of the local fabrics will help to improve their durability and enhance their competiveness with other foreign fabrics.
4. The Ghana Standards Authority should also educate consumers to patronise soaps with the Ghana Standards Authority logo. This will help to reduce patronage of non-standardised soaps and compel soap manufacturers to comply with the standard chemical specifications of laundry soaps. This will also improve the performance and durability of fabrics.
5. The Ghana Standards Authority should make sure both locally produced and imported fabrics meet the colour fastness test. This is to help protect consumers from buying inferior produce and also protect local textile manufacturing companies from unwarranted competition in the market.

Suggestion for Further Studies

Future studies should add the effect of sunshine on the colour fastness, tensile strength and elongation of fabrics when standardised and non-standardised soaps are used in washing. This is because sunshine plays a major role in the treatment and handling of fabrics in Ghana.

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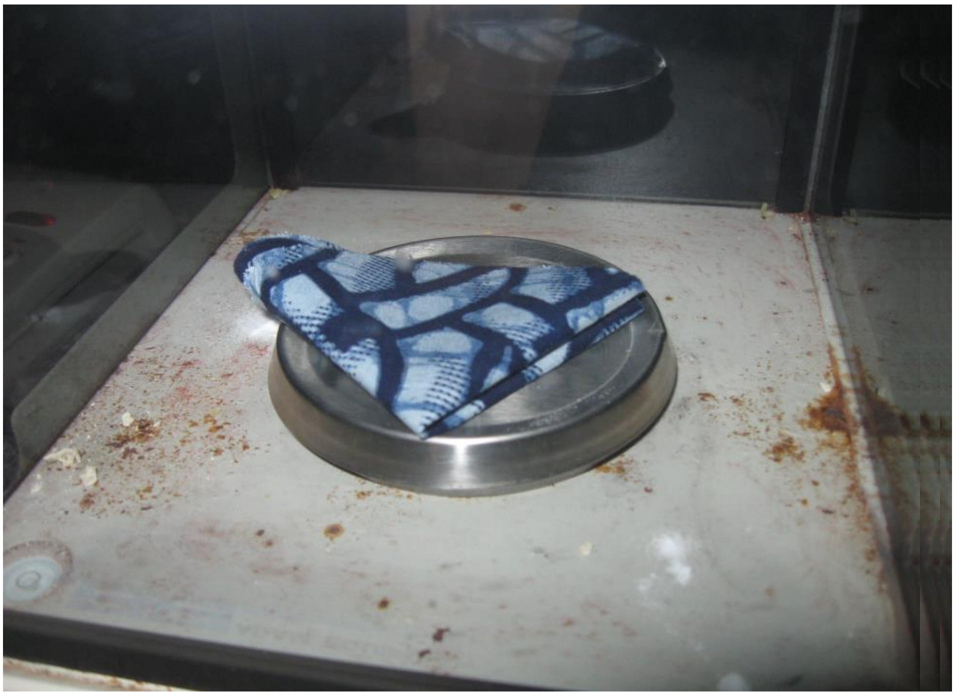
APPENDICES

Appendix A



Weighing balance used for taking the weight of the specimens (Adams equipment)

Appendix B

A.T.L and G.T.P specimens dried on a cloth rack after washing treatments

Appendix C

Calester (cylinders) used for washing of specimens and a measuring jar

Appendix D

Tensile testing machine (Hounsfield H%K-S)

Appendix E

Sample cutter

Appendix F

Magnifying glass

Appendix G

Washing machine (Standard Launder-Ometer, Gyrowash 315)

Appendix H

Key soap (standardisation)

Appendix I

Azumah blow soap (non-standardised)