UNIVERSITY OF CAPE COAST

ANALYSIS OF STRENGTH AND COLOUR FASTNESS OF SMOCK FABRICS FROM SELECTED TRADITIONAL AREAS IN NORTHERN GHANA

SALAM ABUBAKARI

2021

UNIVERSITY OF CAPE COAST

ANALYSIS OF STRENGTH AND COLOUR FASTNESS OF SMOCK FABRICS FROM SELECTED TRADITIONAL AREAS IN NORTHERN GHANA

BY

SALAM ABUBAKARI

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

DECEMBER 2021

DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the 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: Salam Abubakari

Supervisors' Declaration

I 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.

Supervisor's Signature ……………………………… Date …………………

Name: Ms. Irene Ampong

ABSTRACT

The use of smock, primarily a preserve of Northern Ghana ethnic groups, has somehow assumed a national dimension, and even beyond. Considering the high patronage of smock and its other fabric products, it is most important for the consumer to know the basic information about the quality characteristics. The aim of this study is to find out the differences in tensile strength, colour fastness, and dimensional stability among others, that exist among the smock fabrics produced from Yendi, Daboya and Yelwongo all of Northern Ghana. The quasi-experimental research design was adopted and Stratified random sampling technique was used to obtain the sample of 162 for the study. Samples were manipulated to assess the variables under study at the clothing laboratory of Ghana Standard Authority. ANOVA was used to determine the differences between and within groups of the fabrics. It was found out that there existed significant differences in tensile strength and colour fastness, and other fabric characteristics at $p \leq 0.01$ among the categories examined. It can be concluded that the differences in the tensile strength of the smock fabrics will influence the life span of the smocks made from them. Smocks that are made from the fabrics that have poor colour fastness were found to be dyed with weak mordants. Fabrics that have more weight will influence the draping quality of smocks made from them. It is recommended that the ministry of trade and industry together with Ghana Standard Authority should standardise the tensile strength for smock fabric weavers, local producers of yarns should substitute natural dyestuff with synthetic ones or use mordants that can ensure colour sticks to fabrics to be dyed.

KEY WORDS

Colour fastness

Dimensional stability

Smock fabric

Tensile strength

Yarn count

ACKNOWLEDGEMENTS

I would like to extend my profound gratitude to my supervisor, Ms Irene Ampong of the Department of Vocational and Technical Education (VOTEC) for taking time from your busy schedules to read and offer suggestions to put this work in its full state. I also offer my immeasurable appreciation for her support, care and patience in dealing me in my stay in the university and particularly from the beginning to the end of this research work.

I also extend my sincere thanks to Prof. Modesta Gavor of the VOTEC department and her best friend Mrs. Josephine Osie Agyekum, a retired senior lecturer from University of Education, Winneba (UEW) for their words of encouragement and support in the process of undertaking this research. I also owe a gratitude to madam Comfort Kutum Madah of UEW for her motherly care she offered me and many of my friends as well as mates from UEW. I also extend my profound gratitude to Prof. Sarah Darkwa (Dean of Graduate School) for her motherly care and support throughout my stay in the program.

I am also grateful to my wife Sumaya Andani and mother Fati Yahaya for their love, care and prayer for me throughout this period of studies.

Finally, I thank everyone who supported me any form my first day in this institution to date.

DEDICATION

This work is dedicated to my late father, Alhaji Abubakari Amadu for his immense contribution in my upbringing. May the Mercy of Allah be on your soul dad.

TABLE OF CONTENTS

	Page
DECLARATION	ii
ABSTRACT	iii
KEY WORDS	iv
ACKNOWLEDGEMENTS	v
DEDICATION	vi
TABLE OF CONTENTS	vii
LIST OF TABLES	xi
LIST OF FIGURES	xii
CHAPTER ONE: INTRODUCTION	
Background to the Study	1
Statement of the Problem	6
Objectives of the Study	7
Specific Objectives	7
Research Questions	7
Significance of the Study	7
Limitation of the Study	8
Delimitation of the Study	9
Organisation of the Study	9
Definition of Terms	10
CHAPTER TWO: LITERATURE REVIEW	
Theoretical Framework	11
Conceptual Framework	12
Fibre used in the production of Smock Fabric	14

Concept of Yarns	15
Concept of Weaving	15
Planning before Weaving	18
Motions in Weaving	19
Yarn Count of woven Fabrics	20
Fabric Elongation	24
Testing for the Strength of Fabrics	28
Influence of Rate of loading on Breakage	29
Factors Affecting Tensile Strength of Fabrics	29
The Material and its Condition	30
The Arrangement and Dimensions of the Specimen	30
The Nature and Timing of the Test	30
Factors affecting Tensile Testing	31
Specimen Length	33
Rate of Loading and time to Break	34
Dimensional Stability	34
Grammage/Weight	37
Brief History of dyes	37
Early cotton Reactive Dyes	39
The Coloration of Textiles	42
Fabric Production in Daboya	43
Colour Fastness of Fabrics	44
Colour Fastness to Washing	46
Colour Fastness to Crocking/Rubbing	47
Colourfastness to Sunlight	48

Mercury-tungsten Fluorescent Lamp (MBTF) 50

Colourfastness to Perspiration 51

CHAPTER THREE: METHODOLOGY

Research Design 54

Study Area 55

Sample and Sampling Technique 56

Instruments for Data Collection 59

Strength and Elongation 60

Data Collection Procedure 61

Testing for the Tensile Strength and Elongation at Break 61

Method of Data Analysis 64

CHAPTER FOUR: RESULTS AND DISCUSSION

ANOVA Results for Tensile Strength of Smock fabrics 69

Elongation of Smock Fabrics 73

ANOVA results of the Grammage/Weight of Smock Fabrics 79

Colour Fastness to Washing of Smock Fabrics 82

Colour Fastness to Rubbing 85

Colour fastness to Rubbing/Crocking (After second washing) 87

Differences in Dimensional Stability of Smock Fabrics 96

Discussion 98

CHAPTER FIVE: SUMMARY, CONCLUSIONS AND

RECOMMENDATIONS

Summary 106

Key Findings 107

Conclusions 109

Recommendations 110

Suggestions for Further Research 111

REFERENCES 112

APPENDICES 124

APPENDIX A: Input/Output Table 124

APPENDIX B: Sample Smock Fabrics 125

APPENDIX C: Equipment and Processes in Testing Fabrics 127

APPENDIX D: Student's Application Letter to UCCIRB for Ethical Clearance 129

APPENDIX E: Cover Letter from Supervisor to UCCIRB 130

APPENDIX F: HOD'S Introductory Letter of Student to UCCIRB 131

APPENDIX G: Introductory to Ghana Standards Authority 132

APPENDIX H: Consent Form for Weavers of Smock Fabrics 133

LIST OF TABLES

Table		Page
1	Number of Sample Smock Fabrics Examined	57
2	ANOVA Results for Tensile Strength of Smock Fabrics	69
3	Multiple comparison of tensile strengths of Smock fabrics	70
4	One-Way ANOVA analysis of Elongation of Smock Fabrics	74
5	Multiple comparison of the Elongation of smock fabrics	75
6	ANOVA Results of the Grammage/Weight of Smock Fabrics	79
7	Multiple comparison of grammage/weight of smock fabrics	80
8	Colour Fastness to Washing of Smock Fabrics	83
9	Colour Fastness to Rubbing/Crocking	85
10	Colour Fastness of Smock Fabrics to Sunlight	88
11	ANOVA test for Warp and Weft Yarn Count for Smock Fabrics	91
12	Multiple Comparison of Yarn Count among Fabrics	92
13	Correlation between Variables	95
14	Dimensional stability of smock fabrics	96

LIST OF FIGURES

Figure		Page
1	A Conceptual Framework on the Analysis of Smock Fabrics for Performance Qualities	14
2	Differences Mean Tensile Strength of Smock Fabrics	67
3	Elongation among the smock fabrics	73
4	Grammage/Weight of Smock Fabrics	78
5	Yarn count of smock fabrics within groups	90

CHAPTER ONE

INTRODUCTION

Smock wearing in Ghana, though known to be a traditional ethnic costume has become part of cross-cultural fashion among men and women, and has gained international recognition, making it competitive in the textile and fashion industry. According to Abdulai, Adam and Alhassan (2016), there has been a perceived decline in the use of local textile fabrics for importation of ready-made and used clothing. The smock industry however is rather experiencing a rise in patronage and Abdulai et al. (2016) attributed this to its cultural significance. The smock fabrics which are hand woven locally through the use of hand looms form strips which are mostly joined in the process of forming the attire. The fabrics used for smocks are produced in different locations in northern Ghana with each exhibiting peculiar characteristics. The increase in use of smock fabric products makes it imperative for some studies to be done on the different fabric sources to know how each would perform. This study therefore is aimed at finding the differences that exist among the fabrics and the impact of the properties on the end use of the fabrics.

Background to the Study

The use of clothing is an aspect of human life that needs the attention it deserves in our quest for living a decent life. Clothing use has been an important feature in the life of human (Sahoo, 2018) and it reveals the materials and technology available at a point in time. The use of clothing has relationship with the way of life of people in a geographical area. To this, Kwakye-Opong (2011) believes that clothing forms the integral component of a person, a community, a society and the state in which people find themselves and also reflects the past and contemporary way of life. This is evident among all the ethnic groups in Ghana with each having a unique way of adornment during occasions or cultural activities.

Ghana is generally divided into two; the Northern and the Southern blocks. Initially, the Southern block included Greater Accra, Western, Central, Eastern, Ashati, Bono Ahafo and Volta Regions while the Northern block also included Northern, Upper East and Upper West Regions. According to Gyampo (2018) there has been the creation of additional six regions in Ghana, making 16 regions from the original 10 regions. The creation was done by splitting four regions. These included splitting Bono Ahafo into Bono, Ahafo and Bono East Regions, the Western region was also split into Western north and Western, and the Volta into Oti and Volta Regions making up the additional Regions for the Southern block. The Northern Region was also split into three with Savannah and North East Regions adding up to the Northern block. Coincidentally, the two blocks have identical way of dressing peculiar to each block. For instance the people of the Southern block use kente, which is mostly wrapped around the shoulder through to the lower trunk of the body. Akinbileje (2014, :p268) emphasise this statement by commenting that

> *"Men wear kente by wrapping a piece of cloth; on average of 8 feet wide by 12 feet long, around themselves, leaving the right shoulder and hand uncovered, while women wear it wrapped round their body with or without a blouse and in recent times, kente, are sewn into different styles e.g skirts and blouses"*

According to Akinbileje (2014), traditionally, the kente was a reserve for people of certain social standing until this modern era where that status quo has been broken with its use now tied to affordability.

People from the northern block also wear the smock which is in the form of loose circular attire with godets at lower part. It is a traditional attire for most of the ethnic groups in Northern Ghana but has been adopted to become national attire and even gained international recognition. What smock an indigenous northerner wear and how it is worn brings about the identity of the wearer. For instance, when a Dagomba, Gonja or a person from the Upper East Region wears a smock, the peculiar aesthetic outlook of the smock will give an identification to the background of the person. Notwithstanding this, the present generalised use of smock in Ghana has changed the traditional identification of smock users. This is as a result of the fact that majority of people now find it the easiest way to appear gorgeous in public. At the early stage it was also recognised by political leaders, especially when it was worn by Ghana's first president and his team on the day of independence. This influenced the use of the attire by most politician regardless of their ethnic background. The use of smock has now become a new fashion trend among male and female sexes. Smock wearing in Ghana has become an ordinary fashion for people of all walks of life ranging from children, young and older people. The use of smock which was initially reserved for chiefs and opinion leaders and was also worn during festivals and special occasions (Dzramedo & Dabuo, 2015) has now assumed a cross cultural and international gratification especially for Africans living outside the continent. While the design for males has somehow been classic, there have been innovations in styling the female figure as well.

Based on the new trend in the use of smock, there is a high demand for the fabrics, and weavers are cashing in on that by introducing new design patterns that help to bring out the beauty of the cloth making it attractive for smock lovers. The fabrics that are used to make the smock are exclusively hand woven and are made from cotton and are produced from all the northern regions of Ghana (Abdulai et al, 2016). The fabrics for the smock according to Fusheini, Adu-Agyem and Appau (2019), are woven from cotton yarns which were largely produced from fibres cultivated in the Northern regions of Ghana, and come in variety of colours. The indigenous fabrics for the smock are woven from hand-spun yarns. Fusheini et al. again asserted that foreign cotton yarns have now been widely used in the smock fabric industry with few weavers still using the hand-spun yarns in producing the smock fabrics. Synthetic yarns are also used these days to produce the smock fabrics beside the cotton yarns that is originally used (Dzramedo & Dabuo, 2015). The fabric for the smock is mostly woven into strips of about 3.5 to 4 inches in width with unlimited length.

Users of smock mostly chose their smock of their choice only to be faced with issues with colour running, fading, fibre pulling and elongation of parts of the smock. Smock weavers and makers also choose the fabrics based on their own preferences and sometimes on customisation of clients. Nonetheless, the quality of the smock fabric is an issue of concern to smock makers and users of smock. Fabrics used in sewing smocks should exhibit some characteristics that indicate their performance in terms of colourfastness and strength. The understanding of the properties and performance of fabrics gives the smock maker a fair idea on the type of fabric to choose in making a good quality smock for the customers and also inform the consumer the type of smock that is made of good quality fabric. The performance of smock fabrics tends to influence the quality of the smock sewn. For instance, the smock fabric that has a high tensile strength will last longer compared to the one with low tensile strength. Fabric that has been woven with high yarn per square inch ratio is stronger, heavier, has good dimensional stability and has a good godet when sewn into smock than the one that has low yarn per inch ratio. Also, a fabric with good affinity to dyes (colour fast) will be brighter and attractive for a considerable period of time compared to the fabric with poor colourfastness.

Smock fabrics are produced from different traditional areas with their unique characteristics in terms of colour and colour combination, weave, texture, and embroidery designs that are made on the neck and pockets of the sewn smock. These embroideries are mostly done by hand using needle and double layer threads or by the use of embroidery sewing machine.

The origin of the smock fabric weaving has varied narrations in Ghana. One group of narration has it that it originated from a community known as 'Tang' near Karaga who later resettled to Kpatinga near Gushegu in the northern region. Other narration also indicated it was introduced by the Moshie traders who entered into the northern territories for trading expedition and started the craft of weaving the strips of the fabric which were joined together to create wider fabrics used for the smock, making of shroud and covering of nakedness (Amateye, 2009). This craft evolved among the tribes around the northern, and the then Upper Volta. The weaving of the smock fabric also extends to the Volta region of Ghana where quality fabrics are woven with a variation from those woven in the Northern, Upper East/West and Savannah regions. Modern weaving of the smock fabric has more improvement in the aesthetic qualities, texture and the yarns that are used due to technology and modernity.

Statement of the Problem

Fabrics used for smocks are made from different locations in the northern belt of Ghana. Fabrics made from each location have some unique features peculiar to the people. Some of these features include the combination of yarn colours in the weaving of the fabrics and the general aesthetic features of the fabrics in terms of the weave design. In addition, characteristics such as strength and colourfastness of the fabric are things to bear in mind when producing the smock fabrics. Weavers are most often concerned with personal preference and the quantity of fabric to produce neglecting the strength and other quality variables. Some smock users also do not mostly take the strength quality of the fabric into consideration but the attractive nature of the fabric.

Most studies conducted on smocks (Acquaah et al., 2017, Fusheini et al., 2019 & Essel, 2015) have concentrated on the fit, types, cultural significance, historical background and aesthetic appearance of the sewn smock neglecting the colour fastness and strength qualities which determine the performance of the fabrics that are used in making the smocks. This study is aimed at finding out the differences in the characteristics such as colourfastness and strength of the fabrics from Yendi, Daboya and Yelwongo in order to determine how they would perform in the use since performance is the next thing consumers consider after using aesthetic qualities to choose textile products.

Objectives of the Study

General objective

The general objective of this study was to find out the differences that exist in smock fabrics made from different traditional areas in Northern Ghana.

Specific Objectives

The specific objectives of the study were to:

1. Determine the differences in tensile strength of the smock fabrics produced in Yendi, Daboya and Yelwongo.
2. Evaluate the differences in colourfastness of the smock fabrics produced in Yendi, Daboya and Yelwongo.
3. Analyse the performance of the different fabrics based on the results of the tests conducted.

Research Questions

1. Are there difference in tensile strength between the smock fabrics produced in Yendi, Daboya and Yelwongo?
2. What differences exist in colourfastness between smock fabrics produced in Yendi, Daboya and Yelwongo?
3. How will the three smock fabrics perform considering results of their tested properties?

Significance of the Study

The study is aimed at making available data on the characteristics of fabrics for smocks made from the three areas. This data will benefit smock makers to select appropriate fabrics that will be suitable for their customers.

Customers will also be guided by this data to select smocks made from fabrics that will match their desires. Weavers will also be informed on the characteristics of the yarns that they use so that they select yarns that will produce quality smock fabrics for their clients. This study will also benefit importers of yarns to select good quality yarns that will suit the smock industry in Ghana. To shape the smock industry, the Ministry of Trade and Industry in collaboration with the Ghana Standard Authority may depend on the findings of this study to enact laws that will bring about standardisation of smock fabrics in Ghana.

Limitation of the Study

In the process of putting this study together, a number of challenges were met. The study was conducted using three smock fabrics from different production centres in northern Ghana. Due to time constraints and lack of capacity to test wider range of samples they were limited to only three from each of the traditional areas instead of larger sample for each area. This would affect the generalisation of the outcome of the study to all smock fabrics produced and used for smocks. Tensile strength and colour fastness are not the only factors that determine the performance of a fabric therefore findings of this study cannot be used to conclude on the total performance of the samples.

In testing for the tensile strength of the specimen, the study focused on samples at their unwashed stage instead of inclusion of testing at washing intervals to be able to ascertain the strength of the fabrics during the care life of the smocks made from them. This was also largely based on the fact that the smock does not require frequent washing as with other garments, due to its design.

The natural sun light was used to test for the colour fastness of the samples to light. This was as a result of the breakdown of the Xenon Arc machine that is used for that purpose in the laboratory. This affected the outcome of the test since I could not control the degree of exposure of the specimen to the natural sunlight.

Delimitation of the Study

This study was focused on gathering data on smock fabrics from different locations and finding out about their differences and how these differences may affect the performance of smocks made from them. The ethnic groups that produce fabrics for smocks include Dagombas from the Northern Region, Gonjas from the Savannah Region, the Frafra from the Upper East Region, the Wala from Upper West Region, Ewe from the Volta Region and the Moshe tribe. This study was aimed at conducting study on the fabrics made by the Dagombas, Gonjas and that of the Frafra and not fabrics from all the areas mentioned. The study also focused on the fabric characteristics which are colour fastness and tensile strength.

Organisation of the Study

This study consists of five chapters with their content as follows: Chapter one consists of introduction which has background to the study, statement of the problem, objectives of the study, research questions, significance of the study, limitation of the study, delimitation of the study and organisation of the study. Chapter Two covers review of related literature which captures the theoretical and conceptual basis of the study. Empirical review from relevant authorities and scholars are integral part of this chapter. The methodology which is the Chapter three consists of research design, description of instruments for data collection sampling techniques and population. It also deals with research procedures and equipment that were used in data collection and analysis. Chapter four basically presents and discusses the findings while Chapter five is concerned with the summary of the findings from which conclusion are drawn and recommendations made. Areas for further studies are also suggested in this chapter.

Definition of Terms

1. **Smock/fugu:** A loose attire with a godet at the base made by joining strips of hand woven.
2. **Smock fabric:** Long strips of fabrics that are used in making the smock attire.
3. **Smock ware:** Any garment made from the smock fabrics

CHAPTER TWO

LITERATURE REVIEW

The study was conducted to ascertain the performance of three different smock fabrics produced in three traditional areas in the northern part of Ghana by testing their colour fastness and elongation properties. There has been increased patronage of products from this fabric but studies have not focused on the testing of properties that determine their performance. This chapter specifically deals with the theoretical and conceptual review of literature related to the topic under study. It looks at theories and concepts as well as empirical review of studies on properties related to fabric performance.

Theoretical Framework

The taste of fashion consumers keep on changing based on the availability of quality fabric on the market. Smock fabrics have also received their share of varied demands on the type of fabric to choose for smock ware. The selection of fabrics for use in sewing of smock depend on the properties of the fabric. Cotton yarns are the most widely used in making of the smock fabrics even though some weavers use blended yarns as well. The property of a textile material is a characteristic of the material it should possess for it to be used in a preferred purpose satisfactorily (Venkatraman, 2013).

This study is informed by the theory of input-output analysis by Leontief (1986). He described this theory stating that, it is a process of systematically quantifying the relationship between systems. He further stated that, the structure of each sector is represented by a vector that seeks to describe quantitatively the relationship between the inputs it absorbs and the outputs it produces. In the area of fabric production, it is identified that the structural properties of fibres and the constructive details of yarns and fabrics interact with each other to define the overall performance of a textile product. The inputs in this study therefore are the properties of the fabric used in making smock**.** The output would be the resultant performance of each of the fabrics according to their purported characteristics as obtained in the tests to be conducted. According to Duchin (2005), inputs-outputs lends itself to physical qualities measured in physical units. Nin-pratt (2015) described 'inputs' as the resources that are injected into production system to generate a desired result (output). He also described output as the desired results generated as a result of injecting resources (inputs) into a system. According to Masum and Inaba (2018), the input-output analysis brings about forward and backward linkage indicators. The reason for the necessity of such properties is as a result of the fact that, functional apparel products are exposed to different end uses in such a way that apparel products will be concerned with factors inherent in them such as fibres, yarn fineness, warp/weft movement, fabric density, thickness, fabric count. In addition, external properties such as (external environment – exposure to sunlight, wind, moisture, cold weather conditions and the time of use). These factors affect the behaviour of smocks. The input-output analysis theory therefore directs the relationship between the end use properties of the smock fabrics from the various factors which come into play in production and use.

Conceptual Framework

Smock ware has become a major fashion among males and females in Ghana and across the globe since it has now attracted international recognition. The fabrics that are used in the production of the smock products need to be produced to meet certain standards in terms of colour, strength and other characteristics if not substandard fabrics will be used which will affect the quality of the smocks.

In organising a research, it is always the best practise to establish a framework that defines and describes the study's design. Like a blueprint of a building, it offers critical support for the study elements while also clarifying the study's context for readers (Crawford, 2019). The description to conceptual framework as stated above is indifferent from that of this study. This study is guided by the input-output analysis theory of Leontief as described by Willis & Straka (2017) which seeks to systematically quantify the relationship between systems. The structure of each sector is represented by a vector that seeks to describe quantitatively the relationship between the inputs absorbed and the outputs produced.

The concepts to be reviewed in this study are built around obtaining quality smock fabrics. Fabrics are produced from yarns which impact varying characteristics to the fabric and make them perform accordingly. The performance can therefore be analysed by finding out the exact characteristic properties inherent in the structural and morphological makeup of the fabric. These are done by the conduct of laboratory analysis on the specimen fabrics using various machines and devices to reveal the qualities of the fabrics such as tensile strength, colour fastness to washing, rubbing and light; yarn count, dimensional stability and elongation. The results would help predict the performance in the use of the various smock fabrics. This phenomenon is presented diagrammatically in Figure 1.

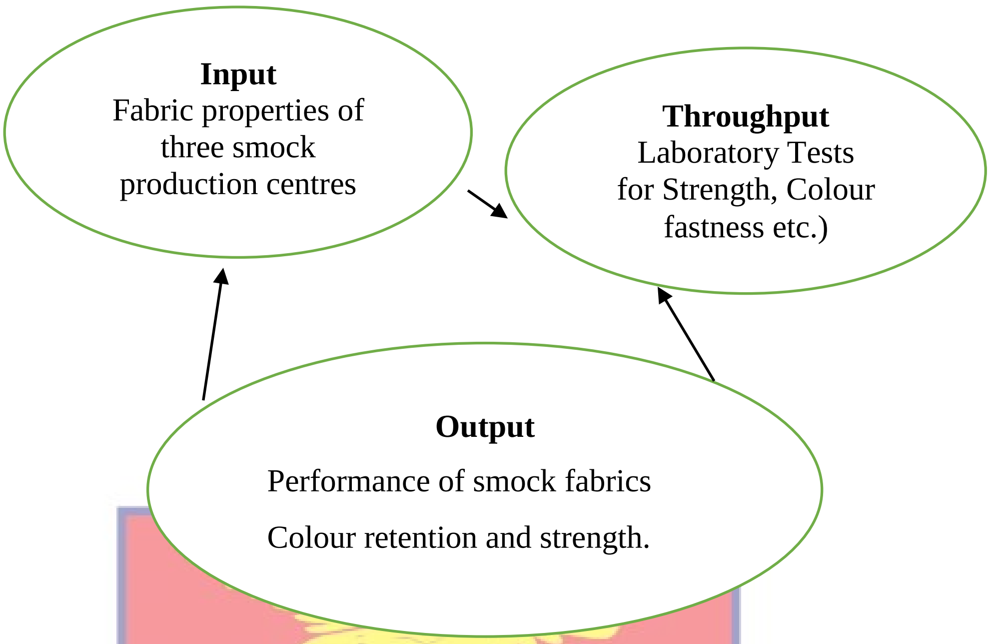


Figure 1: A Conceptual Framework on the Analysis of Smock Fabrics for Performance Qualities

Source: Leontief (1986)

Fibre used in the production of Smock Fabric

Cotton fabric is a natural cellulosic fibre which accounts for about 1/3 of the world fibre needs (Broadbent, 2001). It is a cellulosic fibre because it contains about 90-95% of cellulose. Smock fabrics are made from fabrics that are purely of cotton background (Abdulai et al., 2016). Cotton has unique characteristics that makes it suitable and desired fibre in the production of smock fabrics.

Properties of cotton

Cotton is a natural cellulosic fibre that is obtained from the plant as the sources. It is universally used for most domestic and commercial articles.

Rana, Pichandi, Parveen & Fangueiro (2014) enumerated some of the properties of cotton as:

Tensile Strength: it has medium strength with a fibre tenacity of 3–5 g/d. when cotton is in its wet form, it has a strength of 20% higher compared to when it is in its dry state. This therefore suggest that cotton is stronger when it is wet.

Elongation at break: when fabric doesn't stress easily and has an elongation at break of 5–10 %.

Cotton is a relatively stiff fibre: However, making the fibre wet plasticizes the cellulosic composition, and the fabric is rendered more flexible and soft.

Resi1iency: cotton in its dry or wet form has poor resiliency, and this has caused many manufacturers to develop finishes to enhance its wrinkle recovery properties.

Affinity to water: cotton has high affinity to water based on the hydroxyl groups. Under standard condition, it has a moisture regain of 7%-9% and at a humidity of 100%, cotton has the ability of absorbing up to 25%-30% moisture. This explains why it is good to use cotton in the tropics since it has the ability of absorbing perspiration and this makes it cooler to wear. This also makes it have high affinity to dyes.

Concept of Yarns

Gavor, Ampong and Tetteh-Cofie (2014) defined a yarn as continuous strands of fibres that are put together with aim of producing textile fabrics. They also indicated that yarns could be made by twisting together spun fibres. Cotton yarns are mostly used in the weaving process.

Concept of Weaving

Williams (2009) traced weaving to the stone age where the inspiration of fabric weaving was drawn from the weaving of basket. It is revealed that the first fibre woven was made from the flax plant. Weaving is the interlacing of warp and filling yarns perpendicular to each other (Adanur, 2004). Weaving is the process of fabric production where one or two collection of yarns are interlaced at perpendicular angles (Gavor et al., 2014). Ogulata (2006) also gave definition of weaving by stating that weft yarns are interlaced between warp yarns to form the fabric. It is however noted that the warp yarns are in longitudinal direction while the weft yarns are horizontal or in cross direction. Weaving is the process of placing two or several strands of yarns across each other using the loom (Amissah & Afram, 2018). It is also noted that every weft yarn is isolated from other weft yarns as they are cased by the warp yarns. Ogulata (2006) again indicated that spaces are found between the warp and the weft yarns and that, the volume of spaces found determine some characteristics of the fabric such as comfort, flammability, drape, thermal insulation and other performance characteristics of the fabric.

Weaving is seen as an old method of producing fabrics dating back to thousands of years before Christ. In 4440 BC a loom for weaving fabrics was discovered in a tomb in Egypt (Williams, 2009). This therefore suggests how long the practice of weaving has been with humankind until more complex methods were developed by India and China. The indigenous weaving of the smock fabric is also an age long tradition for most of the ethnic groups in northern Ghana and Volta region. It is believed to have been introduced in the northern part by the Moshes as far as the era of the ancient Ghana (Asmah & Abas, 2016).

Williams (2009) categorised woven fabrics into those made of plain, basket, satin, twill and leno weaves. A visit to some weavers revealed the use of plain weave and basket in the handloom. The type of weave chosen depends on the choice of the weaver. Some weavers use basket weave while others use plain weave depending on the thickness of the yarns.

Some weavers use single yarns for both warp and weft yarns. Others also use two yarns each for the weft yarns while some use three yarns for the weft and two yarns for the warp. Some of the weavers also are also able to give variation to the fabric in terms of the colour of the strips forming the design, thickness and density. In ensuring the intensity of a particular colours, about three to four of such yarns are used for the warp yarn while a single yarn of a different colour is used as weft yarn. This is said to increase the intensity of the warp colours and the resultant fabric also become compact. Vorhof, Weise, Sennewald and Hoffmann (2020) suggested the use of standard heddles in which warp yarn is designed to move at the equal level as the heddle wire using weft direction (y-axis). For this reason, each warp yarn must not be allowed to gain contact with the heddle that lie adjacent to the warp yarn. In ascertaining the nature of weaving of the smock fabrics, Amissah and Afram (2018) compared the kente from Bonweire and the smock fabric from Daboya and indicated that they are each made for occasions such as wedding, funerals, and rituals as well as leisure and informal use.

Weaving in all the areas of fabric source understudy is done using the traditional loom which weave fabrics with a diameter of 3.5 to 4.5 inches and unlimited length. In the Dagomba traditional areas, raw or undyed and imported coloured yarns are used in the weaving of the smock fabrics using the traditional loom. The indigenous fabrics that were initially woven were the 'bin-mangli' which is from the plain or undyed yarns and the 'kpaankobga' which is also a combination of black and white or blue and white yarns. The fabrics that were made from the undyed yarns 'bin-mangli' were usually dyed by applying blue colour which was called 'shim' meaning colourant. With the importation of variety of dyed yarn, weavers now rely on the imported yarns to be able to obtain variation in the designs on the fabrics woven. The application of the colour to the white smocks is not done any longer since variety of colours are available.

In the Gonjaland fabric production, yarns are dyed before they are woven into fabrics. The dyeing is done to obtain variation in yarn colour and within yarns. This gives the fabric from this area unique and outstanding colours in terms of the aesthetic appearance. The yarns undergo series of processing before the final yarn is obtained for weaving. This undoubtedly give fabrics from this type of yarns varied characteristics. The study will however, review the characteristics of the fabrics from this area and that of the other production centres.

Planning before Weaving

Before the weaving is started, the weaver plans the design to use in weaving a piece of fabric. He/she first of all form mental pictures of the design or work with a pre-determined design by merchandisers or individuals. This leads the weaver to select the yarn colours. During the designing of the fabric to be woven, warping and sizing are done. This is where the weaver would have to choose the yarns that will be used as the warp yarns which forms the background of the fabric and also select a colour of yarn that will be used for the weft as well as the number of yarns to be used for either yarns (Amissah & Afram, 2018). The length and width of the fabric will also have to be determined. Also at this stage, the number of yarns to be used for either the warp or the weft yarns will be considered. The number of yarns for the warp sizing determines the width and count as well as the density of the fabric. Also, variety of colours are used for the designing with the weaver choosing the number of colours to be used for each strip of the fabric design. This is where the uniqueness of weavers and the differences in traditional areas are manifested in fabrics woven. Skills are mastered as they are continually used and become a feature of the trade learnt.

Motions in Weaving

Wadje (2009) outlined some basic motions that are used during weaving. These include:

Shedding: This operation involves the separation of warp yarns into double layers. In this process, one of the layers is elevated while the other is made to lie low.

Picking: This technique involves inserting weft yarns through the warp endings and through the shed.

Beat-up: In this step, the yarns that have been put through the warp endings are pushed up to the cloth fall.

Aside from the three primary basic motions in weaving, there are two additional auxiliary motions that are required for continuous weaving and these are referred to as secondary motions.

Take up: In this motion, the fabric is pulled forward after the weft has been beat-up, keeping the pick thickness and distance consistent all through the weaving process, and rolling the woven fabric onto the roller.

This motion allows the warp to detach from the warp beam while weaving and also keeps the warp tensions stable as the weaving is done. It is vital to get certain stop motions on the loom in order to produce a decent grade of fabric and to avoid damage. These are referred to as auxiliary motions.

Warp protector: This motion guards the warp yarns by putting the loom from motion when the shuttle does not reach the selvedge area and box accurately into both the shuttle box at the time of picking.

Warp stop: This auxiliary is aimed at stopping the loom once the warp yarn is broken or when it is loosened beyond normalcy.

Weft stop: In this motion, the loom is stopped if there is a break in the weft yarns or when the weft yarn moves out of place.

These motions of weaving when done well contributes to the desirable qualities of fabrics of the weaver and fabric users as a whole.

Yarn Count of woven Fabrics

Nawab (2017) defined yarn count as a method of showing how fine yarns are with regards to their thickness. Yarn count as described by Williams (2009) is a quantity of yarns or threads that are used for any piece of fabric. This is the quantity of warp yarns as against the quantity of weft yarns. Islam, Chowdhury and Ikter (2018) also defined yarn count as an expression in terms of numerical value that describes the smoothness, roughness, thickness or thinness of yarns. In simple term yarn count is a numerical value that shows the length per unit mass or mass per unit length of yarns in a fabric. Lieber,

Lieber and Lieber (2005) revealed that yarns used in weaving fabrics is measured in square metres or square centimetres.

Almetwally and Salem (2010) studied breaking load as against filling yarn count and twist factor for ring fabric. They found that the correlation between breaking allowance of compact fabric to twist element and filling yarn count was found to be of the second order. The strength of a woven fabric decreases as a performance of yarn count and weft density and as the density of the weft yarns diminishes, they freely dislodge and the fabric structure is altered making the tearing strength weaker (Sarıoğlu & Babaarslan, 2017).

To calculate the warp yarn count, (Islam et al., 2018) used this formula:

$$\text{Warp count (Ne)} = \frac{\text{No of warp yarns x length in cm x 0.0059}}{\text{Warp yarn's weight in gm}}$$

According to Islam et al. (2018), the procedure can be shown by taking a specific quantity of warp yarns out of a fabric with equal length (cm), this should be multiplied to the constant value of (0.0059) which will then be divided by the result and by the weight of warp yarns. Similarly, weft yarn count can be calculated using the same method as the warp yarn count as demonstrated by Islam and the team. Some amount of warp yarns from the fabric having same length (cm), then multiply the value with a constant (0.0059) and then divided the result by the weight of warp yarns. Therefore:

$$\text{Weft yarn count (Ne)} = \frac{\text{No of weft yarns x length in cm x 0.0059}}{\text{Weft yarn's weight in gm,}}$$

The procedure in calculating for the weft yarn count as proved by Islam et al. is same as that of the weft yarn count. This can also be shown by taking a specific quantity of weft yarns out of a fabric with equal length (cm), this should be multiplied with the constant value of (0.0059) which will then be divided by the result and by the weight of weft yarns. In another calculation Nawab (2017) enumerated the yarn count as indirect and direct count systems. He indicated that the indirect count system is used on cotton, worsted wool and linen and that, the finer or thin a yarn is the higher the number in a count and the other way round. Nawab (2017) outlined the indirect method of yarn count measurement mostly carried out on cotton as below.

$$\text{Indirect Count} = \frac{\text{Length in appropriate unit}}{\text{Weight in appropriate unit}}$$

$$Ne = \frac{8.33 \times (\text{yards})}{W\ (\text{grains})}$$

Islam et al. (2018) also explained thread count as a process of measuring the total number of yarns in the weft and warp bearing, within a one inch square of fabric. Ghosh & Mal (2019) also indicated that, to measure the count of a fabric the end/inch and picks/inch is used.

Yarn count of a fabric has been identified to be influenced by certain conditions such as thickness of yarns, number of yarns and many others (Islam et al., 2018). It is outlined by Islam and others that, the finer and the singular the ply yarns, the more the number of yarns within the 1cm square. This therefore suggest that fine fabrics has more yarns in an inch square than coarse fabrics. This, to Islam and the team makes the fabric to be more compact and firmer. On the other hand, thicker yarns lead to the fabric being rough or coarse. Generally, when the yarn count of a fabric is low the fabric is rendered loose (Islam, Chowdhury & Akter, 2018). Islam et al (2018) added that the measurement of the yarn count is done by the use of the Counting glass which magnifies the warp and the weft yarns to enable easy counting.

Almetwally and Salem (2010) found yarn count and twist factor have a substantial impact on breaking load of fabrics made from dense and ring spun yarns. Sarıoğlu and Babaarslan (2017) analysed yarn count ratio and filament fineness and it revealed a significant impact of filament fineness on tensile, static tearing and dynamic tearing properties of fabrics used for denim. In the study dyed and undyed of cotton fabrics, Khin and Yee (2017) did not find difference between the number of yarns in the dyed and undyed cotton.

Weaving with the traditional handloom is a skill that exist among the weavers. Sarıoğlu and Babaarslan (2017) studied the warp and weft yarn counts of denim fabric and their impact on the fabric strength and density. They found yarn counts of fabric to positively influence strength and density on down product tags, yarn count claims are frequently printed. During weaving, the number of yarns used in the loom is counted using square inch or square centimetres. For instance, a yarn count of 190 could mean a weave of 100 warp yarns and 90 weft yarns per square centimetre of inch. In metric system, it could be written as 40 warp yarns and 36 weft yarns per square centimetre. In this equation, the yarn thickness also has role to play.

When the yarns are finer in nature, it contributes to high number of yarns in a square inch (Kaynak & Babaarslan, 2015). When weaving is done, the higher the number of yarns, the better the drapes in the fabric. However, yarn thickness and method of weaving results in some high yarn count fabrics unsuitable for down products while some low yarn count fabrics may be suitable. The nature of the yarns also contributes to the comfort derived from the fabrics. This is revealed when Harpa and Puscasu (2015) indicated that sensational comfort of the garment is influenced by the structural properties of the woven fabric. It is good to bear in mind that in determining the yarn count of a fabric for quality control purposes, two-ply yarns are taken as one yarn (Sarıoğlu & Babaarslan, 2017). Basu et al. (2007) studied the yarn count and tensile strength of textile fabrics and their results revealed higher count being stronger than less count yarns. Aisyah, Paridah, Wahab, Berkalp and Lee (2018) also conducted a study on effect of yarn count on properties of fabrics. They found out that low yarn count increased the pull of yarns and breakage of the fabrics studied.

Fabric Elongation

Elongation is the extension of a sampled fabric, taking into consideration its initial length (Saville, 1999). The distance at which a fabric has the tendency to extend under a specific force is directly proportionate to its actual length, therefore elongation is normally quoted as strain or percentage extension of a fabric. The elongation at the highest force is what is mostly quoted.

The nature of fibre determine the elongation property of the fabrics made from them. This assertion is supported by Yang and Gordon (2016) when they found from their study that the finer and more mature nature of the fibre, the more its elongation property. Esi and Baykal (2020) found significant relationship between fabric elongation tensile strength. Fabric elongation is measured when a load is placed along the longitudinal direction or the cross direction of the fabric (Ghosh & Mal, 2019).

The strength of a fabric is explained using its resistance to 'breaking load' and 'breaking elongation'. Kumpikaitė (2007) did not find difference in the nature of weave and breaking of fabric but the elongation of fabric. This therefore suggest that the type of weave has a great influence on the elongation of the fabric. In the study of seersucker by Matusiak et al. (2019), they found that elongation at break in the weft yarn direction is more than that of the warp yarn direction. In the study of Adomaitiene and Kumpikaite (2011) on elongation of fabrics from different sources, they found out that elongation at break of PES fabrics is not affected by integrated fabric structure factor. This suggests that fabric elongation depend on the fabric origin. Tensile strength test is carried out to find out how the breaking strength and elongation of fabrics occur when the pressure is applied along the warp or weft of the fabric (Ghosh & Mal, 2019).

Tensile strength of fabrics

Tensile properties are among the most important factors in determining how well textile materials perform during use. The prediction of the textile user's perception is based on fabric properties and are essential for producers of fabrics and products (Zhezhova, Jordeva, Golomeova-Longurova, Dimitrijeva-Kuzmanoska & Dimova, 2019). The measurement of tensile strength will not be complete without the use of force. According to Saville (1999) force is a tension that alters a body's condition of rest or of uniform movement in a linier motion. In other words, a force makes a body to start and continue in a motion. The unit of measurement for force is newton (N).

(Matusiak et al., 2019) defined newton considering the extension that take place when force is applied on a kilogram mass unit. A newton is defined as the force which when exerted to a mass unit of a kilogram gives it an acceleration of a metre per second. In testing for strength, the results however need to be measured using units of force instead of units of mass. Force of gravity pulls all objects in the direction of the earth. If a kilogram mass of an object is enabled to free fall in the direction of the earth, it gains an acceleration of about 9.8 m/s2 9 (Saville, 1999).

The resultant is what is mostly regarded as the strength. The tensile strength is concerned with the force needed to break several yarns of fabric simultaneously either on the direction of weft or warp. When the fabric breaks at a certain force, it is inversely proportional to cross-section. The tensile force recorded at the time the fabric burst is referred to as the tensile strength at break tenacity (Baset & Rahman, 2016). Matusiak, Matusiak and Kwiatkowska (2019) indicate that to satisfy the principle of tensile strength, specimen fabrics are held in the clamps of the testing machine and extended in opposite directions until breaking takes place. The force at which a specimen breaks is directly in proportion to its cross-sectional area, for this reason, when comparing how strong different textile products are such as fibres, yarns and fabrics, allowances have to be made for this (Saville, 1999). The tensile force that is recorded during rupture of a test material in other times denoted to be tensile strength at break. This may differ compared to the tensile strength as defined above since the elongation of the sample may continue once the highest tensile force is developed. Matusiak et al. (2019) believe that under all fabric tensile strength tests, the strength in the weft yarn direction is always higher than that of the warp yarn direction. They stated the weft direction is sometimes twice as high force of warp direction. Htike, Kang and Sukigara (2016) studied the tensile strength of cotton fabrics in relation to humidity.

With regards to the properties of fibres and yarn, fabrics that are constructed with the yarns that were investigated in the works of Htike et al. (2016) were used to determine the relationship that existed among yarn and fabric tensile properties. Their aim was to obtain information for using high-twist cotton yarns to construct fabrics from cotton outerwear used during summer with much higher extensibility**.** Hossienali (2012) studied the tensile properties of individual fibre and bundle fibre tenacity. Her study was meant to predict the performance of cotton fibre in bundle, thread and fabric form. Stevenson et al. (2000) also studied the tensile properties of geotextiles and geogrids using the roller-grip testing machine. Barakat and Tawab (2020) studied the effect of material on tensile strength and elongation. The study found that the weft direction yarns had high strength compared to the warp yarns. Wu and Pan (2005) also tested the tensile strength between the grab and strip specimens of the cotton fabric. The study was concluded to be consistent with a model propounded by Pan known as Pan's model.

According to Saville (1999) the British Standard for fabric tensile strength consists of extending a strip of fabric to the point of breakage using an appropriate mechanical method which will have the ability to ensure that the breaking load and its extension are recorded. Zhezhova et al. (2019) revealed that, tensile characteristics of a fabric is among the important factors that determine how good a fabric performs. The sampled fabrics were frayed along the two warp ends with a specified width. This was done to ensure that the yarns have equal length and length and also to contribute to an independent tensile strength. During the test, the level of stretching was regulated to 50 mm/min with the space that was created in-between two clamps holding the specimen was 20mm. To conduct this test, the specimen is exposed to an initial tension of 1% of the possible load for breaking. When that is done, samples that break within 5mm of the clamp is withdrawn as well as those that break at loads lower than the average. The study of (Sarıoğlu & Babaarslan, 2017) found high yarn count to have a greater impact on the strength of the fabrics. Similarly, Sharma, Malu, Bhowan and Chandna (1983) found that the strength of weft of the fabric increases as the number of weft yarns increases.

The strength of a woven textile material is not merely determined by how strong the component yarns are. It includes the variety of different elements such as linear density of yarns, number of twists in an inch, type of twist that is used, nature of the yarns as determined by the twisting mechanism and the bearing of the twist (Ray, 2014).

Testing for the Strength of Fabrics

In testing for the strength of a fabric, the machine has to be capable of testing the sample material in question. Force capacity, velocity, precision and accuracy are the three major parameters (Ray, 2014). The device's force capacity refers to its ability to create sufficient force to break the sample material. To accurately simulate the actual application, the device has to be able to deliver the force rapidly or gradually enough. The device for measuring elongation need to have the ability of measuring the gauge length and applied forces correctly and accurately; for example, a huge machine meant to measure lengthy elongations may not operate with weak material (Kaynak & Babaarslan, 2015).

The steady is regarded as a moving force that has the tendency of causing a break on a fabric or fibre (Morton & Hearle, 2008). This is proved by using a maximum load through experimentation in a tensile test. For a single fibre, its strength is proven by the breaking load. To compare many fibres, the measure of a particular strain at break is applied and this is referred to as tenacity or specific strength. Based on the above, it can be termed as breaking length. For purposes of comparing strengths of area of cross-section, the stress at break may be referred to as ultimate tensile stress. Yang and Gordon (2016) studied the strength of favimat cotton fabrics and their elongation. Their study revealed positive correlation between the Tensor and Favimat tenacity and elongation.

Influence of Rate of loading on Breakage

The breaking load of textile fibre is based on the level of the load that is used. The breaking extension does not rely on the rate of loading carried out (Morton & Hearle, 2008). When load is applied, the duration at which the fabric will break will depend on force applied and the breaking point reached. When the stretching force is increased the time to break also decreases and also when the stretching force is decreased then the breaking time also increases.

Factors Affecting Tensile Strength of Fabrics

The tensile strength of the fabric depend on several factors and these include the material and its condition, the arrangement and dimensions of the specimen, the nature and timing of the test (Morton & Hearle, 2008).

The Material and its Condition

According to Morton & Hearle (2008) the way a fabric behaves depend on how the molecules it composes are arranged. This vary from one fabric to another or one fibre to another in a specific sample given. It may also differ based on the condition a given sample is exposed to. The condition of the fabric may also depend on its previous history which include the processes it has been exposed to, the mechanical processes it has been exposed to, the quantity of moisture present in it and the temperatures it has been exposed to.

The Arrangement and Dimensions of the Specimen

The dimensional size of the fabric also contributes greatly to the test results. All things being equal, the increase in the breaking load of a textile fibre will be proportional to its area of cross-section, and there will also be proportional increase in the elongation with regards to the length (Morton & Hearle, 2008). It is however believed that there is the tendency of weak place in a long fabric than on a short area since the fibre will break at its weakest point. For this reason, the length at which the test started should be stated. Most often, fibres are put to the breaking test, not all of them do break at the same time. This is as a result of the fact that they are not all exposed to the same magnitude of load.

The Nature and Timing of the Test

Elongation of fibre is not only the resultant cause of the load applied but also the duration of the load and past loads that have been exerted on the fibre. Whenever a continuous load is exerted on a fibre, its rapid stretch will continue until it cannot withstand the load exerted then it will end up breaking (Morton & Hearle, 2008). A test with a speed lead to a greater breakage than a slow test speed. For this reason, the experiment will be more influenced by the given time and the form in which the load is carried out. This could be unceasing loading degree, unceasing elongation rate and/or decrease from a load that is high.

Factors affecting Tensile Testing

According to Morton and Hearle (2008), factors affecting tensile testing depend on the Type of testing machine: There are three different methods that are used in conducting tensile tests which concerns the extension of the specimen, each of them is related historically with a specific type of testing device.

1. Constant rate of extension (CRE): this is a type of test where the rate stretching the length of the sample is done uniformly within a specific time with the clamp of tensile machine moving with an insignificant with distance with an aggregate load.
2. Constant rate of traverse (CRT): in this test one the clamps of the tensile strength testing machine moves uniformly while the load is exerted by the other clamp with a significant movement in order to trigger the load measuring mechanism so that the rate of elongation would not be constant. This is based on the level of pulling behaviour of the sample under test. The mechanism for this test is mostly related to the obsolete machines where load is exerted through the swinging a heavy pendulum in a curved motion. The angle at which the pendulum moves through to create breakage is the measure of the load. The device is prepared to record the highest swinging of the pendulum.

3. Constant rate of loading (CRL): In this type of test the level of increase has unvarying load and timing which make to have free elongation process. The elongation here depends on the extension behaviour of the testing piece whenever load is applied.

Most recent testing devices are operated using the principle of the constant rate of extension. In this principle, the clamp is kept in motion by a screw in a rotational basis at a constant speed. The assemblage of device is dependent on its eventual load capability. Machines that are large in nature contain a beam that carry the load cell and are aided by a different screw at each end. However, most of the machines that are made small are meant for low load. They mostly use a single screw and the clamp that is meant for the top part of the specimen is being aided at the end of the cantilever. It is worth noting that any flexure of the device at the highest load, should not reach the probable accuracy of the extended measurement. Without the use of an extensometer in stretching a specimen, the load is measured with a specified intervals of time which end up in making use of accuracy of the crosshead speed for deriving the distance endured.

When accuracy in extension measurement is desired, the extensometer is used. The extensometer is a device that is used to observe the space between two points on the specimen fabric to prevent issues related to slippage of the jaw slip or any other defect in the extension around the jaws. These attachments are most necessary for specimens with low extension, and they are not typically used in most textile applications where the measurement of tensile strength is the primary consideration.

The velocities of deflection motion discovered on tensile strength testing equipment vary from 0.5 to 500mm/min or close to1000mm/min in certain situations. When compared to the speeds found in shock loading applications, these are all found to be comparatively slow travel velocities. In order to attain greater velocities, a very different type of drive, such as the one that found in pendulum testers, must be employed. Load cells within those strength testers are used to quantify the deformation of a stiffer beam, which can be measured by using a strain gauge or a linear displacement transducer, depending on the application. Thus, the system shows minimal shifts in position as the loading intensity increases. In order to achieve high precision in load measurement, the load cell must have a large capacity**.**

Specimen Length

The gauge length is the length of the specimen, which in most fabric tests is equivalent to the difference between inner edges of the jaws (Saville, 1999). Because of the role of weak areas on the failure point, this length has a significant impact on the material's measured strength. When a material is stressed, it always breaks at its weakest spot. As a result, the longer the length of material that is strained, the more likely it is that a weak area will be discovered within the test length. The strength value measured will be that of the weak spot, rather than an average value for the entire length. Consider a material having a consistent strength of I0N but weak patches of 8 N per 100mm along its length. If the segment of each test is only 10mm long, the chances of finding a weak area in that length are one in ten. Ten tests will provide nine results of 10N and one result of 8N, for a total of 9.8 N. If the test length is raised to 50mm, the chance of a weak area in the test increases to five out of ten, resulting in ten tests yielding five 10N and five 8N, for an average strength of 9.0N. If the test length is greater than 100mm, each test will have a weak point, resulting in an average strength of 8.0N.Yang and Gordon (2016) studied the impact of fabric length on its tensile properties. There was a significant influence of fabric length on the tensile properties.

Rate of Loading and time to Break

The measurement of breaking force and the extension of specimen fabric is controlled by the degree of stretching that is applied during the test. The degree of stretching that may be adopted are directed by the highest speed that can be reached tensile strength machine engaged for the test. Most multi tensile strength devices have speed ranges that are controlled, while testers that are operated automatic are done with high speed as a result of the repeated tests on yarns. Most specimens for test exhibit high change in breaking strength with high degree of extension as well as reduction in extension. Some specimens, on the other hand, reach a maximum at speeds lower than the highest measured and subsequently exhibit a minor drop. The more or less viscoelastic nature of textile materials causes changes in strength as rates of stretching increases.

Dimensional Stability

Dimensional stability refers to a textile material being able to withstand conditions that bring about change in its dimensions. A textile material may show signs of shrinking, which might either be a reduction or increase in some of the dimensions, expansion in proportions or dimensions during care practices or repair (Topalbekiroglu & Kaynak, 2008). Many challenges of fabrics are related to the changes in dimensions. A fabric with bad dimensional stability can bring about challenges in fitness, size, visual perception, and end use appropriateness. Apart from the issues related to fitness and appearance, bad stability in dimensions also results in poor density of the fabric and how it drapes. Textile fabrics may be rendered more compressed and rigid when they are left to shrink. Care practices such as washing and dry-cleaning, can influence their outline, dimensions, and other characteristics. Examining for the impact of care practices of garments can help to foretell customer satisfaction and this can be based on to produce care labels and tags which is an important component of garments produced. In the weaving of fabrics, certain amount of tensions are exerted on the yarns especially the vertical or warp yarns. When finishes such as tentering or calendaring are finally applied to such fabrics, the stretch exerted initially may be increased and that may result in temporal setting of the fabric. When this happens, the fabric concerned will be dimensionally unstable.

The fabric is then in a state of dimensional instability. Consequently, when the textile material is totally wetted it will in general return to its more steady measurements which brings about the constriction of the yarns. This impact is generally more noteworthy in the twist heading than in the weft bearing. The dimensional stability of textile material is its capacity to oppose shrinkage or extending. While fibre content has some impact on this property, mathematical variables are critical. One of the main components in dimensional solidness is the level of pressure under which yarns are held during fabric development. Yarns are held tight during weaving, and after expulsion from the loom they unwind. This unwinding is sped up when the textile material is first exposed to dampness. As the yarns unwind, they return to their unique length and arrange nearer, with the goal that texture shrinkage results. Amazingly minimized fabrics with firm yarns and a high fabric or thread count are less likely to measure change than those with free delicate yarns and low thread count. Abu-Rous, Dabolina and Lapkovska (2018) studied the dimensional stability among polyester fabrics and did not find the significant shrinkage the warp and weft directions. Ramzan, Rasheed, Ali, Ahmad, Salman and Afzal (2019) believe that fabrics with good dimensional stability resist shrinkage.

As indicated by Saville (1999), to gauge dimensional stability the textile material is made to dry in an oven at 221 F and estimated in both the vertical (warp) and horizontal (weft) directions to give L1. It is then made to absorb water and measured as it is wet to give the wet loosened up L2. The specimen is again made to dry in the hot chamber and the length wise dimension is taken to give L3. The accompanying qualities for dimensional stability are then determined from these estimations for both twist and weft:

$$\text{Relaxation shrinkage} = \frac{L_1 - L_3}{L_1} \times 100\%$$

$$\text{Hygral expansion} = \frac{L_2 - L_3}{L_3} \times 100\%$$

Higher amounts of reduction in size in a textile material cause size issues in clothing as a result of panels shrinking; seam distortion may emerge during the ironing stage. For fabrics designed to have pleats, a little degree of shrinkage (mostly less than 1%) is needed. In damp environments, a high hygral expansion value might cause the textile material to lose its aesthetic qualities as it expands in size. In these settings, seams can pucker because the thread used restricts how steady the fabric moves during the sewing.

Grammage/Weight

In analysing a gravimetric condition, obtaining the weight is a crucial step. Typically, an electronic balance that has the lowest readability of 0.1 mg is used. Sample management is crucial for ensuring repeatable findings, specifically when weighing textile materials that are hygroscopic nature (Lieber et al., 2005). Continuous warming -temperature lowering-weighing till a steady weight is obtained is the best way to get an exact weighing result for most woven fabrics. The draping quality of garments increases as the weight of the fabric used is high (Gobbi, 2018). The following measures should be considered when weighing is ongoing.

- The balance should be adjusted accurately and kept level as much as possible.
- Vibrations should not be found in the immediate vicinity.
- Weighting of the specimen should be done with no air blowing.
- The laboratory and the specimen must be kept as clean as possible.
- The environment's temperature and relative humidity must be kept in check.

Brief History of dyes

The manufacture of fabrics and how colour is applied to them precedes documented history. Several societies had developed dyeing systems before 3000 BC. These ancient craftsmen processed the available natural fibres – linen, cotton, wool and silk into fabrics, initially by the use of hand, and subsequently using relatively simple devices (Broadbent, 2001). Despite the fact that perfectly ground, coloured minerals emulsified in water have been used in paints over several thousands of years ago, any substance coloured with them washed away quickly. Plant and animal resources were used with water to extract natural dyes, most of the time under conditions that involve fermentation. By soaking the fabric in the aqueous extract and drying it, the fabric was dyed. These dyes only came in a small variety of bland colours, and the dyeing often had poor washing fastness and fade in the sun.

In many manufacturing sectors, colourants are used to give colour to products. These could be plastics, metals, wood, ceramics textile products and many others. Mahapatra (2016) described colourants as substance that could either be in the form of a pigment or dye. A good dye has the ability to be soluble in water or being able to disperse in solvent and can be transferred to the fabric or other materials to be dyed through the process of absorption and exhaustion (Ozougwu & Anyakoha, 2017). Pigments are compounds that are not soluble and are used in paints, printing inks, ceramics and plastics.

Mauveine, according to history, was the pioneer synthetic dye. It is said to have been invented by accident through a search for quinine in the laboratory by William Perkin in 1856 (Mahapatra, 2016). Documentation proved that the colour became popular when Queen Victoria put on a silk attire that was dyed with the mauveine with the colour in an Exhibition of 1862 in London [By kind permission of the Society of Dyers and Colourists]

The first work of Cross and Bevan was possibly the pioneer effort to come up with dye–fibre covalent bond and consequently accomplish dyeings of very high wet-fastness (Rana et al., 2014). The early findings on dyes were aimed at producing a covalently bonded colour on cellulose fibre substrates; the driving force was undoubtedly coming from the very modest wet-fastness properties of colourations produced with direct dyes on cotton and viscose (Lewis, 2011). Substantial early study was also conducted to covalently attach dye chromophores to wool but there was little urgency to market such products since wool fibres could be dyed to reasonably high fastness standards using chrome mordant dyes.

According to Rana et al. (2014), Cross and Bevan conducted initial treatment in 1906 to cotton with benzoyl chloride, nitrated the benzoyl ester, reduced the nitro groups to amines, diazotised the amine residues and coupled them to 2-naphthol, producing an orange colouration that was resistant to very harsh washing conditions (Lewis, 2011). There were six phases in the chemical bonding reaction. When viewed in the context of recent reactive dye application, this method was largely impractical; however, it demonstrated that such covalently bonded colorations can achieve excellent wet-fastness. in it a pendant amino group, to give dyeing of good wet-fastness.

Early cotton Reactive Dyes

Lewis (2011) indicated that Guthrie published a paper in 1952 demonstrating that an alkaline pad-dry-bake process could be used to apply and covalently fix a sulphatoethyloxyphenylazo dye to cotton, resulting in washfast dyeings**.** Some of these dyes were only rendered water soluble by the pendant sulphato group; as a result, the fixation process created a mixture of covalently bonded dye and water-insoluble pigment; the latter was difficult to remove by soaping and was the source of the dyeings' poor rub-fastness properties, especially in deep shades**.** Sulphonate groups were directly attached to the chromophore in some of the dyes. This work is deserving of further attention because it was the first time that successful wash-fast dyeings on cotton fabric were achieved using a preformed water-soluble chromophore with a pendant reactive group. The same researchers discovered that the pendant sulphato group could be substituted with chlorine to produce dyes that would covalently bind to cotton under alkaline pad-bake conditions.

Types of dyes

Acetate rayon dyes: This type of dye according to Mahapatra (2016) acetate rayon dye is developed for cellulose acetate and some synthetic fibres.

Acid dyes: Used for colouring animal fibres through acidified solution (containing sulphuric acid, acetic acid, sodium sulphate, and surfactants) in combination with amphoteric protein.

Azoic dyes: Contain the azo group (formic acid, caustic soda, metallic compounds, and sodium nitrate) especially for application to cotton. The azo dyes are the most common chemical group, accounting for at least 66 percent of all colorants (Mahapatra, 2016). The existence of one or more azo groups, as well as hydroxyl groups, amine, and substituted amine groups as auxochromes, is a distinguishing feature. The fastness of azo dyes varies greatly depending on the structure and environment in which they are used. Azoic colours include yellows, oranges, scarlets, reds, blacks, and purples. There are many of whites, but there are less greens.

Basic dyes: Amino derivatives (acetic acid and softening agents) used mainly for application on paper. The direct dye acts as a mordant for the basic dye and this makes the basic dye to more set on the substrate creating a compound shade (Mahapatra, 2016).

Direct dyes: Azo dyes, and sodium salts, fixing agents, and metallic (chrome and copper) compounds; used generally on cotton and wool, or cotton-silk combinations. Direct dyes are recognised by their affinity for cellulosic fabrics and how soluble they are in water. This therefore suggest that it has the potential to be dyed easily and with some level of fastness, even if not much. In printing practice, the direct dye in a thickened solution is printed on to the fabric and then dried.

Mordant or chrome dyes

Metallic salt or lake formed directly on the fibre by the use of aluminium, chromium, or iron salts that cause precipitation in situ.

Lake or pigment dyes

Form insoluble compounds with aluminium, barium, or chromium on molybdenum salts; the precipitates are ground to form pigments used in paint and inks.

Sulphur dyes

Contain sulphur or are precipitated from sodium sulphide bath. Sulphur dyes are mostly applied to cellulosic fibres for corduroy items, working jeer and men's outer garments (woven and knitted goods) and leisurewear. When applied to rayon rather than cotton, sulphur dyes are more resistant to washing and light and produce a brighter shade. They are crucial in the production of a wide range of shades on a variety of cotton and rayon fabrics, especially on hard, long-lasting shades of fabrics**.** They are mostly applied on low-cost cotton fabrics. Sulphur dyes are fairly cheaper compare to other synthetic dyes. The colours are dull and resistant to strong oxidizing agents, especially sodium.

Vat dyes

Impregnated into fibre under reducing conditions and reoxidis\ed to an insoluble colour. From the statement of Mahapatra (2016) dyes are created in a reactor, passed through filters, made to dry up, and mixed in combination with some additives to gain the finished product. Sulfonation, halogenation, amination, diazotization, and coupling are examples of reactions in the synthesis stage, which are accompanied by separation processes such as distillation, precipitation, and crystallization. To make a dye mixture, organic compounds like naphthalene are reacted with an acid or alkali, as well as an intermediate such as a nitrating or sulfonating compound and a solvent. After that, the dye is isolated from the rest of the mixture and filtered. On completion of the production of the real colour, they are taken through finishing that has to do with making it to dry, smoothening, and standard setting are carried out. These processes are necessary in order to maintain continuous quality in the production process. Vat dyes are considered to be the dyes that are easily applied to cotton, linen, viscose rayon, blends and union (warp and weft of different fibres) fabrics that are mostly cellulosic fibres. They also may be applied to wool, nylon, polyesters, acrylics and modacrylics with the addition of mordant. Vat dyes resist light, acids and alkalies as well as strong oxidizing bleaches that are mostly applied in laundries.

The Coloration of Textiles

The chemical and physical properties of the fibres in fabrics to be coloured affect the dye's chemical composition. Protein, cellulosic, regenerated (based on cellulose or derivatives), and synthetic fibres are the four primary forms of fibres. The dye is dispersed between the two phases of the dyeing process, the solid fibre phase and the aqueous phase, and at the end of the dyeing process, the solution is depleted and the majority of the dye is connected with the fibre. There is immediate contact between the two components once the dye molecules enter the fibre, which prevents the dye molecules from desorbing back into solution.

Fabric Production in Daboya

Daboya is the district capital of the North Gonja District. It is the major place of production of yarns for the Gonja smock fabrics. The yarns for the smock fabrics from this area are normally dyed before they are used to weave the fabrics.

Indigenous colourants and mordants are mostly used for dyeing the yarns in Daboya. The dyeing is done by the use of a local colourant. This is obtained from leaves (gara) that are pounded and mixed with 'kibi' (acid) and water in the dye bath. The yarns to be dyed are immersed in the dye bath depending on how the nature of dyeing desired. Some yarns are folded and tied to get uneven colouring while others are immersed fully without tying in order to obtain even colouration. The yarns are left soaked in the dye bath for a period of between five to six days with periodic turning to ensure proper colouration.

When yarns are immersed in the dye the bath, initial colour to obtain on the yarns that is blue-black. When the yarns are left soaked in the dye bath for an extended period, the blue-black colour turns to black colour. In the Daboya dyeing centre, blue-black and the black colours are the two main colours that are obtained. Variety of colours are tied and soaked in the dye bath to obtain the blue-black and black colours alongside these colours on the same strips of yarns. The yarns are removed and dried when the colour intensity desired is obtained.

Yarns removed from dye bath are later woven into the smock fabrics. The variation of colours on the strips of yarns make smock fabrics from this area to exhibit unique aesthetic qualities and differs from all other fabrics woven in the entire northern sector (Fusheini et al., 2019).

Colour Fastness of Fabrics

Colourfastness is a phrase that is used to describe the level of propensity of a fabric to alter in colour or fade in colour when subjected in a certain manner (Ghosh & Mal, 2019). Kuramoto, Yoshihisa, Yoshihisa & Sato (2017) described colourfastness with regards to change in colour and staining. Colour intensity on fabrics may reduce as a result of the of certain environmental influences such as rubbing, light, seawater, chlorine and water. These are indications that, the colour intensity on fabrics are most likely to change when taking care of them such as washing, dry cleaning, hot pressing and drying.

In the use of fabrics, the colour of some of them fade significantly, while others lose little no colour**.** The colour added to fabrics to increase and enhance their aesthetic appearance but however, there may be discolouration of these fabrics due to certain environmental influences such as rubbing and light (Lan et al., 2014). Certain care practices such as washing, dry cleaning and drying contribute to fading of colours added to fabrics. Textile products that may lose little or no colour due to care practices or environmental factors are said to be colourfast and its reverse is same.

It is noted that fabrics that do not show signs of colour running during washing have good colourfast to washing and those that may show signs of colour running have poor colourfastness to washing. (Khin & Yee, 2017) are of the view that the possibility of colour transmission from one fabric to the other during care such as rubbing against other fabrics or washing signifies poor colourfastness. According to Mahapatra (2016) the fastness properties of some of the dyes can be enhanced by treatment with metallic salts after dye application; normally copper salts enhance fastness to light and chromium salts also increase fastness to washing. Khattak, Rafique, Hussain & Ahmad (2014) revealed that colourfastness are affected by certain factors. These among other things are the chemical and the physical nature of the dye; the chemical composition of the fibre, the structure of the molecules in the dye, the nature of the dye has been bonded to the fibre, the level of the concentration of the dye, the quantity of dye found in the fibre, the type of mordant used. They also include other chemicals found in the bath and the other conditions that are taking place at the time of use.

Having the understanding in testing of fabric and its performance analysis can contribute to efficiency in solving consumer problems (Krishnamoorthi & Jagannathan, 2018). As stated by Kuramoto et al. (2017) Japanese Industrial Standards introduced methods for evaluating colourfastness by using instruments and manual testing for the fact that the instrumental evaluation does not produce the best results unless backed with the manual evaluation. The ability of consumers to accept textiles made manual evaluation time laundering. Smocks made from certain fabrics that are not colourfast may not influence users to select similar colours when buying smock. Colourfastness may differ in terms of sunlight, washing, crocking and perspiration when different fabrics and dyestuff are used (Ozougwu & Anyakoha, 2017).

Colour Fastness to Washing

When coloured fabric does not run while being washed[, then that fabric is said to have an excellent colour fastness to washing, whereas if the fabric bleeds colour, then the fabric is said to have poor colour fastness to washing (Ghosh & Mal, 2019). Colourfastness to washing is a desirable aesthetic quality of fabrics (Atalie, Ashagre & Nalankilli, 2017). In conducting test on colour fastness in washing of fabrics, multi-coloured specimen fabrics are attached to the plain fabric and stitched. To them, the transfer of colour due to washing is assessed using the (ISO 105-C06 2019) in a launderometer where the temperature, detergent and duration of washing are controlled. Khin and Yee (2017) found a fair difference between mordant dyed cotton fabric and non-dyed cotton fabrics in their study. Rashid, Ahmed and Azad (2012) are of the view that when a fabric is colourfast to washing it is an indication that the colour of the fabric is resistant to the action of washing. This characteristic of a fabric is of great importance to fashion consumer. To measure the level of colourfastness of a fabric, the washed fabric sample is displayed in the standard light in the darkroom using the standard grey scales. This scale is labelled from 1 to 5 with 5 being an indication that the fabric has a good colourfastness and 1 also indicating that the fabric has poor colourfastness (Rashid, Ahmed & Azad, 2012). Colourfastness test is used to determine the performance of dyed fabrics using the washing procedure using standard soaps.

Colour Fastness to Crocking/Rubbing

Burkhart (2019) described crockery as the process where colourant is transferred through rubbing. Colourfastness to rubbing is the ability of colour of a fabric to resist transfer of the colour onto other fabrics (Rashid et al., 2012). The fastness to rubbing test is mostly used to evaluate how colour from a dyed fabric is transferred onto other fabrics. This could be done in the dry form or wet form. According to Burkhart (2019), a fabric with poor fastness to this may rub off colour on fabric on wearers. In this method of determining the colourfastness is established by placing fabrics with multicolour and rubbed against each other (Ghosh & Mal, 2019). When this is done, it is believed that a multi-coloured fabric with poor colourfastness will transmit it's colour onto the fabric that is plain and cause stain on it. From the study of Khin & Yee (2017), the colourfastness to crocking of the dyed fabrics revealed a better appearance when in dry state and also showed a fair appearance in wet state of fabric.

However, fabrics that are dyed using pre-mordanting method showed fair appearance if they are subjected to dry crocking. In testing for the crocking colour fastness, Burkhart (2019) indicated that crockmeter with two rubbing fingers are used to rub across the warp and weft grains of the fabric by a rotating lever. The direction of rubbing by the fingers of the crockmeter is influenced by the type of weave used for the fabric. Ghosh and Mal (2019) revealed that two different tests are used when testing colourfastness to crockery, the first one is by the use of dry rubbing fabric and other is the use of wet one rubbing. The difference in both of the rubbed cloths and untreated cloth are compared with the pair of white and grey in the grey scale of colour staining and graded. When the grade is high (5), the fastness is better and when the grade is low (1), the fastness is poor. The staining resulting from the rubbing is verified by the use of the Grey Scale for Staining. The rating of the staining is graded and grade 3 is acceptable for wet rubbing while grade 4 is acceptable for dry rubbing. To determine the colourfastness to perfume using the rubbing method, Krishnamoorthi and Jagannathan (2018) found varied levels of colour transfer onto other fabrics using the corckmeter.

Colourfastness to Sunlight

Fabrics will mostly change a little or more in its colour intensity when exposed to sunlight (Atalie et al., 2017). When this takes place on fabrics it is said to be poor in colourfastness. According to Ghosh and Mal (2019), all dyes that are exposed to light fade. A dye on a fabric is said to be of good lightfast when it absorbs radiation and does not show signs of discolouration or distraction. According to Atalie et al. (2017), the testing for colourfastness can be exhibited by exposing the said fabric to artificial light for a considerable time to reveal the impact of the light on the specimen fabric. Fabric that is poor in colourfastness has more tendency to show signs of fading. Most fashion product users will always want to select fabrics that are colourfast for their outdoor articles.

This therefore calls for producers of fashion products to select fabrics that are colto ourfast to all agents responsible for the deterioration of colour. Colourfastness to washing and sun differs in their level of effect on fabrics. Colour fading on fabrics exposed to light are nonetheless, the most difficult of all the reactions that dyes passes through on fibres (Lawal & Nnadiwa, 2014). Dye absorbs energy in the form of light, which causes some of its molecules not be stable and the dye can react with the materials around it under these conditions. They also observed that with increase in exposure time, cotton fabric decreases in the colourfastness to washing grade. Thiagarajan & Nalankilli (2013) observed that the longer the exposure of fabric to light the progressive the change in colour. Khin and Yee (2017) found a fair difference between mordant dyed cotton fabric and non-mordant dyed ones in their study. For prolonged use of garments without the effects of the sunlight on their fastness in the tropics, most fashion retailers ensure colourfastness to sun test is carried out before they purchase from producers (Burkhart, 2019). When the artificial lighting system is not available, the natural sun is used. In the exposure to the natural sunlight, the fabric is made to get the natural sunlight for a period of 24 hours. The 24 hour exposure to the sunlight is done in a piecemeal on daily basis as and when the sun is bright till the number of hours required is achieved. The samples are then exposed to the standard light and measured with the grey scale to determine the level of colour change as a result of exposing the fabrics to the sun.

The resistance of coloured fabrics to fading while they are exposed to sunlight is measured by colourfastness to sunlight. The producer of the colorant, the person who conducts the dyeing and the person who sells the dye all value the test. Due to various exposure to sunlight during usage, many textile products, such as curtains, upholstery, carpets, awnings, and coatings, need a high level of fading resistance. Many types of clothing, however, need some colourfastness to sunlight since they are exposed to light when on show, especially near the window of the shop. The British Standard permits for sunlight to be used or xenon arc light in the test.

Use of sunlight

To find out how fabric resists to fading under sunlight, pick its piece and expose it to face south (in the northern hemisphere), allowing it to slope at an angle of flat where it is almost the same to the test site latitude (Saville, 1999). The specimen is placed under glass and an avenue is created for ventilation to be provided. In addition to the samples to be tested, eight 'standard blue wool dyeings' are exposed. This technique reveals the real colourfastness to light. However, this method is identified to be slow comparatively.

Xenon arc

The xenon arc is a device that produces a light with high intensity that have a similarity with the brightness of daylight which makes conducting of colourfastness to light to be very fast (Saville, 1999). The lamp of the device produces very high heat. For this reason a filter is placed as a shield between the sample to be tested and the lamp to prevent the effect of the high heat on the specimen fabrics and the temperature is checked. This adds up to the filter of glass to eliminate the ultra-violet rays on the fabric.

Mercury-tungsten Fluorescent Lamp (MBTF)

This is a device that serves as a source of light used to conduct lightfastness test commercially. The intensity of the light it provides is as that of the Xenon arc however results in faster test than sunlight. The bulbs used in this device are less costly and also keep longer than that of the Xenon tester. It is also said to give similar end results as that of the sunlight.

Colourfastness to Perspiration

When perspiration from the body of the wearer touches the garment, it is more likely to discolour if the fabric is not colourfast to perspiration. The perspiration may render the colour on the fabric loose and lead to colour transfer onto other fabrics brought closer to it (Ghosh & Mal, 2019). Perspiration is a complex composition of either acidic or basic based on the nature of the body from which it is coming. Colourfastness to perspiration is tested by using a device known as 'perspirometer'. Specimen fabrics are placed in the middle of two plates aimed at keeping them wet. A specified weight is also kept on the plates to exert some amount of pressure onto the specimen fabrics. Laboratory prepared acidic perspiration solutions (both acidic and basic) is made available and coloured fabric and multi-fibre fabric which are stitched together are moist in the solutions separately. These specimens are placed between two plates of different perspirometers under a constant pressure. The perspirometers are put into a hot chamber and made to dry at a given temperature and time. When the specimen fabrics are removed, they are then compared to ascertain the colour change in the adjacent multi-fibre fabric with the help of grey scales**.** Perspiration leads to smell on the body and clothing. Based on this most people use perfumes on the clothing to tone down the odour from the perspiration. This paved way for Krishnamoorthi and Jagannathan (2018) to conduct a study on colour fastness of textile fabrics to perfume.

Fabric density

The density of fabrics that are woven is one of the strong attributes to the weaving enterprises. Different kinds of methods are used in determining the fabric densities of woven fabrics. Pan, Gao, Gou and Zhu (2015) identified the methods of determining the densities of fabrics as frequency-domain analysis methods and time-domain analysis method. One of the ways of determining the density is the use of magnifying glass to find the quantity of warp and weft yarns in a specified dimension of the fabric. Galih, Putra and Wijayono (2019) also identified one of the methods of finding density as the Fourier transformation analysis method. The peaks that identify the frequency of periodic elements are found in the power spectrum to analyse the density of the fabric (Moussa, Dupont, Steen, and Zeng, 2010). Co-occurrence matrix and grey line-profile as other methods used in the calculation of the density of fabrics. High densities in warp and weft yarns leads to density of the main fabric making it difficult for liquid and dyestuff to penetrate easily (Çay & Atav, 2007).

The density of a fabric is an essential feature that determine how the fabric performs. Fabric density depend on the characteristic of the fabric in terms of its weft and warp linear density, thread density and their contractions (Kim & Kim, 2018). The density of the fabric is expressed in different ways which include the per unit area of a fabric and the fabric weight per unit length. The fabric weight per unit area is expressed as grams/meter square. This therefore led to the formula for finding areal density of a fabric as indicated by (Nawab, 2017) as:

$$Fabric\ GLM = \frac{Fabric\ GSM \times Width\ of\ cloth}{39.37}$$

Where GLM refers to fabric grams per linear metre and GSM is referred to 'fabric size per metre square'

Fabric GLM = GLM (warp) + GLM (weft). The fabric GLM is the summation of the GLM of the warp and the GLM of the weft yarns of the fabric.

(Ghosh & Mal, 2019) indicated that the density of a fabric is the mass/unit area and this can be shown by using Grams/square metre (GSM). The sample fabric is laid on a cutting board and sliced using the GSM cutter. The area of the sample fabric is measured, and the mass of the cut sample is calculated using the electronic balance.

Adanur (2001) believes that when the weft density of a fabric is high, there is no enough space for the various yarn elongation and this makes the fabric not to be more resistance to dynamic tearing forces.

CHAPTER THREE

METHODOLOGY

The study was to analyse the performance characteristics of smock fabrics from Yendi, Daboya and Yelwongo. The strength and colour fastness of fabrics are of utmost importance in the choice of fabrics, and for their use and care. There was therefore the need to conduct tests to find out how these fabrics can maintain their performance characteristics of strength and colour fastness in use and care through manipulation of materials and procedures at the laboratory. This part of the study is concerned with procedures that were employed to ensure the achievement of the aims of the research. These include the research design adopted, population used, sample selected and sampling procedures, instruments employed in obtaining data and the procedure, and finally how the data was managed and analysed.

Research Design

The objectives of this study cannot be achieved without using appropriate design that can offer the needed results. Though there are different research designs that assist researchers to obtain answers to pertinent questions that are of concern, choosing the appropriate one helps get the right answers or results. The experimental design was adopted as the most appropriate as it would assist in manipulating the variables to get the accurate results that would help achieve the purpose of this study. Cohen et al. (2007: p272) explained that, in experimental design, "investigators deliberately control and manipulate the conditions which determine the events in which they are interested, introduce an intervention and measure the difference that it makes"

Walliman (2011) categorised experimental design into true experimental design, quasi-experimental design and ex post facto experimental design. According to him, the true experimental design exposes itself for all variables to be selected at random and tested and matched with the control groups in order for the outcomes to be compared and this can enable data gathered to be relied on to make generalisation. (Cohen et al., 2007) explained that the quasi-experimental designs are used when there is no possibility of selecting variables at random but the control group and the experimental group are matched. In another vain, he explain that if the control group cannot be used, then the parallel are experimented by consistently comparing to one another.

In view of the types of experimental research design, the quasi-experimental design was adopted for this study since control and experimental groups were used without random selection of the groups.

Study Area

Samples of smock fabrics were obtained from three different production areas in the northern part of Ghana which are Northern, Savannah and the Upper East Regions. These include smock fabrics from Yendi, Daboya and Yelwongo respectively which are similar and used in producing same products, they are deemed to have peculiar characteristics that may exhibit different responses under the same conditions they are subjected to. Though they are all located in the northern part of Ghana, these are different ethnic groups with their own cultures and skills which inform the characteristics of the products they produce. Smock fabric production has been an age long industry that has been practiced and perfected over the years by the indigenes.

Smock fabrics produced from Northern (Yendi), Savannah (Daboya) and Upper East (Yelwongo) regions of Ghana are the main subject of study. Though all these areas produce the same type of fabric for use in making smock and other clothing, there are still peculiarities that set each apart. The fabrics are woven from local raw materials but modernisation has brought in its wake the use of some imported yarns.

Materials

To be able to undertake this study, some materials were used. They included smock fabrics that were acquired from three traditional areas in northern Ghana. Standard soap was also used as a material in washing the smock fabrics.

Sample and Sampling Technique

The sample size for the study included three sampled fabric from three weavers identified in each traditional area and one (1) sample was collected from each of the three (3) weavers. This brought the number of sample fabrics from each production centre to be (3) and the total fabrics became nine (9). Out of the total number of the nine (9) sample smock fabrics obtained from the weavers, hundred (171) specimens were generated to be manipulated with. Table 1 shows the samples of the smock fabrics that were manipulated under the headings: tensile strength and elongation, yarn count, colour fastness to washing, colour fastness to rubbing, colour fastness to sun, dimensional stability and weight.

Table 1: Number of Sample Smock Fabrics Examined

Fabric	Ten. St. & Elongation	Yarn count	Colour fastness to washing	Colour fastness to rubbing	Colour fastness to sun	Dim. Stability	Weight	Total
Y1	3	3	3	3	3	1	3	19
Y2	3	3	3	3	3	1	3	19
Y3	3	3	3	3	3	1	3	19
D1	3	3	3	3	3	1	3	19
D2	3	3	3	3	3	1	3	19
D3	3	3	3	3	3	1	3	19
W1	3	3	3	3	3	1	3	19
W2	3	3	3	3	3	1	3	19
W3	3	3	3	3	3	1	3	19
Total								171
Std. Fabric				81				81

To obtain a fair sample for the study, the stratified sampling technique was adopted to ensure homogeneity in the samples of the smock fabrics that were acquired. Cohen, Manion and Morrison (2007) described the stratified sampling method as a process that deals with the division of population into homogenous groups with each group constituting subjects with similar characteristics. Stratified sampling is a simple two-stage procedure that one need to first of all identify the characteristics that are common in the broader population that need to be part of the sample. To get the sample, one need to first split the broader population into homogenous or probably discrete groups. Secondly, within the groups samples can be randomly selected, the size of each group selected may be determined either by the researcher's own judgement or with reference to existing random sample table.

Based on the principle of the stratified sampling technique, the samples for this study were selected by categorising the study areas into strata. For instance smock fabric production is done in most towns in the northern belt of Ghana and for the purpose of the starter, the production areas are identified as Yendi, Salaga, Tamale Gushegu, Zabzugu, Savulegu, Daboya and Yelwongo. For the purpose of convenience, Yendi, Daboya and Yelwongo were selected. These are the indigenous areas where the weaving of the fabrics is done in the North. Weavers were randomly selected for collection of samples of the smock fabrics by the use of systematic random sampling. The strategy used was that, a weaver is selected after the count of two (2) weavers in each area where the samples were taken. In the collection of the sample fabrics for the study, fabrics that have common colours that were identified and selected to match throughout from the areas of production. The first sample fabric has colour combination blue-black and white. The second fabric also had colour combination of red, yellow, white and black while the third fabric had black and white strips. The same colour of fabrics were sought from each location to ensure easy and fair comparisons of the various parameters of the analysis to be carried out on the fabrics.

Instruments for Data Collection

Data collection performs a key role in research report writing and analysis. To achieve this, smock fabric samples were sent to the textile laboratory unit of the Ghana Standard Authority. Some of the instruments that aided the conduct of the examination on the specimen fabrics include:

1. Tinius Olsen tensile strength testing machine: this is an electro-mechanical device which is used to test the tensile strength and elongation of textile fabrics and other polymer materials.
2. A pair of scissors: this is used to cut fabrics in the laboratory
3. Electronic scale: this is used to measure the grammage of textile fabrics and other substances.
4. Gyrowash machine/standard launder-meter: this is an electro-mechanical device that has chamber and used to wash specimen fabrics in the laboratory.
5. Crockmaster: This is a device that has a handle with a glass finger that is used to examine colourfastness on textile fabrics in the laboratory.
6. Grey scale: is a group of shades without any visible colour. It is used to determine the amount of colour change on fabrics or indicate the amount of light, ranging from the weakest amount of light, or black, to the strongest amount of light, or white.

7. Standard light device: This is a device that process light of varied brightness and it helps in reading or comparing colour of fabrics and objects using the grey scale.
8. Sun colourfastness tester: This is an electrical device that produces light that is used in place of sun light to determine colourfastness to sun on fabrics.
9. Input-output analysis table: It is a table that is constructed to record the results of the experiments that will be conducted on the sample smock fabrics in the laboratory.

Preparation of Specimen smock fabrics

The specimen fabrics obtained for the study were taken through certain preparations to get them ready for the analysis under each of the parameters sought for the study. These included the following:

Strength and Elongation

The sample fabrics for this parameter were cut **into** 16cm by 5cm. The selvedge of the fabrics were cut off to assess the strength of the fabrics at clamping.

Yarn Count per 1cm^2

The specimen fabrics were cut into 3cm x 3cm and the warp and weft directions were frayed to expose the yarns for the count to be effectively done after they were cut.

Mass per unit area of Fabric

The specimen fabrics were measured and cut into 8cm x 6cm dimensions for the analysis to be carried out on them as demanded by the study.

Colourfastness to washing, sunlight and water

The sample smock fabrics were cut into the dimension of 7.5cm X 10cm. The actual width of the smock fabric is 7.5cm so the length was measured to 10cm. The samples were then used for the washing for the analysis.

Colourfastness to rubbing/crocking

For the specimen fabrics for the colourfastness to rubbing/crocking, the fabrics were cut into 25.5cm length for the procedure of rubbing with the finger of the crockmaster.

Data Collection Procedure

Data collection is one of the cogent steps in research report writing that need to be done with much commitment. To collect data for this study, in introductory letter was obtained from the Department of Vocational and Technology Education Department of the University of Cape Coast to facilitate the collection of specimen smock fabrics from weavers in Yendi, Daboya and Yelwongo of the Northern, Savannah and Upper East regions respectively. An introductory letter was also sent to the Ghana Standard Authority where the experiment on the specimen smock fabrics was conducted. The specimens obtained were going to be sent to the laboratory to be examined based on their colourfastness, density, elongation and yarn count. The results from this were recorded in the input-output analysis table for further manipulation of the data.

Testing for the Tensile Strength and Elongation at Break

To test for this parameter, the tensile strength testing machine was used. The length of fabrics used for the test was 160mm with the clapping distance between the two warp endings being 100mm. Thirty (30) mm allowance was left at each warp ending to ensure stiff gripping of clamps. The device has two handles that are positioned up and down with the clamps (handles) facing each other in opposite directions. Knobs to the clamps are tightened to grip the fabrics firmly in order to prevent slipping from the clamps. The device is controlled by computer application that initiate the device to put the clamps in motions in opposite direction causing the elongation and break to take place. All the specimen fabrics were taken through these activities to obtain the results. To obtain data on the tensile strength and elongation at break for the weft endings, the specimens were cut into 50mm x 50mm. This was due to the short nature of the width of the fabrics.

Testing for yarn count

To test for the yarn count of the specimen fabrics, the warp and weft yarn endings were frayed. A diameter of 1cm was measured within the frayed area and cut off using a pair of scissors. The cut yarns were then counted to obtain the number of yarns in the 1cm square area. This was done to both the warp and weft endings of the specimen fabrics.

Testing for the mass per unit area of the Fabrics (Grammage/Weight)

To get the grammage of the specimen fabrics, all the fabrics were measured and cut into 8cm x 6cm dimeter. They were placed on the weighing tray of the electronic scale to obtain their mass per unit area.

Testing for colourfastness

To test for colourfastness to washing, the specimen fabrics were cut into 7.5 x 10 cm. multi-fibre fabric was cut and stapled alongside the specimen fabrics. Four grams (4g) bicarbonate of soda and 10g of standard test soap were dissolved in warm water and mixed in water to obtain 4000ml of standard soap solution. The Gyrowash machine was already filled with water in its reservoir. The machine was made to pre-heat at a temperature of sixty degrees Celsius (60^{o}C) to get it ready for the wash. The specimen fabrics were put into stainless steel containers and filled with the standard soap solution. The containers were fixed into their sockets in the reservoir of the machine and the machine was timed to spin for 30 minutes for the washing to be done. After the 30 minutes washing of the specimen fabrics, they were rinsed under splashing water. The multi-fibre fabrics were detached from the specimen fabrics and they were allowed to dry at room temperature for a standard period of twelve (12) hours.

In determining the colour change in the washed fabrics, the specimen fabrics were exposed to standard light. At this stage, the grey scales were used to read out the colour change on the specimen fabrics as well as the level of staining the specimen fabrics caused on the multi-fibre fabrics.

Testing for colourfastness to rubbing/crocking

Each specimen of the smock fabrics for this variable were cut into a length of 25.5cm. Standard white fabrics were also cut into 6cm^2 and tied round the glass finger of the crockmaster. The specimen fabrics were placed on the bedplate of the crockmaster. The arm of the device was lowered and the finger covered with the standard fabric was made to sit directly on the specimen fabric and the arm was put into motion making the glass finger to rub the standard fabric on the surface of the specimen fabric. This leaves a stain of the colour of the specimen fabric on the standard if it is poor in colourfastness to rubbing. This activity was carried out in two folds. The first rubbing was done with dry standard fabric while the second one was done with a wet standard fabric. Two specimen fabrics were obtained for each of the categories of the specimen smock fabrics.

Coding of specimen

The results generated from the laboratory from the specimen were tabulated with specimen codes written alongside for identification purpose. The specimen were codded by using the initials of the towns from which they are made. These include **Y**endi for 'Y', **D**aboya for 'D' and Yel**w**ongo for 'W'. Numbers were attached to the initials to distinguish fabrics within the groups. For instance, Y had three different fabrics so they were labelled Y1, Y2 and Y3 and the same was done to the other two groups. A table was constructed to represent each of the variables under study (colourfastness to washing, colour fastness to rubbing, colour fastness to sunlight, tensile strength, elongation, yarn count, dimensional stability per square inch). The coding of the samples were tabulated in a table.

Method of Data Analysis

The study being experimental research made use of an analysis that brought out the differences in the results of the data from the various sources of the smock fabrics and their corresponding variables such as the colour fastness, density, elongation and fibre count characteristics of each of the specimen fabrics. The fabrics for each category were tested in three (3) replicates and mean for each replicate were worked to obtain the data for the study. The data of experiment was entered into SPSS version 22 and analysed using Analysis of Variance (ANOVA) at 5% level of significance ($p \leq 0.05$) to verify which mean of the sampled fabrics gives better performance across the measured parameters. Each of these characteristics from the various sources was cross-matched to verify how different they were in those characteristics being measured to each other. The result of experiment was entered into the input/output tables to discuss the differences. The data statistics were analysed and interpreted in line with the objectives and research questions of the study.

CHAPTER FOUR

RESULTS AND DISCUSSION

This study is sought to find out the differences in tensile strength and colourfastness, smock fabrics produced from some parts of Northern, Savannah and Upper East regions of Ghana. The research design adopted for the study was quasi-experimental design which sought to manipulate specimen smock fabrics in order to obtain the results. Data for this study was obtained by testing the specimen fabrics in the textiles laboratory of the Ghana Standards Authority which was subsequently imputed into the SPSS to be manipulated. The data was statistically analysed using the ANOVA and correlation in order to be able to obtain differences between the specimen smock fabrics and the relationship between the results generated.

This section of the study is concerned with the analysis and discussion of the results based on research questions.

Research question one: what are the differences in tensile strength of smock fabrics from Yendi, Damongo and Yelwongo?

Differences in Mean tensile strength of smock fabrics

Figure 2 displays data on the tensile strength of smock fabrics under study. The fabrics were tested in three folds for each entry. The tensile strength test was conducted on the warp and weft directions of the various specimen fabrics. According to ISO 139 specimen samples of fabrics are expected to be conditioned before testing is done. These tests were conducted by the guidance of standard state of 20±2ºC and 65±4% of humidity. The properties of tensile strength and elongation are determined in accordance with

GS ISO 13934-1 standards in the determination of highest force and elongation by the use of the strip method.

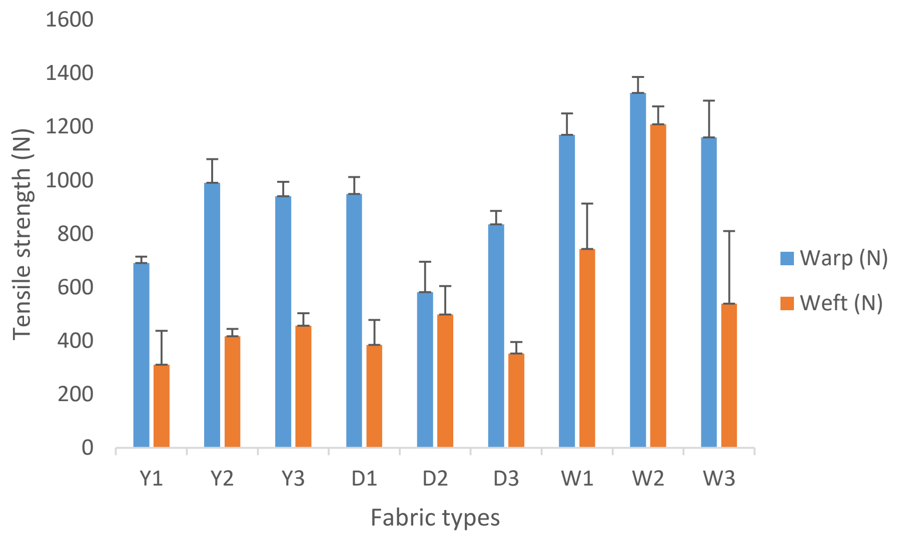


Figure 2: Differences Mean Tensile Strength of Smock Fabrics

From Figure 2, it can be realised that the fabrics from the 'W' group had the highest mean warp tensile strength of W2 (1326.67), W1 (1170) and W1 (1160) respectively. The highest being W2 (1326.67) and W3 (1160) being the smock fabric with the lowest warp tensile strength within the group. In the weft direction, W2(1210) was found to be the fabric with the highest weft yarn mean tensile strength and the fabric with least mean tensile strength being turned out to be W1 (539.33) within this group. This suggests that W1 (539.33) will not produce a strong smock fabric compared with the rest of the fabrics within the group.

In comparing the tensile strength of the Y group of fabrics, it can be found out that Y2(990.33) had the highest mean tensile strength while Y1(690.33) had the lowest mean warp tensile strength within the group.

In comparing the weft tensile strength of the Y group of fabrics, it was found out that Y3(456.33) had the highest warp mean tensile strength while Y1(310.67) had the lowest within the group. This group of smock fabrics also had variation in tensile strength of the fabrics. The highest in the warp direction was Y2 (990.33) while Y3 (456.33) appears to be the fabric with the highest weft mean tensile strength within the group.

In comparing the D group of fabrics, it was realised that D1 (948.67) had the highest warp mean tensile strength within the group with D2 (581) being the fabric with the least warp tensile strength in the group. In the weft direction of tensile strength, D2 (498) had the highest mean tensile strength while D3 (352.33) emerged to be the fabric with the least weft tensile strength within the group. This group of fabrics also demonstrated a variation in the tensile strength of the fabrics. This is observed when D2 (581) with the least warp mean tensile strength turned out to be the fabric with highest weft mean tensile strength D2 (498).

From Figure 2, it can be realised that the tensile strength of the warp yarns of all the fabrics are more and sometimes as twice of the weft yarns. For instance, Y1 (690.3) had a mean tensile strength in the warp yarns and Y1(310.67) on the weft yarns. This is an indication that the tensile strength of that smock fabric on the warp yarns is more than that of the weft yarns. In addition, the tensile strength of the warp of the W fabrics is also greater than their weft even though the yarn count of the W fabrics are more than the weft count. From the analysis, it can be realised that the tensile strength of each of the fabrics under study are not the same. This called for the running of

ANOVA to ascertain the significant differences in the tensile strength of the specimen smock fabrics.

ANOVA Results for Tensile Strength of Smock fabrics

Table 2 is an ANOVA table that seeks to find out whether there is significant differences between the smock fabrics that are under study in terms of their tensile strength.

Table 2: ANOVA Results for Tensile Strength of Smock Fabrics

Fabric strength	Groups	Sum of squares	df	Mean Square	F	Sig
Warp	Between Groups	1355058.963	8	169382.370	25.209	.000
	Within Groups	120945.333	18	6719.185		
	Total	1476004.296	26			
Weft	Between Groups	1877855.185	8	234731.898	14.284	.000
	.'Within Groups	295803.333	18	16433.519		
	Total	2173658.519	26			

Source: Field survey (2021)

To compare the significant mean differences in the tensile strength among the smock fabrics, a one-way ANOVA analysis was conducted using SPSS Version 22. In Table 2, the outcome of the ANOVA indicated that there was a significant difference ($p<0.05$, df= 8,18, F = 25.2) between the warp strength and ($p<0.05$, df= 8,18, F = 14.21) weft strength among the various fabrics under study. Based on the presence of significant differences in tensile strength among the fabrics, a post-hoc analysis test was undertaken using Tukey Honesty Significant Difference (Tukey HSD). The multiple comparison in Table 3 is the output of the test statistics of the post-hock test.

Post-hock analysis of the tensile strength of smock fabrics

Table 3 is a post-hock test that is aimed at finding out the significant level of the tensile strength among the various fabrics under study. The level of significance in the difference is 0.05.

Table 3: Multiple comparison of tensile strengths of Smock fabrics

Warp Fabric	Mean Diff.	sig. ($p \leq 0.05$)	Weft Fabric	Mean Diff.	sig. ($p \leq 0.05$)
Y1-Y2	-300.000	.007	Y1-Y2	-106.000	.980
Y1-Y3	-250.667	.031	Y1-Y3	-145.667	.887
Y2-Y3	49.333	.997	Y2-Y3	39.667	1.000
Y1-D1	258.333	.025	Y1-D1	-73.333	.998
Y1-D2	109.000	.778	Y1-D2	-187.333	.688
Y1-D3	-144.667	.467	Y1-D3	-41.667	1.000
Y2-D1	41.667	.999	Y2-D1	32.667	1.000
Y2-D2	409.000	.000	Y2-D2	81.0000	.996
Y2-D3	155.333	.380	Y2-D3	64.000	.999
Y3-D1	-7.667	1.000	Y3-D1	-72.333	.999
Y3-D2	359.667	.001	Y3-D2	-41.677	1.000
Y3-D3	106.000	.801	Y3-D3	104.000	.982
Y1-W1	-479.667	.000	Y1-W1	-228.667	.453
Y1-W2	-636.333	.000	Y1-W2	-899.333	.000
Y1-W3	-469.667	.000	Y1-W3	-432.333	.014
Y2-W1	-179.667	.220	Y2-W1	-122.667	.953
Y2-W2	-336.333	.002	Y2-W2	-793.333	.000
Y2-W3	-169.667	.297	Y2-W3	326.333	.104
Y3-W1	-229.000	.059	Y3-W1	-83.000	.996
Y3-W2	-385.667	.000	Y3-W2	-753.667	.000
Y3-W3	-219.000	.078	Y3-W3	-286.667	.202
D1-D2	367.333	.001	D1-D2	-114.000	.969
D1-D3	113.667	.740	D1-D3	31.667	1.000
D2-D3	-253.667	.028	D2-D3	145.667	.888
D1-W1	-221.333	.073	D1-W1	-155.333	.849
D1-W2	-378.000	.001	D1-W2	-826.000	.000
D1-W3	-211.333	.097	D1-W3	-359.000	.058
D2-W1	-588.667	.000	D2-W1	-41.333	1.000
D2-W2	-745.333	.000	D2-W2	-712.000	.000
D2-W3	-578.667	.000	D2-W3	-245.000	.370
D3-W1	-335.000	.002	D3-W1	-187.000	.698
D3-W2	-491.667	.000	D3-W2	-857.667	.000
D3-W3	-225.000	.003	D3-W3	-390.667	.320
W1-W2	-156.667	.369	W1-W2	-670.667	.000
W1-W3	10.000	1.000	W1-W3	-203.667	.694
W2-W3	166.667	.298	W2-W3	467.000	.007

Source: Field survey (2021)

Table 3 contains a multiple comparison output of the results which revealed that there is significant differences in the tensile strength of the fabrics under study. The table reveals that Y1(690.33) was statistically less different from Y2(990.33), Y3(941) D1(948), W1(1170), W2(1326.67) and W3(1160). However, it was revealed that the weft tensile strength of Y1(310) was only statistically less different from W2(1210) and W3(743) with no significant difference from the rest of the fabrics under study. This suggests that Y1 has a weaker weft yarn strength than majority of the other fabrics even though the difference in strength were not wide. From the analysis, it can be realised that there are significant differences in the tensile strength among all the fabrics under study

The post-hoc analysis also revealed that warp mean tensile strength of Y2(990) was found to be more significantly different to D2(580) and less significant to W2(1326.67). The mean weft tensile strength of Y2(416.57) was found to be less significantly different from W2(1210) and not significantly different from any of the other fabrics. This is an indication that the weft tensile strength of Y2 was as strong as that of any other fabrics under study.

In comparing warp tensile strength of Y3(941) to the other fabrics, it was found out that it was more significantly different to D2(580) but less significantly different to W2(1326.67) and has no significant difference to the rest of the fabrics under study. However, the mean weft tensile strength of Y3(456.33) was found to be less significant to W2(1210) and not statistically significant to the weft yarns of all the fabrics. This suggested that Y3 is strong in the warp and weft directions.

The mean warp tensile strength of the D1(948) was found to be more significantly different to D2(581.33), less significantly differently to W2(1326.67) and not significantly different to all the other fabrics under study. This suggested that warp of D1(941) fabric is found to be stronger as any of the warp of the other fabrics except the warp of the W2(1326.67) fabric. However, the weft yarns of D1(348) were found to be less significantly different to only W2(1210) and not statistically different to all the weft yarns of the other fabrics under study. The mean warp tensile strength of D2(581.33) was also found to be significantly less different to D3(835), W1(1170), W2(1326) and W3(1160). This is an indication that D2 appeared to be weaker in the warp direction in comparison to these fabrics listed and for that matter smocks made from D2 will not last as those made from D3, W1, W2, and W3 respectively. In comparison of the weft tensile strength of D2(498) to that of the fabrics, it was found to be significantly less different to only W2(1210) with no significant difference recorded between that and the other fabrics.

In finding out about the differences in the warp of the D3 fabric, it was realised that the mean weft tensile strength of D3(835) was more significantly different to D2(581.33) but less significant to W1(1170), W2(1326.67) and W3(1160) respectively. In the weft direction, D3(352) was statistically less significant to only W2(1210) and W(743) but not statistically different from all the weft yarn of all the remaining fabrics. This reveals that D3 has almost equal weft tensile strength to all the other fabrics under study. The mean tensile strength of the W fabrics were not significantly different from each other. In finding out the differences in the weft tensile strength of the W fabrics, the table revealed that mean tensile strength of W1(539.33) is less significantly different to W2(1210) and no significant difference to all the other fabrics under study. The mean weft tensile strength of W2(1210) is found to be more significantly different to the mean weft tensile strength of W3(743) and weft tensile strength of all the other fabrics under study. The analysis indicates that there are varied differences in the tensile strength among the smock fabrics in both the warp and weft directions. This therefore suggests that smocks made from the various fabrics will last differently as a result of the varied strengths among them.

Elongation of Smock Fabrics

Elongation qualities are among properties which textiles fabrics are susceptible to during use and care Elongation properties of a fabric is determined by the constructional factors of woven fabrics, such as warp and weft density, properties of yarns and weave. Figure 3 shows a bar graph of the differences in elongation of the smock fabrics.

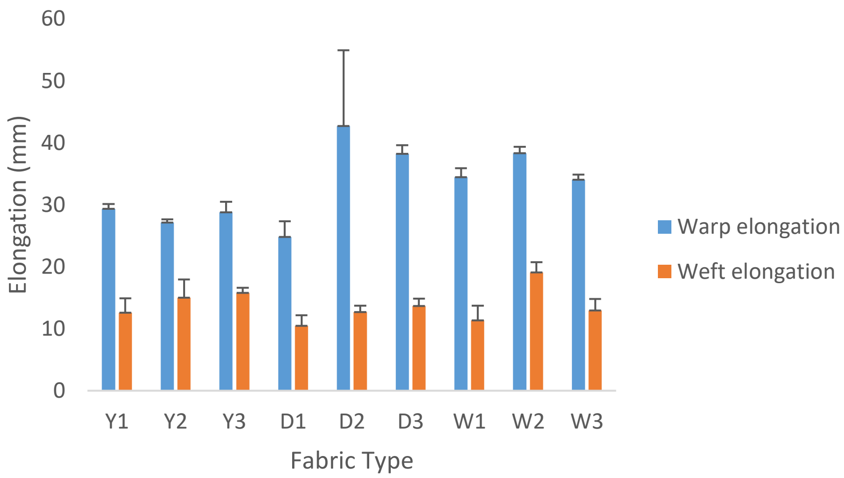


Figure 3: Elongation among the smock fabrics
Source: Field Survey (2021)

Figure 3 exhibits the mean elongation of the smock fabrics for warp and weft directions of the fabrics. In the warp direction D2(42.70) had the highest mean elongation. The next mean elongation were D3(38.34), W2(38.30) while D1(24.83) had the lowest mean elongation. From the graph, it can be realised that there are differences in the mean warp elongation of the smock fabrics.

In the weft direction of the fabrics W2(19.10) had the highest mean elongation while D1(10.48) had the lowest mean elongation. The data in the graph of Figure 3 shows differences in the mean elongation of the smock fabrics. To ascertain the level of significant differences in the elongation of the smock fabrics under study, an ANOVA test was carried out. Table 4 is One Way ANOVA analysis of elongation of smock fabrics.

Table 4: One-Way ANOVA analysis of Elongation of Smock Fabrics

Elongation	Groups	Sum of Squares	Df	Mean Square	F	Sig.
Warp	Between Groups	853.699	8	106.712	5.792	.001
	Within Groups	331.620	18	18.423		
	Total	1185.319	26			
Weft	Between Groups	162.205	8	20.276	5.750	.001
	Within Groups	63.473	18	3.526		
	Total	225.678	26			

Source: Field survey (2021)

To compare the significant mean differences in the elongation among the smock fabrics, a one-way ANOVA analysis was conducted. The outcome indicated that there was a significant difference ($p<0.05$, df= 8,18, $F = 5.79$) between the warp strength and ($p<0.05$, df= 8,18, $F = 5.75$) weft elongation among the various fabrics under study. Based on the presence of significant differences in elongation among the fabrics, a post-hoc analysis test was undertaken using Tukey Honesty Significant Difference (Tukey HSD). The multiple comparison in table 4 is the output of the test statistics of the post-hock test.

Post-hoc test on elongation of smock fabrics

Table 5 contains results of the post-hoc multiple comparison results.

Table 5: Multiple comparison of the Elongation of smock fabrics

Warp Fabric	Mean Diff.	sig. (p≤0.05)	Weft Fabric	Mean Diff.	sig. (p≤0.05)
Y1-Y2	2.233	.999	Y1-Y2	-2.433	.800
Y1-Y3	.567	1.000	Y1-Y3	-3.233	.497
Y2-Y3	-1.667	1.000	Y2-Y3	-.800	1.00
Y1-D1	4.533	.921	Y1-D1	2.083	.899
Y1-D2	-13.333	.028	Y1-D2	-.133	1.00
Y1-D3	-8.867	.281	Y1-D3	-1.100	.998
Y2-D1	2.300	.999	Y2-D1	4.517	.142
Y2-D2	15.567	.007	Y2-D2	2.300	.842
Y2-D3	-11.100	.095	Y2-D3	1.333	.992
Y3-D1	3.967	.961	Y3-D1	5.317	.054
Y3-D2	-13.900	.020	Y3-D2	3.100	.549
Y3-D3	-9.433	.218	Y3-D3	2.133	.887
Y1-W1	-5.067	.865	Y1-W1	1.243	.995
Y1-W2	-8..933	.273	Y1-W2	-6.533	.011
Y1-W3	3.505	.909	Y1-W3	-.400	1.00

Table 5: Cont

Y2-W1	-7.300	.512	Y2-W1	3.677	.341
Y2-W2	-11.167	.092	Y2-W2	-4100	.224
Y2-W3	-6.900	.581	Y2-W3	2.033	.910
Y3-W1	-5.233	[illegible]	Y3-W1	4.477	.148
Y3-W2	-9.500	.211	Y3-W2	-3.300	.472
Y3-W3	-5.233	.845	Y3-W3	2.833	.653
D1-D2	-17.887	.002	D1-D2	-2.217	.865
D1-D3	-13.400	.026	D1-D3	-3.183	.516
D2-D3	4.467	.926	D2-D3	-967	.999
D1-W1	-9.600	.202	D1-W1	-.840	1.000
D1-W2	-13.467	.025	D1-W2	-8.617	.001
D1-W3	-9.200	.242	D1-W3	-2.483	.783
D2-W1	8.267	.360	D2-W1	1.377	.990
D2-W2	4.400	.932	D2-W2	-6.400	.013
D2-W3	8.667	.306	D2-W3	-267	1.000
D3-W1	3.800	.967	D3-W1	2.343	.829
D3-W2	-.067	1.000	D3-W2	-5.433	.046
D3-W3	4..200	.947	D3-W3	.700	1.000
W1-W2	-3.867	.966	W1-W2	-7.777	.002
W1-W3	.400	1.000	W1-W3	6.533	.011
W2-W3	4.267	.942	W2-W3	.400	.019

Source: Field survey (2021)

Table 5 contains multiple comparison of level of elongation at break among the smock fabrics under study. A post-hock analysis test for the elongation at break among warp direction of the fabrics revealed that Y1(29.37) mean elongation at break is less significant difference with D2(38.30). It can be deduced from the table that there is more significant difference in the elongation at break in the weft direction between the Y1(12.57) and W2(19.10) with no significant difference between Y1(12.57) and the remaining smock fabrics under study. This is an indication that level of break of this fabric when load is exerted on it is equal to the rest of the fabrics. The warp mean elongation at break of Y2(27.13) is found to be more significantly different with warp mean elongation at break of D2(42.70) and no significant difference existed with the other smock fabrics under study. In weft direction of the fabrics, it was realised that no significant difference existed between Y2(27.13) and all the other fabrics. The outcome of the results also indicated that there is less significant difference in the elongation at break between D1(24.83) and W2(38.30). No significant difference was however found in the elongation between D1(24.83) and the rest of the other smock fabrics under study.

In conducting the test for the elongation at break of the weft direction of the smock fabrics, the post-hock test revealed that the mean elongation at break of Y1(12.59) was found to be less significantly different from the weft mean elongation at break of W2(19.10). The test also revealed that the elongation at break of D1(10.48) was less significantly different from mean of elongation at break of W2(19.10) with no observed significant difference in the elongation at break with the other smock fabrics under study. The test also revealed that the weft mean of elongation at break of D2(12.70) was less significantly different from W2((19.10)) and no observed significant difference with the other smock fabrics under study. The table also revealed that the elongation of weft yarns of D3(13.67) is less significantly differed from W2(19.10) with no observed significant difference with the rest of the smock fabrics under study. This finding is an indication that the elongation of the weft yarns of D3(13.67) is more or less equal to that of the rest of smock fabrics. The elongation of weft yarns of W1(11.32) was also found to be less significantly different from the elongation of W2(19.10). The weft elongation at break of the W2(19.10) is more significantly different from W3(12.97). The general outcome of the study reveals that the level of significance of differences in elongation at break of all the fabrics under study differ slightly from each other and for most of the comparison, no difference existed.

Weight of Smock fabrics within groups

The weight of a fabric is said to have a great influence on other characteristics. To find the weight, the smock fabrics were examine using the electronic scale. The unit used for this measurement was g/m^{-2}. Figure 4 shows the mean weight of the smock fabrics under study.

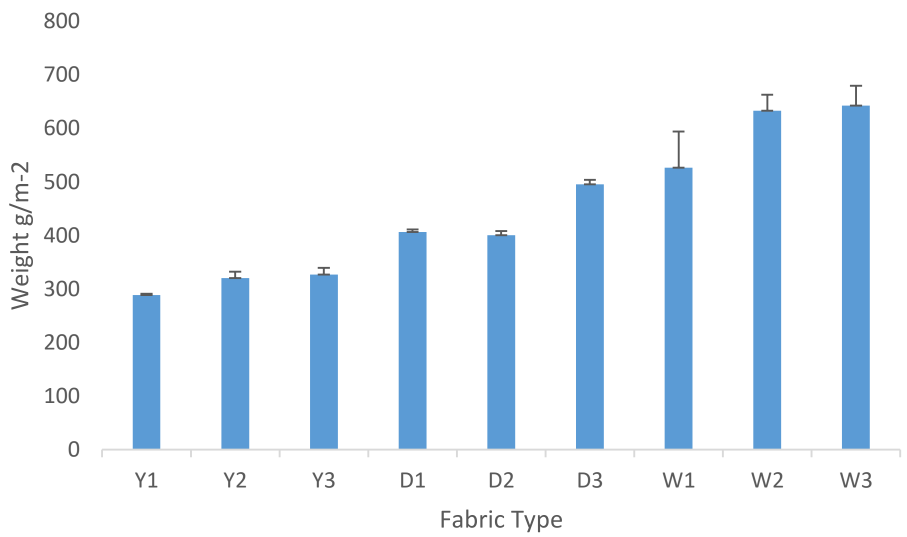


Figure 4: Grammage/Weight of Smock Fabrics
Source: Field Survey (2021)

Figure 4 contains the grammage/weight results of the smock fabrics under study. From the weighing done, fabrics from the 'W' group had the most weight with the mean weights of W1(642.33), W2(633.00) and W3(526.67). The group that came that had the least mean weight was the Y group with Y1(289.00), Y2(320.67) and Y3(326.67). This outcome of the grammage of the smock fabrics is an indication that the 'W' group of fabrics will produce smocks that have more weight than any of the other two groups and that means they will be more draping and exhibit good flair in the lower part of the smock.

ANOVA results of the Grammage/Weight of Smock Fabrics

Table 6 contains ANOVA results of the weight of the smock fabrics under study.

Table 6: ANOVA Results of the Grammage/Weight of Smock Fabrics

Grammage	Groups	Sum of Squares	Df	Mean Square	F	Sig.
Grammage	Between Groups	421812.296	8	52726.537	65.154	.000
	Within Groups	14566.667	18	809.259		
	Total	436378.963	26			

Source: Field survey (2021)

To compare the significant mean differences in the grammage/weight among the smock fabrics, a one-way ANOVA analysis was conducted using SPSS Version 22. The outcome of the ANOVA in Table 6 indicated that there was a significant difference ($p<0.05$, df= 8,18, $F = 65.2$) between the various fabrics under study. Based on the presence of significant differences in grammage/weight among the fabrics, a post-hoc analysis test was undertaken using Tukey Honesty Significant Difference (Tukey HSD). This can be found in Table 7.

Post-hoc analysis of the level of significance of the weight of smock fabrics

Table 7 displays the result of the post-hoc analysis that seeks to find out the level of significant differences of the weight of smock fabrics under study.

Table 7: Multiple comparison of grammage/weight of smock fabrics

Warp Fabric	Mean Difference	Sig.
Y1-Y2	-31.667	.000
Y1-Y3	-37.667	.897
Y2-Y3	-6.000	1.000
Y1-D1	-117.333	.002
Y1-D2	-111.667	.003
Y1-D3	-206.333	.000
Y2-D1	-85.667	.035
Y2-D2	-80.000	.056
Y2-D3	-1774.667	.000
Y3-D1	-79.667	.058
Y3-D2	-74.000	.092
Y3-D3	-168.667	.000
Y1-W1	-353.333	.000
Y1-W2	-344.000	.000
Y1-W3	-237.667	.000
Y2-W1	-321.667	.000
Y2-W2	-321.333	.000
Y2-W3	-206.000	.000
Y3-W1	-315.667	.000
Y3-W2	-306.333	.000
Y3-W3	-200.000	.000
D1-D2	5.667	1.000
D1-D3	-89.000	.026
D2-D3	-94.667	016
D1-W1	-236.000	.000
D1-W2	-226.667	.000
D1-W3	-120.333	.002
D2-W1	-241.667	.000
D2-W2	-232.333	.000
D2-W3	-126.000	.001
D3-W1	-147.000	.000
D3-W2	-137.667	.000
D3-W3	-31.333	.903
W1-W2	9.333	1.000
W1-W3	115.667	.002
W2-W3	106.333	.006

Source: Field survey (2021)

Table 7 displays the result on the multiple comparison of the weight of the smock fabrics under study. In comparing the smock fabrics head-on-head, it was realised that the weight of Y1(289.00) was less significantly different from the weight of Y2(320.67), D1(406.33), D2(400.67), D3(495.33), W1(642.33), W2(633.00) and W3(526.67). These findings suggest that all these smock fabrics listed are significantly heavy than the Y1 smock fabric. This is also an indication that the yarn count of Y1 are less in comparison to all these fabrics. In comparing the Y2 fabric, it was found out that it was less significantly different from D1(406.33), D3(495.33), W1(642.33), W2(633.00) and W3(526.33). This therefore implies that these smock fabrics listed are all heavier than the Y2(320.67) fabric. The comparison of the Y3(326.67) smock fabric also revealed that, it was less significantly different to D3(495.33), W1(642.33), W2(633.00) and W3(526.67). This finding implies that all these smock fabrics listed have more weight than the Y3 smock fabric. This finding is also an indication that smock made from this fabric are going to be light in terms of weight on the body and it will also affect the draping quality of the smock.

The comparison of the weight of D1(406.33) smock fabric to the rest of fabrics under study was found to be less significantly different to D3(495.33), W1(642.33), W2(633.00) and W3(0.002). This implied that all these smock fabrics listed above have more weight than D1(406.33) smock fabric. In comparing D2(400.67) fabric specimen, it was found out that it was less significantly different from D3(495.33), W1(642.33), W2(633.00) and W3(526.67). This implied that all these smock fabrics listed above have more weight than the D2(400.00) smock fabric. The weight of the D3(495.33) smock fabric was also found to be less significantly different from W1(642.33) and W2(633.00).

The analysis also revealed that the weight of the W1(642.33) smock fabric was found to be more significantly different from W3(526.67). This is an indication that W1(642.33) smock fabric has the highest weight among all the fabrics under study as it has been observed to weigh more than almost all the other groups of fabrics in the cross comparison. The W2 fabric was also found to be more significantly different from W3(526.67) and all the other smock fabrics under study except W1 which has no significant difference with it. From the multiple comparison, it can be deduced that the 'W' group of fabrics weighed more than the rest of the other groups of fabric with Y group having the least weight.

Research Question two: What difference exists in the colour fastness of fabrics from Yendi, Damongo and Yelwongo:

Colour Fastness to Washing of Smock Fabrics

Colour fastness to washing is the ability of a fabric to be washed in water and soap without bleeding of the colours of the garment in the water used. To get the results for this test, the various smock fabrics were taken through washing using standard soap in the washing machine. The washing was done in accordance with GS ISO 105-C10 as outlined in GS 124 (2019). In this, three cycles of washing was done in three days with one cycle taking place after the preceding one dries under a room temperature. The GS 124 (2019) standard demanded that for a fabric to be colour fast to washing, it must obtain 3 to 5 on the grey scale while those that obtain 1 to 2 on the grey scale are considered not to be colour fast to washing. The range of scaling as used on the grey scale according to the GS 124 (2019) for colour fastness is 1, 1-2, 2, 2-3, 3, 3-4, 4-5 and 5. The results from the washing that was carried out are presented in Table 8.

Table 8: Colour Fastness to Washing of Smock Fabrics

Fabric	Colour Fastness to washing (1st wash)	Colour Fastness to washing (2nd wash)	Colour Fastness to washing (3rd wash)	Mean Colour Fastness
Y1	4-5	4	4	4.00
Y2	5	4-5	4	4.33
Y3	5	4-5	4	4.33
D1	3	2-3	2	2.33
D2	2	2	2	2.00
D3	5	4-5	4	4.33
W1	5	4-5a	4	4.33
W2	5	4-5	4	4.33
W3	5	4-5	4	4.33

Source: Field Survey (2021)

When the first cycle of washing was done, it was realized that all the fabrics in the Y group scored 5 on the grey scale, the fabrics in the W group also scored 5 on the grey scale. This therefore suggests that the Y and W groups of fabrics were colour fast as they passed the GS 124 (2019) standard which states that textile products should obtain colour fastness of 3 to 5 on the grey scale to be considered good. Only D3 from the D group scored 5 on the grey scale with D1 and D2 scoring 3 and 2 respectively indicating that D2 has a fair colour fastness with D1 not colour fast to washing as it has failed ISO GS 124 (2019) pass value for colour fastness.

After the second cycle of washing, the Y2 and Y3 scored 4-5 on the grey scale while Y1 scored 4 which means they attained the GS 124 (2019) standard of colour fastness. However, Y1, Y2 and Y3 have each lost 0.5 of their colour intensity. Also, the fabrics from the W group all scored 4-5 on the grey scale after the second cycle of washing. It is also an indication that the W group of fabrics still passed GS 124 (2019) standard of good colour fastness after repeated washing even though they each lost 0.5 of their colour intensity. It was also realized that only D3 from the D group scored 4-5 with the rest scoring (D1 and D2) 2-3 and 2 respectively on the grey scale this means that D3 passed the GS 124 (2019) standard while D1 and D2 fell short of it. This result shows that D1 had worsened in its colour fastness to washing after the second cycle of washing by losing 1 of its colour fastness while D3 also lost 0.5 of its colour fastness. The grades obtained by these two fabrics (D1 and D2) after the second washing is revealing how poor these fabrics are to colour fastness to washing after repeated washing as they fell short of the DS 124 (20119) standard of colour fastness to washing.

After the third cycle of washing using GS ISO 105-C10 of the GS 124 (2019) standard, the Y and W groups maintained good colour fastness to washing by scoring 4 on the grey scale indicating that they each met the GS ISO 105-A02 of the GS 124 (2019) standard of maintaining colour after several washings. However, D1 and D2 also maintained their score of 2 on the grey scale. This also sugges**ts** that the fabric D1 had lost 0.5 of its colour. Based on these finding**s,** it can be concluded that there are varied differences in colour fastness to washing among the fabrics under study, most especially within the D fabric groups.

Colour Fastness to Rubbing

The various specimen fabrics were examined using the crock machine to ascertain colour fastness to rubbing. This was done in two forms with one done using dry standard fabric on the finger of the crock machine while the other done using wet standard fabric. This was done in cognisance with the GS ISO 105- X12 of the GS 124 (2019) standard. In carrying out this, the finger of the crock machine was covered with the standard fabric and lowered onto the specimen fabrics to be moved along the straight grain of the fabrics back and forth for up to 20 counts (GS 124, 2019). This can be found in Table 9.

Table 9: Colour Fastness to Rubbing/Crocking

	Before washing		After first wash		After second wash	
Fabric	Dry	Wet	Dry	Wet	Dry	Wet
Y1	5	4-5	4	4	4	4
Y2	4-5	4	4	4	4	4
Y3	4-5	4	4	4	4	4
D1	3	2	2	1-2	1	1
D2	3	2	2	1-2	1	1
D3	5	4	4	4	4	4
W1	5	4-5	4-5	4	4-5	4
W2	4-5	5	4-5	4-5	4-5	4
W3	4-5	4	4-5	4	4-5	4

Source: Field Survey (2021)

Table 9 displays the outcome of the test that was conducted regarding the colour fastness to rubbing of smock fabrics for dry and wet testing. The rubbing test was conducted after every wash for three separate washing for the same specimen fabrics. From the table, the initial dry colour fastness to rubbing test that was conducted before the first wash revealed that Y1, D3 and W1 each measured 5 on the grey scale according to the 124 (2019) standard. In addition, Y2, Y3, W2 and W3 each measured 4-5 on the grey scale which is an indication that they attained the GS 124 (2019) standard of good colour fastness to rubbing. However, the fabric with lowest colour fastness to dry rubbing before the first wash came from the D group (D1 and D2). They were graded 3 each on colour fastness to dry rubbing. This also indicates that the D1 and D2 fabrics had passed the GS 124 (2019) standard of colour fastness to rubbing before the first cycle of washing. Even though this was a pass mark obtained, there was a significant staining on the standard fabric.

The fabrics were also taken through the wet method of testing colour fastness to rubbing. After this test, it was found out that W3 had the highest colour fastness to wet rubbing with 5 on the grade scale which meant that it attained the GS 124 (2019) standard of colour fastness to rubbing. Y1 and W1 also scored 4 on the grey scale which is also indication of attaining the GS 124 (2019) standard of colour fastness to wet rubbing while D1 and D2 measured 2 on the grey scale indicating a fall below the GS 124 (2019) standard. The two fabrics (D1 and D2) each lost 1 grade of its colour fastness.

Colour fastness to rubbing/crocking (After first washing)

At this stage also, the specimen fabrics were washed using the GS ISO 105-C10 of the GS 124 (2019) standards before they were again subjected to the colour fastness to rubbing tests. For the colour fastness to rubbing, the GS ISO 105-X12 of the GS 124 (2019) standard procedure was used. For the dry colour fastness test, W1, W2 and W3 all measured 4-5 on the grey scale while D1 and D2 also measured 2 on the grey scale. This, according to the GS 124 (2019) standards indicates that all the fabrics on the W group have good colour fastness to dry rubbing after repeated washing. The mark 2 on the grey scale suggest that the fabrics have failed the GS 124 (2019) standard of colour fastness to dry rubbing. This means that the D1 and D2 fabrics after washing for the second time still revealed poor colour fastness to dry rubbing and that can still stain under garments that are of lighter colour.

In conducting the colour fastness to wet rubbing, Y1, Y2, Y3, D3, W1, W2 and W3 all measured 4 on the grey scale. This therefore suggest that these fabrics still have passed the GS 124 (2019) standard of colour fastness to wet rubbing after they have been washed repeatedly. However, D1 and D2 measured 1-2 on the grey scale which suggest that they lost 0.5 grade of their colour fastness and that still put them below the GS 124(2019) standard. This therefore means that when the smock sewn with these fabrics are wet they can easily transfer their colour onto other fabrics that come closer to them. From this test carried out, one can confidently say that there are differences in the colour fastness to rubbing between the smock fabrics from the Y and W groups as against the D1 and D2 from the D group in northern Ghana.

Colour fastness to Rubbing/Crocking (After second washing)

The second washing of the smock fabric was carried out making use of the GS ISO 105-C10 standard. Starting with the colour fastness to dry rubbing, it was realized that the Y and W groups as well as D3 smock fabric all measured 4 on the grey scale which is still an indication of attainment of the GS 124 (2019) standard of colour fastness to crocking. However, D1 and D2 also measured 1 on the scale. This reveals a lost of 0.5 grade of their colour fastness. This reveals that D1 and D2 fell short of the GS 124 (2019) standard of colour fastness to rubbing. The results from tables 12 indicates that there is no difference in colour fastness to dry rubbing between Y and the W groups with D3 but with some difference between the Y and W groups with D1 and D2 of the D group of smock fabrics.

Colour fastness to wet rubbing was also conducted on the smock fabrics under study. This revealed that Y and W groups together with D3 of smock fabrics maintained the mark 4 on the grade scale which is an indication of good colour fastness to wet rubbing after second washing. This indicates that they still maintain the GS 124 (2019) standard of colour fastness to wet rubbing after the second washing. However, the D1 and D2 smock fabrics recorded scale 1 on the grey scale for the colour fastness to wet rubbing. This suggest a fall below the GS 124 (2019) standard. From this analysis, it can be deduced that the smock fabrics from the Y and W group together with D3 maintained their colour fastness to wet rubbing after several washing cycles. This therefore suggest that differences exist between D1 and D2 in comparison to the rest of the smock fabric under study in terms of colour fastness to wet rubbing after repeated washing. It can be concluded that D1 and D2 will continue to exhibit poor colour fastness to rubbing as far as washing and rubbing on the fabric is carried out.

Table 10: Colour Fastness of Smock Fabrics to Sunlight

Fabric	Colour fastness to sunlight
Y1	5
Y2	5
Y3	5
D1	5
D2	5
DS3	5
W1	5
W2	5
W3	5

Source: Field Survey (2021)

Table 10 shows results from the colour fastness to sun results. The various specimen fabrics were exposed to sunlight taking into consideration GS ISO 105-B01 of the GS 124 (2019) standard procedure. In doing this, the specimen were exposed to sunlight for a 24-hour period from which there was an expectation of possible colour change in the appearance of these fabrics. After the 24-hour exposure of the specimen fabrics to sun light, all fabrics exhibited strong resistance to the fading by the sunlight. After the comparison with the controlled specimen and the grey scale using GS ISO 105-A02, they each were graded 5 on the grey scale as shown in table 5. This therefore suggest that all smock fabrics under this study have good resistance to fading by sunlight. It is realized that the D1 and D 2 fabrics are made with yarns dyed with natural colourants and they show the same colour fastness to sun with the rest of the fabrics that are made from pre-dyed yarns.

Differences in yarn count

To be able to respond to the demand of yarn count, physical counting of the warp and weft yarns were conducted, this was done by the guidance of GS ISO 72111-2 of the GS 124 (2019) standards of analyzing the woven fabric construction methods through the processes leading to the point of counting the yarns. Kaynak & Babaarslan (2015) indicated that the standard count for yarns is 40 x 36 or a little above this. However the count as stipulated by Kaynak & Babaarslan (2015) is most appropriately for fine yarns. In conducting yarn count on smock fabrics, we may expect less to this counts since yarns for smock fabrics appear to be coarse. Figure 5 is the comparison within group of yarn counts of smock fabrics.

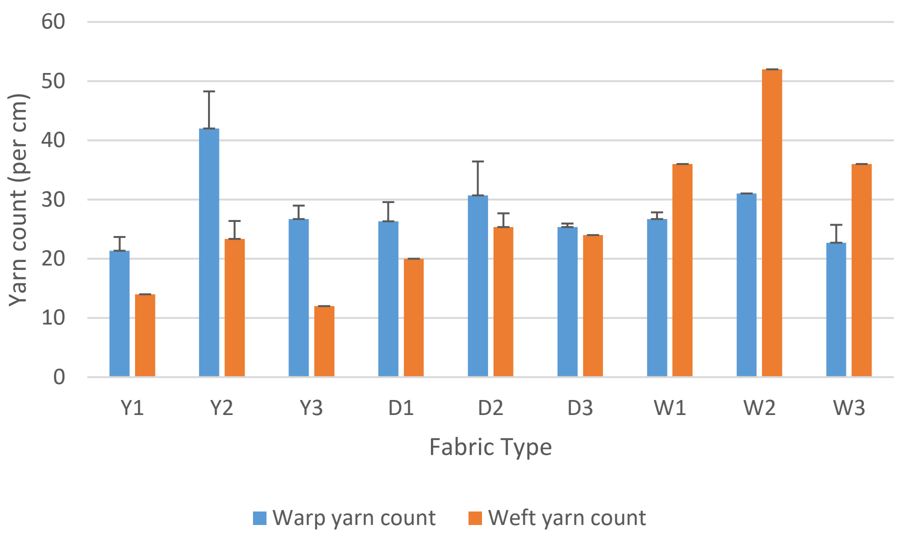


Figure 5: Yarn count of smock fabrics within groups

Source: Field survey (2021)

Figure 5 displays the yarn count of smock fabrics from the various groups under study. The fabric from the 'Y' group had mean counts as follows: Y1(21.33 x 14.00), Y2(42.00 x 23.33) and Y3(26.67 x 12.00) respectively. The highest warp yarn count within this group is Y2(42) with a minimum weft count of 23.33. The lowest yarn count among the Y group is the Y1(21.33) which also has the lowest mean weft count Y1(14) within the group. Among the D group mean yarn counts recorded were D1(26.33 x20.00), D2(30.67 x 25.33) and D3(25.33 x 24.00) respectively. The highest warp mean count within this group is D2(30) with a minimum warp count of 25.33. The least warp count within this group is D3(25.33) with a minimum mean weft yarn of count of 24.

Among the W group of fabrics, it was realized that yarn count were that, W2(31 x 36), W1(26.67 x 36.00) and W3(22.67 x 36.00) respectively. From this group, W2(31) has the highest mean warp yarn count with a maximum weft mean count of 36. The least warp mean yarn count from the group is W3(22.67) with a maximum mean weft yarn count of 36.

From the observation made on the analysis of the yarn count among the various groups of fabrics it can be observed that the Y and D groups of fabrics have high warp yarn count to weft yarn counts while the W group also has high weft count to warp yarn count. This undoubtedly contributed to the high weight of the 'W' group of fabric compared to that of the other groups.

Table 11: ANOVA test for Warp and Weft Yarn Count for Smock Fabrics

Yarn Count	Groups	Sum of Squares	df	Mean Square	F	Sig.
Warp t	Between Groups	895.185	8	111.898	9.653	.000
	Within Groups	208.667	18	11.593		
	Total	1103.852	26			
Weft	Between Groups	3765.630	8	470.704	288.841	.000
	Within Groups	29.333	18	1.630		
	Total	3794.963	26			

Source: Field survey (2021)

To compare the significant mean differences in the yarn count among the smock fabrics, a one-way ANOVA analysis was conducted using SPSS Version 22. The outcome of the ANOVA indicated that there was a significant difference ($p<0.05$, df= 8,18, $F = 9.65$) and ($p<0.05$, df= 8,18, $F = 288.8$) between the warp and weft directions of the smock fabrics respectively. This is shown in Table 11. Based on the presence of significant differences in yarn count among the fabrics, a post-hoc analysis test was undertaken using Tukey Honesty Significant Difference (Tukey HSD). This is found in Table 12.

Table 12: Multiple Comparison of Yarn Count among Fabrics

Warp Yarn Count			Weft Yarn Count		
Warp Fabric	Mean Diff.	sig. (p≤0.05)	Weft Fabric	Mean Diff.	sig. (p≤0.05)
Y1-Y2	-20.667	.000	Y1-Y2	-9.333	.000
Y1-Y3	-5.333	.611	Y1-Y3	2.000	.611
Y2-Y3	15.333	.001	Y2-Y3	11.333	.000
Y1-D1	-5.000	.683	Y1-D1	-6.000	.000
Y1-D2	-9.333	.066	Y1-D2	-11.333	.000
Y1-D3	-4.000	.868	Y1-D3	-10.000	.000
Y2-D1	15.333	.001	Y2-D1	3.333	.090
Y2-D2	11.333	.016	Y2-D2	-2.000	.611
Y2-D3	16.667	.000	Y2-D3	-.667	.999
Y3-D1	.333	1.000	Y3-D1	-8.000	.000
Y3-D2	-4.00	.868	Y3-D2	-13.333	.000
Y3-D3	1.333	1.000	Y3-D3	-12.000	.000
Y1-W1	-5.333	.611	Y1-W1	-22.000	.000
Y1-W2	-9.667	.053	Y1-W2	-38.000	.000
Y1-W3	-1.333	1.000	Y1-W3	-22.000	.000
Y2-W1	15.333	.001	Y2-W1	-12.667	.000
Y2-W2	11.000	.020	Y2-W2	-28.667	.000
Y2-W3	19.333	.000	Y2-W3	-12.667	.000
Y3-W1	.000	1.000	Y3-W1	-24.000	.000
Y3-W2	-4.333	.814	Y3-W2	-40.000	.000
Y3-W3	4.000	.868	Y3-W3	-24.000	.000
D1-D2	-4.333	.814	D1-D2	-5.333	.002
D1-D3	1.000	1.000	D1-D3	-4.000	.026
D2-D3	5.333	.611	D2-D3	1.333	.925
D1-W1	-.333	1.000	D1-W1	-16.000	.000
D1-W2	-4.667	.751	D1-W2	-32.000	.000
D1-W3	3.667	.913	D1-W3	-16.000	.000
D2-W1	4.000	.868	D2-W1	-10.667	.000
D2-W2	-.333	1.000	D2-W2	-26.667	.000
D2-W3	8.000	.160	D2-W3	-10.667	.000
D3-W1	-1.333	1.000	D3-W1	-12.000	.000
D3-W2	-5.667	.539	D3-W2	-28.000	.000
D3-W3	2.667	.985	D3-W3	-12.000	.000
W1-W2	-4.333	.814	W1-W2	-16.000	.000
W1-W3	4.000	.868	W1-W3	.000	1.000
W2-W3	8.333	.129	W2-W3	16.000	.000

Source: Field survey (2021)

Table 12 displays multiple comparison of yarn count of the smock fabrics under study. In comparing the yarn count within the Y group of fabrics, it can be realized that Y1 (21.33 x 14) has less significant mean warp and weft count compared to Y2(42 x 23.33). This implies that Y2 will have more weight and strength than Y1.

The yarn count of Y2(42.00 x 23.33) has **more** significant difference in both warp and weft yarn compared to Y3(26.67 x 12.00). The mean yarn count of Y2(42.00 x 23.33) is more significantly different to D1(26.33 x20.00) in the warp direction but with no significant difference recoded in the weft directions of the fabrics. In the same condition, Y2(42.00 x 23.33) has mores significant difference in the warp direction compared to D2(30.67 x 25.33) but with no significant difference in the weft direction of the fabrics. In another comparison, Y3(26.67 x 12) also had more significant difference of weft yarn count than D3(25.33 x 24.00) but with no significant difference in the warp direction of the fabrics.

The comparison of Y and W groups reveals that, Y2(42.00 x 23.33) has more significant difference W1(26.67 x 36.00) in the warp direction but less significant difference in the weft direction of the fabrics. This implies that Y2 has more warp yarns than W1 but less weft yarns compared to W1. The situation of Y2 and W1 is indifferent to all the other W group fabrics. It can also be observed that the W group fabrics have more significant difference in the weft yarn count than all the other groups of fabrics.

Research Question Three: How will the three smock fabrics perform considering results of their tested properties?

Impact of Fabric Properties on Performance of Smocks

To be able to ascertain the relationship or the impact of the variables measured on the performance of the smocks made from the fabrics, a correlation analysis was conducted. The results is found in Table 13.

Table 13: Correlation between Variables

Fabric Test	Tool	Warp Str.	Warp Elong.	Weft Str.	Weft Elon.	Warp Yarn Count	Weft Yarn Count	Grammage
Warp Strength	Pearson Correlation	1						
	Sig. (2-tailed)							
Warp Elongation	Pearson Correlation	-.108	1					
	Sig. (2-tailed)	.591						
Weft Strength	Pearson Correlation	.680**	.366	1				
	Sig. (2-tailed)	.000	.060					
Weft Elongation	Pearson Correlation	.374	.159	.612**	1			
	Sig. (2-tailed)	.055	.429	.001				
Warp Yarn Count	Pearson Correlation	.052	.050	.123	.332	1		
	Sig. (2-tailed)	.797	.804	.540	.090			
Weft Yarn Count	Pearson Correlation	.709**	.465*	.829**	.337	.124	1	
	Sig. (2-tailed)	.000	.014	.000	.086	.537		
Grammage	Pearson Correlation	.664**	.445*	.596**	.125	-.125	.861**	1
	Sig. (2-tailed)	.000	.020	.001	.535	.534	.000	

Source: Field Survey (2021) **. Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

From the correlation analysis in Table 13, weft yarn count revealed significant positive correlations with Warp strength (r=0.71; p≤0.01), weft strength (r = 0.68; p≤0.01), grammage (r = 0.66; p≤0.01).

Differences in Dimensional Stability of Smock Fabrics

In conducting the various tests on the smock fabrics, the dimensional stability of the fabrics was also tested using the GS ISO 5077 of the GS 124 (2019) standards. This was done by initially taking the dimensions of the fabrics before washing the fabrics and taking measurement of the warp and weft dimensions after the washing and drying. According to the GS 124 (2019) standard, a negative value recorded is an indication of shrinkage while a positive value show increase in size or enlargement with 0 meaning stability in dimension or no change in dimensions. The results of the dimensional stability is shown in Table 14.

Table 14: Dimensional stability of smock fabrics

Fabric	Warp %	Weft %
Y1	-2	-2
Y2	0	-4
Y3	0	-2
D1	0	-4
D2	-4	0
D3	-6	-8
W1	-2	-4
W2	0	0
W3	-2	-4

Source: Field Survey (2021)

From Table 14, it is revealed that Y1 was not dimensionally stable in both warp and weft directions of the fabric as it exhibited -2mm at both warp and weft ends. This was an indication that it shrunk or reduced in its dimensions from the original size. The Y2 labeled fabric also showed a stable warp direction with 0 mm but with -4mm in the weft direction indicating shrinkage in that direction. The last fabric in the Y group (Y3) was also found to be dimensionally stable in the warp direction with 0 mm but shows a shrinkage value of -2mm in the weft direction. This fabric was however better compared to Y1 and Y2 respectively.

In finding the stability nature of the D fabric group, it was realized that D1 was dimensionally stable in the warp direction with 0 mm but was found to be dimensionally unstable in the weft direction with a shrinkage value of -4mm. this also suggest that smocks made from this fabric will reduce in the dimension of its width. The D2 labeled fabric had a reverse stability as the D1. In this case, the D2 fabric was found to be dimensionally unstable in the warp direction with a shrinkage value of -4mm with a 0 mm shrinkage value in the weft direction. The D3 fabric was found to be dimensional unstable in both warp and weft directions. It exhibited a shrinkage value of -6 mm in the warp direction and -8mm in the weft direction. This was an indication that smocks made from the fabric will have a high shrinkage value in both its width and depth dimensions. The dimensional stability of this fabric was seen to be worse in the D fabric group and among the fabrics under study.

In testing for dimensional stability of the W group of fabrics under study, it was observed that W1 and W3 all had the same shrinkage value in both their warp and weft directions with -2 mm for their warp and -4 mm for weft respectively. However, the W2 fabric revealed no change in its dimensions with a 0 mm change in both warp and weft directions.

Discussion

Research question one: Are there difference in tensile strength between the smock fabrics from Yendi, Daboya and Yelwongo?

The findings revealed that there were differences within and between groups in the tensile strength of the fabrics studied at significant value of $p<0.05$ in the warp and weft directions of the fabrics. The results also indicated that the mean tensile strength in the weft direction was more than that of the warp direction. This coincided with findings of Barakat & Tawab (2020) which found that the weft direction of the fabrics studied showed more strength than the warp direction. Venkatraman (2015) found that high twist of yarns, amount of folds, and yarn count are quality parameters that influence the strength, drape and other characteristics of the fabric. This also suggests that the tension exerted on the weft picks during the weaving was more leading to compacted fabric. This therefore suggests that smocks made from the various fabrics will last differently as a result of the varied strengths among them. For instance, the W group had the highest strength and the Y and the D groups had the lowest strength. This invariably will influence how long smocks made from them will last. The W group as was found to be more strong especially in the weft direction indicates that they will last long. This was influenced by the high yarn count in the weft direction of the fabrics.

Elongation of smock fabric

The warp elongation of the smock fabrics indicated that D2 had the highest warp elongation. This was followed by D3 and D1 being the fabric with the lowest warp elongation. Interestingly the, D2 turned out to be the fabric with the lowest tensile strength. This is an indication that high elongation of a fabric does not guarantee strength of the fabric. Similarly, D1 had the lowest warp elongation among the fabrics. This fabric however turned out to possess high tensile strength.

In the weft direction, W2 had the highest elongation with D1 being the lowest. This translated into W2 becoming the fabric with the highest weft yarn tensile strength with D1 still exhibiting low tensile strength. The tensile strength of W2 is seen to be influenced by the high weft yarn count in that fabric. It can therefore be concluded that, the elongation and tensile strength of a fabric highly depend on the yarn count of the fabric. This falls in line with the statement of Kumpikaitė et al. (2018) that the breaking of textile fabric lies on the quality and number of yarns used. They also found out that the tensile strength of a plain woven fabric is stronger than that of a twill woven fabric and this to them was influenced by the count of yarns within a unit area. Esi & Baykal (2020) also found a significant relationship between fabric elongation and tensile strength.

Research Question Two: What differences exist in colourfastness among smock fabrics from Yendi, Daboya and Yelwongo?

The colour fastness in washing for the fabrics under study revealed that there were no difference between the Y and W groups together with D3. However, differences existed between these groups and D1 and D2 after repeated washing cycles. This suggests that Y and W groups with D3 are resistant to fading when washed repeatedly. This finding is in line with the statement of Rashid, Ahmed and Azad (2012) that when a fabric is colourfast to washing it is an indication that the colour of the fabric is resistant to the action of repeated washing. It is however, a sign that consumers will prefer to choose fabrics from group with good colour fastness. The differences that existed between the D1 and D2 and the rest of the fabrics are as a result of the fact that, they were woven using locally dyed yarns which resulted in poor colour fastness. The use of suitable mordant in dyeing yarn results in better colour fastness. This is therefore a revelation that the dyers do not use suitable mordant for their dyeing process. This confirms the study of Khin and Yee (2017) where they found a fair difference between mordant dyed cotton fabric and non-mordant dyed ones in their study. This finding is similar to the study of Ghosh and Mal (2019) where some garments lost their colours while others maintained the colours when they were washed and examined. Those that had poor colour fastness were found to stain other fabrics that came into contact with them. This is in confirmation of the statement of (Ghosh & Mal, 2019) that a fabric is said to be excellent in colour fastness when it does not bleed in water and the Y and W groups with D3 fabrics are indifferent from this statement. This finding is in line with the study of Rashid et al. (2012) that, fabrics with good colour fastness show no sign of bleeding or staining. External factors such as rain can influence the behaviour of garments. This can therefore lead to garments that are not colour fast to transmit their colour onto nearby garments.

The examination of colour fastness to rubbing resulted in all the fabrics belonging to Y and W groups together with D3 having good colour fastness to dry and wet colour fastness to rubbing with the mean value between 4 and 4.5 for each rubbing. While D1 and D2 also had mean value 1.5 to 2 colour fastness to rubbing for the three stages of the test conducted. These means still confirms the fact that D1 and D2 have lower colour fastness to dry and wet rubbing compared to the rest of the groups. This suggest that when smocks made from these fabrics are worn, they can stain undergarment on which they are worn.

Yarn count of smock fabrics

The test conducted indicated that there were significant differences in yarn count among the various fabrics under study. From the observation made on the test for the yarn count among the various groups of fabrics, it was realised that the Y and D groups of fabrics had high warp yarn count than weft yarn counts while the W group also had high weft count than warp yarn count. The warp yarn counts of all the fabrics do not have significant differences but differences does exist between the W group and the rest of the groups. This undoubtedly contributed to the high weight of the 'W' group of fabric compared to that of the other groups. This also contributed to high tensile strength of the W group especially in the weft direction. This therefore signifies that when the yarn count of a fabric is low it affects the strength and other characteristics of the fabric. This conforms to the findings of Sarıoğlu and Babaarslan (2017) that the strength of fabric reduces as performance of warp yarn count and weft density of the constructed fabric diminishes. This also confirms the findings of Basu et al. (2007) where they studied the yarn count and tensile strength of textile fabrics and their results revealed higher count being stronger than less count yarns. In addition, this confirms the statement of Ogulata (2006) that when spaces are founds between the warp and the weft yarns it is an indication of low yarn count and that contributes to the characteristics of the fabric or article made from the fabrics such as drape, comfort, flammability and other performances.

Weight of Smock Fabrics

The study found out that the W group had the highest weight with the Y group being lowest weight fabrics. Interestingly, Y2 had the highest warp yarn count with an appreciable weft yarn count but that did not influence the weight over the other fabrics. This is an indication that high yarn count does not necessarily influence high weight of the fabric. This was highly possible to have been influenced by the twist factor in the yarns used. This suggest that the W group of fabrics will produce smocks with much weight which will invariably influence the drape. The Y group will also produce smocks with low weight which will also influence the drape negatively. This findings has conformed with the study of Gobbi (2018) that, the weight of the Khadi fabric was found to increase the draping quality of the fabric.

Dimensional stability of smocks

The fabrics that had negative values in their warp and weft directions is an indication that smocks made from this fabric will have a reduction in their width. In the situation of fabric exhibiting negative in the warp direction but shows zero or no change in the weft direction is an indication that a smock made from this fabric will shrink in its depth or lengthwise but maintain the width dimension. Fabrics such as W2 exhibited zero or no change in the weft and warp directions. This result is an indication that smocks made from this fabric will not shrink or enlarge during its use life. This result falls in line with the description of good utility and transformation characteristics given by Ramzan et al (2019) that, they are fabrics with good dimensional stability and crease resistance. Venkatraman (2015) also believes that fabric with high yarn count results into good dimensional stability of the fabric and abrasion resistance of the garments made from them. Venkatraman further noted that fabric with low count of yarn results into the fabric not being resistant to abrasion, fabric cover and also has poor dimensional stability.

Research Question Three: How will the smock fabrics perform considering their tested properties and uses?

Effects of yarn count on tensile strength of smock fabric

To find out the impact of yarn count on tensile strength of smock fabrics, a correlation analysis was conducted. The results from this can be found in table 13. The aim of this test is to find out the relationship between yarn count and fabric tensile strength. Based on this, a correlation analysis was conducted to reveal how yarn count of a fabric will impact the strength of the smock fabrics under study. From the analysis in table warp tensile strength was found to have significant correlation with weft yarn count ($r = 0.71$; $p \leq 0.01$). This confirms the findings of (Sharma et al., 1983) that the strength of the warp of the fabric increases as the count of the weft yarns are increased. It was also established that weft yarn count had a significant correlation with weft tensile strength at ($r= 0.83$; $p \leq 0.01$). This signifies that, as the number of weft yarns increases the strength of the weft of the fabric also increases and the reverse is the same. This finding is indifferent from the findings of Sharma et al. (1983) that the strength of weft of the fabric increases as the number of weft yarn counts increases. It also confirms the finding of Aisyah et al. (2018) where yarn count affect other properties of fabrics which include low yarn count leads to decrease in fabric strength and also increases the pull of yarns and breakage of the fabrics. The finding also coincides with the finding of Nasrun et al. (2016) that an increased weft count results in high fabric tensile strength than an increased warp yarn count. In a similar findings, Sarıoğlu and Babaarslan (2017) realised that the strength of a woven fabric decreases as a performance of yarn count and weft density of the weft yarns diminishes. According to them, they freely dislodge and the fabric structure is altered making the tearing strength weaker. To avert the dislodging of yarns leading to its weakness Haque and Alam (2016) suggest that, the increase in number of twist per inch of the yarn to ensure compactness and good drape of fabric. This therefore suggest that the smock fabrics that have low yarn count will produce smocks that are not strong compared to the smock fabrics with high yarn count.

Effects of yarn count on weight of smock

Fabric weight plays a very important role in the characteristics and end use of the fabric. To obtain the relationship between yarn count and the weight, a correlation analysis was conducted as displayed in table 13. This showed a significant positive relationship between weft yarn count and grammage ($r = 0.86$; $p \leq 0.01$). This finding therefore suggests that when weft yarn count is high then the weight of the fabric will also be influenced to be high. The study of Aisyah et al. (2018) support this findings where yarn count influenced fabric weight and density. This was observed when the 'W' group of fabrics had the highest weft yarn count and also the highest weight among the smock fabrics under study. Ahmed (2021) found that, the fabric that has coarse yarns produces heavy fabrics. This therefore confirms the weight of the 'W' group of smock fabrics since they were constituted of fairly coarse yarns compared to the other groups of fabrics. The high weight value of the 'W' group of fabrics will therefore make them to have good draping quality since the beauty of a smock lies on its drape. This is supported by the study of Gobbi (2018) that, the weight of a fabric influence the draping quality of the garment made from it. This is also supported by the study of Masteikait et al. (2014) where yarn count parameters increased weight subsequently affected the drape of the garment. Venkatraman (2015) also found that the coarse yarn with high yarn count of a fabric ensure good drape.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

To be able to fulfil the objectives of this study, varied research questions were posed to guide the modalities in finding responses to the objectives set. Among other things, research questions were posed to find out the differences in tensile strength colour fastness and yarn count of smock fabrics from Yendi, Daboya and Yelwongo. Samples of smock fabrics were obtained from three production centers and taken to the textile laboratory of Ghana Standards Authority for analysis in order to obtain data that would give responses to the research questions that were posed to guide this study.

In this chapter, summary of the research findings and conclusions drawn on the main findings have been made and recommendations made. Suggestions for further studies on the problem identified have also been made.

Summary

The use of smocks have become a fashion with many wearers having less information on the type of fabric, its origin, the strength and colour fastness of the smock fabrics that are used in sewing these smocks. The study therefore sought to find out the differences in tensile strength and colour fastness that exist among the smock fabrics woven from three different producing areas in the northern sector of Ghana.

To be able to achieve the aim of this study, quasi-experimental research design was selected. Samples were taken from three traditional areas in northern Ghana where these fabrics are produced. Three weavers were selected from each production centre with one sample of fabric obtained from each weaver. These samples were taken to the standard textiles laboratory of the Ghana Standards Authority where tests were conducted to generate the results that guided the study. These results were interpreted by the use of ANOVA, mean, correlation and multiple-comparison of Tukey Honesty Significant Difference (Tukey HSD).

Key Findings

The key findings of the study are:

1. The results from the study reveals that the smock fabrics produced from Yendi, Daboya and Yelwongo do have differences in terms of their tensile strength. For instance, there existed significant differences within the various groups of fabrics (Y1, Y2, Y3; D1, D2, D3 and W1, W2, W3) and between each group. The differences in the tensile strength of the smock fabrics were seen to be influenced by the yarn count of the fabrics under study.
2. There were no differences in colour fastness of the smock fabrics which are made from imported coloured yarns but difference do exist between fabrics woven from the imported yarns as against the locally dyed yarns at the end of third cycle of washing. This was observed as in the case of D1 and D2 which were fabrics made from yarn that were dyed locally as against Y1, Y2, Y3; D3 and W1, W2 and W3 which were the fabrics made from coloured imported yarns. This was seen when D1 and D2 measured 2 with and the rest measuring 4 on the grey scale after the third cycle of washing.
3. It was also revealed that, the fabrics under study were all of good colour fastness to sunlight. Again, there existed significant differences in colour fastness to both dry and wet rubbing between all the groups

of fabrics (Y1, Y2, Y3, W1, W2, W3 and D3) and D1 and D2 from the rubbing that was done before washing and those that were done up to the second washing. It was found out that, the smocks made from D1 and D2 could stain under garment when wet.

4. It was found that, there existed significant difference between the yarn count of all the sampled smock fabrics (Y1, Y2, Y3; D1, D2, D3 and W1, W2 and W3). It was also revealed that significant differences existed within groups and between the groups. The variation in the yarn count of each of the specimen fabrics contributed to their high or low tensile strength and elongation which invariably would affect the quality of smocks sewn using these fabrics. It was revealed that the 'W' group of the fabrics had high yarn count in the weft direction than in warp direction. This high weft yarn count in this group resulted in high weight of the fabric which will invariably ensure good drape in smocks made from them. This therefore suggests that, smocks sewn from these fabrics will be heavier compared to the other groups of fabrics.
5. It was also revealed that, yarn count influences the weight of some of the fabrics positively especially the 'D' and 'W' groups. There was no increase in weight due to high yarn count on the 'Y' group of the fabrics especially Y2. This is therefore an indication that, some fabrics attain high weight due to yarn count while others do not.
6. It was also established that, yarn count influences the tensile strength of the fabric.

7. There was significant difference in elongation at break between all the fabrics both within and between groups. The differences showed clearly both in the elongation in the warp and weft directions of all the fabrics under study. The elongation at break of the fabrics were influenced by the yarn count.
8. Dimensional stability of the fabrics varied from fabric to fabric regardless of the group the fabric belong. For instance, the Y2 and Y3 were found to be dimensionally stable in the warp direction but shrink in the weft direction. The fabric that was stable in the wa rp and weft directions was W2 while the rest varied.

Conclusions

There existed significant differences in the tensile strength of the smock fabrics under study. The fabrics that had high tensile strength were from the 'W' group. The strength of this group of fabrics were attributed to the high yarn count especially in the weft direction. This therefore means that when smock fabrics have high yarn count, it translates into high tensile strength. It can therefore be concluded that, fabrics with high yarn count will produce fabrics and smocks that will be more durable.

The study revealed insignificant differences in the colour fastness to washing of the fabrics that were made from the imported coloured yarns. Differences in colour fastness to washing however existed between the fabrics that were made from locally dyed yarns especially D1 and D2 and the rest of the other groups. These results were keenly observed after each cycle of three successive washing. It can therefore be concluded that smock fabrics made from imported coloured yarns have good colour fastness to washing than the fabrics made from locally dyed yarns. It can again be concluded that smocks that are sewn using the fabrics made from dyed yarns can easily bleed and crock.

The variation in the yarn count of all the fabrics under study is an indication that all the fabrics would have varied tensile strength, weight/grammage as well as good draping quality of smocks sewn from them since yarn count has been found to have an impact on these characteristics. Smock users therefore need to look out for smocks that are sewn using fabrics with high weight.

The study also found out that there existed differences in dimensional stability among all the fabrics under study. They were found to mostly shrink in either the warp or weft directions. It could therefore be concluded that the smocks made from any of these fabrics would have changes in its size in future as they were used and washed in the bid to care for them. These changes in size were however insignificant.

Recommendations

In view of the findings of the study, a number of recommendations have been made as follows:

1. Weavers of smock fabrics should adopt a mechanism of looking out for yarns that are strong in the production of their fabrics since the imported yarns are of grades.
2. Local producers of yarns in Daboya should ensure they use suitable mordant when dyeing their yarns. They can also resort to the use of chemical or synthetic dyes. The aim for dyeing the yarns is to produce multi-coloured single yarns. To achieve this, weavers can give colour

specifications to importers to supply them with the desired colour combination of yarns for the weaving of the fancy smock fabrics.

3. Ghana Standard Authority should standardize the yarn count of smock fabrics produced in Ghana to guide weavers to produce fabrics with good quality. To improve on the yarn count of smock fabrics produced, the National Board for Small Scale Industry (NBSSI) should embark on giving technical support and training to smock fabric weavers so that they can learn to produce fabrics with high yarn count and of the best quality. Weavers themselves should develop the zeal to producing fabrics with high yarn count so as to keep them in business.
4. The Ministry of Trade and Industry, National Commission on Culture and other relevant authorities should team up to regulate the weaving industry to ensure overall quality in their production process.

Suggestions for Further Research

Future researchers can consider testing for the tensile strength of the smock fabrics after washing in repeated washings since this study was limited to tensile strength of unwashed smock fabrics. Further researchers can also seek for funding to widen the number of specimen fabrics since the cost of the laboratory analysis curtailed the number of fabrics to use.

REFERENCES

Abdulai, A.-R., Adam, A. M., & Alhassan, A. Y. (2016). Indigenous industries in the face of growing competition in textile markets: a study of smock/fugu industry in tamale metropolis, Northern Ghana. *International Journal of Development Research*, *6*(2), 6826–6833. http://www.journalijdr.com/sites/default/files/4781.pdf

Abu-Rous, M., Dabolina, I., & Lapkovska, E. (2018). Fabric physical properties and clothing comfort. *Aegean International Textile and Advanced Engineering Conference*, *459*(1), 1–6. https://doi.org/10.1088/1757-899X/459/1/012028

Acquaah, S., Amissah, E. R., & Yankson, P. de G. (2017). Dress Aesthetics of Smock in Northern Ghana: Form, Function, and Context. *Journal of Textile Engineering & Fashion Technology*, *1*(2), 68–77. https://doi.org/10.15406/jteft.2017.01.00013

Adanur, S. (2001). *Handbook of Weaving* (1st ed.). Technomic Pub. Co.

Adanur, S. (2004). *Handbook of Weving*. Taylor & Francis. http://www.taylorandfrancis.com

Adomaitiene, A., & Kumpikaite, E. (2011). Analysis of mechanical properties of fabrics of different raw material. *Medziagotyra*, *17*(2), 168–173. https://doi.org/10.5755/j01.ms.17.2.487

Ahmed, S. (2021). A study on the physical properties of 100 % cellulosic woven fabrics. *Journal of Textile Engineering & Fashion Technology*, *7*(4), 127–132. https://doi.org/10.15406/jteft.2021.07.00279

Aisyah, H. A., Paridah, M. T., Khalina, A., Wahab, S. M., Berkalp, O. B., Lee, C. H., & Lee, S. H. (2018). Effects of Fabric Counts and Weave Designs on the Properties of Laminated Woven Kenaf / Carbon Fibre. *Multidisciplinary Digital Publishing Institute*, *10*(1328), 1–19. https://doi.org/10.3390/polym10121320

Akinbileje, T. Y. (2014). Symbolic values of clothing and textiles art in traditional and contemporary Africa. *International Journal of Development and Sustainability*, *3*(4), 626–641.

Almetwally, A. A., & Salem, M. M. (2010). *Comparison Between Mechanical Properties of Fabric Woven from Compact and Ring Spun Yarns*. *10*(1), 35–40. http://www.autexrj.org/No1-2010/0329.pdf

Amissah, E. K., & Afram, A. P. (2018). Comparative study of Bonwire kente and Daboya benchibi. *Latest Trends in Textile and Fashion Designing*, *1*(5), 96–108. https://doi.org/10.32474/LTTFD.2018.01.000121

Asmah, A. E., & Abas, S. (2016). Deficiencies and Decline of Daboya Local Dyeing Industry in Ghana. *ADRRI Journal of Arts and Social Sciences*, *14*(4), 35–50. http://www.journals.adrri.org/

Atalie, D., Ashagre, G., & Nalankilli, G. (2017). Impact of Sunlight Exposure to different Dyed fabrics on Colorfastness to Washing. *International Journal of Modern Science and Technology*, *2*(11), 360–365.

Barakat, O. A. S., & Tawab, H. K. A. (2020). Improve the efficiency of fabrics performance to the services workers (Cleanliness) according to nature of their job. *Egyptian Journal of Chemistry*, *63*(3), 823–832. https://doi.org/10.21608/ejchem.2019.13716.1848

Baset, M. A., & Rahman, M. (2016). Application of Industrial Engineering in Garments Industry for Increasing Productivity of Sewing Line. *International Journal of Current Engineering and Technology 6*(3), 1038–1041.

Basu, A., Pasupathy, R., & Kadivrel, S. (2007). The quality of cotton yarns. *Asian Textile Journal, April 2007*, 35–39.

Broadbent, A. D. (2001). *Basic Principles of Textile Coloration*. West Yorkshire: Society of Dyers and Colourists.

Burkhart, B. M. (2019). *Five color fastness tests to prevent textile fading and staining*. Manufacturing and QC Blog. https://www.intouch-quality.com/blog/5-color-fastness-tests-to-prevent-textile-fading-andstaining%0D

Çay, A., & Atav, R. (2007). Effects of Warp-Weft Density Variation and Fabric Porosity of the Cotton Fabrics on their Colour in Reactive Dyeing. *Fibres & Textiles in Eastern Europe*, *15*(1), 91–94.

Cohen, L., Manion, L., & Morrison. (2007). *Research Methods in Education* (6th ed.). New York: Routledge. http://en.bookfi.net/book/1403129

Crawford, L. M. (2019). Conceptual and theoretical frameworks in research. *Foundations in Research Designs*, *1*(3), 35–48. https://uk.sagepub.com/sites/default/files/upm-binaries/105274_ ch03_ 14.pdf

Duchin, F. (2005). Input-output economicsand material flows. *Working Papers in Economics*, *January 2005*, 1–20. https://doi.org/10.1007/978-1-4020-5737-3

Dzramedo, B., & Dabuo, R. (2015). *Challenges and Sustainability of Smock Weaving Within the West Gonja District of the Northern Region*. Ghana Journal of Science, Technology and Development, *3*(1), 36–43.

Esi, B., & Baykal, P. D. (2020). Investigation of tensile strength and elongation properties of chenille upholstery fabrics including recycling polyester yarns. *Journal of Engineered Fibers and Fabrics*, *15*, 1–10. https://doi.org/10.1177/1558925020916040

Essel, O. Q., & Amissah, E. R. K. (2015). *Smock Fashion Culture in Ghana ' s Dress Identity-Making*. Historical Research Letter, *18*(January 2015), 32–39.

Fusheini, M. Z., Adu-agyem, J., & Appau, A. E. (2019). *Indigenous Aesthetic Qualities Inherent in the Dagomba Bim ' maŋli (Smock) in Northern Region of Ghana*. International Journal of Research and Innovation in Social Science, *III*(IV), 237–248.

Ghana Standard Authority (GS) 124 (2019). Specification fortraditinal prints. Accra: GSA.

Galih, V., Putra, V., & Wijayono, A. (2019). Knitted Fabric Density Measurement Using Image Processing Techniques. *Poceeding Indonesian Textile Conference*, *3*, 218–224. https://doi.org/10.5281/zenodo.3470862

Ghosh, A., & Mal, P. (2019). Testing of fibres, yarns and fabrics and their recent developments. *Fibres to Smart Textiles*, *August*, 221–256. https://doi.org/10.1201/9780429446511-12

Gobbi, S. S. (2018). Effect of Some Fabric Parameters on Drapeability of Khadi. *International Journal of Engineering Research & Technology*, *7*(10), 93–95.

Gyampo, R. E. V. (2018). Creating new regions in Ghana: Populist or rational parhway to development. *Ghana Journal of Development Studies, 15(2), 1-16.* DOI//http:dx.doi.org/10.4314/gjds.v15i2.1

Haque, E., & Alam, S. (2016). Effect of Stitch Lengths and Yarn Counts on Areal Density and Drape Behaviour of Different Weft Knitted Single Jersey Structures. *American Journal of Applied Scientific Research*, *2*(6), 33–37. https://doi.org/10.11648/j.ajasr.20160206.11

Harpa, R., & Puscasu, A. G. H. (2015). Characteristics of Woven Fabrics for comfortable summer dresses - subjective and objective evaluation. *15th AUTEX World Textile Conference*, Bucharest, Romania. https://www.researchgate.net/publication/289239330

Hosseinali, F. (2012). *Investigation on the tensile properties of single cotton fibre*. Texas Tech University.

Htike, H. H., Kang, J., & Sukigara, S. (2016). Tensile property of highly twisted cotton yarns under varied relative humidity. *International Journal of Clothing Science and Technology*, *28*(4), 390–399. https://doi.org/10.1108/IJCST-08-2015-0089

Islam, S., Chowdhury, S., & Akter, S. (2018). The Experiential Analysis of Woven Fabric for Reproduction. *Journal of Textile Science and Technology*, *04*(01), 18–48. https://doi.org/10.4236/jtst.2018.41002

Kaynak, H. K., & Babaarslan, O. (2015). Breaking Strength and Elongation Properties of Polyester Woven Fabrics on the Basis of Filament Fineness. *Journal of Engineered Fibers and Fabrics*, *10*(4), 55–61. https://doi.org/10.1177/155892501501000416

Khattak, S. P., Rafique, S., Hussain, T., & Ahmad, B. (2014). Optimisation of fastness and tensile properties of cotton fabric dyed with natural extracts of marigold flower by pad-steam method. *Life Science Journal*, *11*(7), 52–60.

Khin, O. O., & Yee, O. S. (2017). A study on the fastness properties of cotton fabrics. *International Journal for Innovative Research in Multidisciplinary Field*, *3*(8), 135–138.

Kim, S. J., & Kim, H. A. (2018). Effect of fabric structural parameters and weaving conditions to warp tension of aramid fabrics for protective garments. *Textile Research Journal*, *88*(9), 997–1000. https://doi.org/10.1177/0040517517693981

Krishnamoorthi, K., & Jagannathan, S. (2018). A test method for evaluation of colourfastness of textiles to perfumes. *International Journal of Clothing Science and Technology*, *30*(2), 235–245. https://doi.org/10.1108/IJCST-06-2017-0075

Kumpikaitė, E., Tautkutė-Stankuvienė, I., & Dovilė Redeckienė. (2018). Interrelation between tensile properties of yarns and woven fabrics with these yarns. *AUTEX Research Journal*, *15*(10), 1–7. https://doi.org/10.1515/aut-2018-0054

Kumpikaitė, E. (2007). The Fabric Weave‘s Influence on the Character of Fabric Break, Materials Science, 13 (3), 245 – 248.

Kuramoto, K., Yoshihisa, M., Kitaguchi, S., & Sato, T. (2017). Visual colour fastness assessments for multi- coloured fabrics. *Materials Science and Engineering*, *254*, 1–6. https://doi.org/10.1088/1757-899X/254/14 /142014

Kwakye-Opong, R. (2011). Clothing and Adornment in the Ga Culture. In *A thesis submitted to the School of Graduate Studies*. Kumasi: Kwame Nkrumah University of Science and Technology.

Lan, J., Huang, C., Lv, L., Cui, Y., Colouration, G. L., Wang, X., Lan, J., Huang, C., Lv, L., Cui, Y., & Liu, G. (2014). *Colouration and decolouration of cellulose material with pigments obtained by enwrapping dyes onto TiO 2 Colouration and decolouration of cellulose material with pigments obtained by enwrapping dyes onto TiO 2*. *8917*. https://doi.org/10.1179/1432891714Z.000000000648

Lawal, A. S., & Nnadiwa, C. (2014). *Evaluation of Wash and Light Fastness of Some Selected Printed Fabrics*. *1*(4), 1–4.

Leontief, W. (1986). Input-output economics (2nd ed.). New York: Oxford University Press.

Lewis, D. M. (2011). Related titles : In M. Clark (Ed.), *Handbook of Textile and Industrial Dyeing: Principles, Processes and Types of Dyes* (1st ed., pp. 301–364). Woodhead Publishing Limited.

Lieber, W. K., Lieber M. J. and Lieber, C. L. (2005). Chemical testing of textiles. Cambridge: Woodhead Publications.

Masteikait, V., Sacevi, V., Igembayeva, G., & Nurzhasarova, M. (2014). Drape analysis of fabrics used for outerwear. *Indian Journal of Fibre & Textile Research*, *39*(December), 373–379.

Masum, M., & Inaba, K. (2018). A Role of Textile-Clothing Industry in the Economic Structure of Bangladesh : An Input-Output Analysis. *The Ritsumeikan Economic Review*, *67*(3), 34–54.

Matusiak, M., Zieliński, J., & Kwiatkowska, M. (2019). Measurement of tensile properties of seersucker woven fabrics of different structure. *Fibres and Textiles in Eastern Europe*, *27*(2), 58–67. https://doi.org/10.5604/01.3001.0012.9988

Morton, W. E., & Hearle, J. W. S. (2008). *Physical properties of textile fibres* (4Th ed.). Cambridge: Woodhead Publishng Limited.

Moussa, A., Dupont, D., Steen, D., & Zeng, X. (2010). Structure analysis and surface simulation of woven fabrics using fast Fourier transform techniques. *The Journal of The Textile Institute*, *101*(6), 556–570. https://doi.org/10.1080/00405000802596958

Nasrun, F. M. Z., Yahya, M. F., Ghani, S. A., & Ahmad, M. R. (2016). Effect of weft density and yarn crimps towards tensile strength of 3D angle interlock woven fabric Effect of Weft Density and Yarn Crimps Towards Tensile Strength of 3D Angle Interlock Woven Fabric. *AIP Conference Proceedings*, *1774*(October), 020003–020006. https://doi.org/10.1063/1.4965051

Nawab, Y. (2017). *Fabric manufacturing calculations process and product* Lahore: Higher Education Commission.

Nin-Pratt, A. (2015). Agricultural Intensification in Africa A Regional Analysis. *International Food Policy Research Institute* (Issue March).

Ogulata, R. T. (2006). Air Permeability of Woven Fabrics. *Journal of Textile and Apparel, Technology and Management*, *5*(2), 1–10.

Ozougwu, S. U., & Anyakoha, U. (2017). Analysis of colourfastness of fabrics treated with dyes extracted from Roselle calyces. *African Journal of Agricultural Research*, *12*(3), 133–144. https://doi.org/10.5897/AJAR 2014.9107

Pan, R., Gao, W., Li, Z., Gou, J., & Zhang, J. (2015). Measuring Thread Densities of Woven Fabric Using the Fourier Transform. *Fibres & Textiles in Eastern Europe*, *23*(109), 35–40.

Ramzan, M. B., Rasheed, A., Ali, Z., Ahmad, S., Naeem, M. S., & Afzal, A. (2019). Impact of wash types and stitching parameters on shrinkage of knitwear made from pique fabric. *International Journal of Clothing Science and Technology*, *31*(2). https://doi.org/10.1108/IJCST-04-2018-0057

Rana, S., Parveen, S. P., & Fangueiro, R. (2014). *Roadmap to Sustainable Textiles and Clothing*. Springer. https://doi.org/10.1007/978-981-287-065-0_1,?

Rashid, M. R., Ahmed, F., & Azad, A. K. (2012). Study on color fastness to wash & rubbing , whiteness index and color efficiency of weft knitted fabrics made from conventional ring and compact spun yarn. *Institutional Engineering and Technology*, *2*(1), 1–10.

Ray, A. (2014). Prediction of Tensile Strength of Woven Fabrics. *Textile Learner*, *6*(3), 1–14. https://doi.org/10.13140/RG.2.2.35922.81600

Sahoo, H. B. (2018). Concept of clothes. *IInternational Journal of Legal Development and Allied Issues*, *4*(2), 1–7.

Sarıoğlu, E., & Babaarslan, O. (2017). A comparative strength analysis of denim fabrics made from core-spun yarns containing textured microfilaments. *Journal of Engineered Fibers and Fabrics*, *12*(1), 22–32. https://doi.org/10.1177/155892501701200103

Saville, B. P. (1999). *Physical testing textiles*. Cambridge: Wooghead Publishing Limited.

Sharma, I. C., Malu, S., Bhowan, P., & Chandna, S. (1983). Influence of Yarn and Fabric Properties on Tearing Strength of Woven Fabrics. *Indian Journal of Textile Research*, *8*, 105–110.

Stevenson, P. E., Skochdopole, T. R., Cassady, L., Pihs, D., & Kelkar, A. D. (2000). Testing of High Strength Fabrics : *Journal of Inddustrial Textiles*, *29*(4), 260–272.

Tettehfio, L. A. (2009). *The role of the indigenous Ghanaian textile industry in relation to the president's special initiative (PSI) on textiles and garment.* Masters Theses submitted to the Graduate School. Kumasi: Kwame Nkrumah University of Science and Technology. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjGuq6Todf0AhVR5eAKHRTVD2MQFnoECAgQAQ&url=https%3A%2F%2Fwww.scribd.com%2Fdocument%2F438373307%2FLuke-Tettehfio-Thesis-PDF&usg=AOvVaw3FIUgY9ri8AnU5JCvrFjRi

Thiagarajan, P., & Nalankilli, G. (2013). Improving light fastness of reactive dyed cotton fabric with antioxidant and UV absorbers. *Indian Journal of Fibre & Textile Research*, *38*(June), 161–164.

Topalbekiroglu, M., & Kaynak, H. K. (2008). The effect of weave type on dimensional stability of woven fabrics. *International Journal of Clothing Science and Technology*, *20*(5), 281–288. https://doi.org/10.1108/09556220810898890

Venkatraman, P. J. (2013). Fabric Properties and their Characteristics. *E.Space*, *3*, 1–46. https://e-space.mmu.ac.uk/605900/2/Chapter 3 Fabric properties and their characteristics_Symplectic.pdf

Vorhof, M., Weise, D., Sennewald, C., & Hoffmann, G. (2020). New method for warp yarn arrangement and algorithm for pattern conversion for three- dimensional woven multilayered fabrics. *Journal of Industrial Textiles*, *49*(10), 1334=1356. https://doi.org/10.1177/1528083718813530

Wadje, P. R. (2009). Textile - Fibre to fabric processing. *Journal of the Institution of Engineers (India), Part TX: Textile Engineering Division*, *90*, 28–36.

Walliman, N. (2011). *Research Methods: The Basics*. Cambridge: Routledge.

Williams, W. (2009). *A Study of Fibers and Textiles. Georgia: Cengage Learning*.

Willis, D. B., & Straka, T. J. (2017). The Economic Contribution of Natural Resources to a State Economy : A South Carolina Case Study. *Scientific Research Publishing*, *8*(March), 115–129. https://doi.org/10.4236/nr.2017.83009

Wu, J., & Pan, N. (2005). Grab and Strip Tensile Strengths for Woven Fabrics : *Textile Research Journal*, *75*(11), 789–796. https://doi.org/10.1177/0040517505057525

Yang, S., & Gordon, S. (2016). A study on cotton fibre elongation measurement. *33rd International Cotton Conference Bremen, March 16 - 18, 2016*, *1000*, 1–15.

Zhezhova, S., Jordeva, S., Golomeova-Longurova, S., Dimitrijeva-Kuzmanoska, V., & Dimova, T. (2019). Tactile properties of fabrics. *Tekstilna Industrija*, *67*(2), 4–10. https://doi.org/10.5937/tekstind1902004z

APPENDICES

APPENDIX A

INPUT/OUTPUT TABLE

Colourfastness									
Fastness to washing	Y1	Y2	Y3	D1	D2	D3	W1	W2	W3
Fastness to rubbing									
Fastness to sun									
Strength									
Tensile strength	Y1	Y2	Y3	D1	D1	D3	W1	W2	W3
Elongation									
Yarn count per square inch	Y1	Y2	Y3	D1	D1	D3	W1	W2	W3
Dimen. Sta.									
Grammage/ weight									

APPENDIX B

SAMPLE SMOCK FABRICS

Y1

Y2

D1

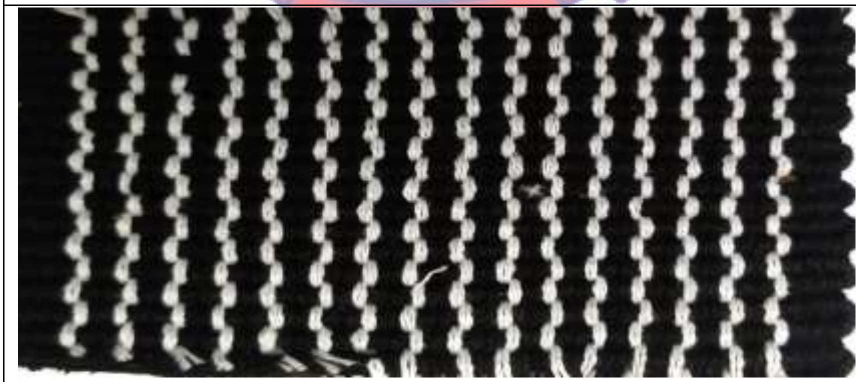
D2

W1

W2

Y3

D3



W3

APPENDIX C

EQUIPMENT AND PROCESSES IN TESTING FABRICS

Using the Crock Master

Tensile Strength Testing

Tensile Strength Testing	Colour Assessment Chamber
 Grywash Machine	 Washing Cylinders
 Grey Scale	 Electronic Weighing Scale

APPENDIX D

STUDENT'S APPLICATION LETTER TO UCCIRB FOR ETHICAL CLEARANCE

University of Cape Coast
Department of Vocational and Technical Education
Cape Coast
15th August 2021

The Chairman/Chairperson
Institutional Review Board
University of Cape Coast
Cape Coast

Dear Sir/Madam,

APPLICATION FOR ETHICAL CLEARANCE

I would like to apply for ethical clearance to enable me collect data for my theses report writing.

The following are my details for your consideration:

Name: Abubakari, Salam

Programme: MPhil. Home Economics (Clothing and textiles)

Student ID. ET/HEP/19/0012

EMAIL: SALAM.ABUBAKARI@STU.UCC.EDU.GH

Research topic: "Analysis of strength and colourfastness of smock fabrics from selected traditional areas in northern Ghana" Supervisor: Irene Ampong (0244745900)

Yours Faithfully,

Salam Abubakari.

(0243085565).

APPENDIX E

COVER LETTER FROM SUPERVISOR TO UCCIRB

DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

University of Cape Coast

23rd May 2021

The Chairperson

Institutional Review

Board University of

Cape Coast

Dear Sir

COVERY LETTER FOR CV

I write as the supervisor for, Salam Abubakari, an MPhil student of the Department of VOTEC who is writing on the topic Analysis of strength and colour fastness of smock fabrics from selected traditional areas in Northern Ghana. I am a Senior lecturer in the area of Clothing and Textile with expeftise in Social Psychology of Clothing, Clothing Production and Textiles.

As a supervisor I have the responsibility of helping students come up with researchable topics, develop their proposals for defence, supervise work in the field, and sometimes supervise experiments at the laboratory. I also guide students to publish their work in refereed journals

I have the capability to supervise in a team, or alone.

I look forward to working with this student.

Sincerely yours,

Ireene Ampong (Ms)

Senior Lecturer

APPENDIX F

HOD'S INTRODUCTORY LETTER OF STUDENT TO UCCIRB

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF VOCATIONAL AND TECHNICAL EDUCATION

Direct: 03320-91097

Telegrams & Cables: University, Cape Coast

University of Cape Coast

Cape Coast

our Ref: VTE/1AP/V.1/158

24th August, 2021

The Director

Institutional Review Board

UCC

Dear Sir/Madam

INTRODUCTORY LETTER

We have the pleasure of introducing to you Salam Abubakari who is an M. Phil student of this Department and working on the thesis topic "Analysis of colourfastness and strength of Smock Fabrics from Selected Traditional Areas in Northern Ghana".

Currently, she is at the data collection stage of her research work and we would be most grateful if you could grant her an ethical clearance from your outfit to enable her progress with the collection of data, Thank you.

Yours faithfully,

Dr. Augustina Araba Amissah

HEAD OF DEPARTMENT

APPENDIX G

INTRODUCTORY TO GHANA STANDARDS AUTHORITY

UNIVERSITY OF CAPE COAST

COLLEGE OF EDUCATION STUDIES

FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF VOCATIONAL AND TECHNICAL

EDUCATION

Direct: 03320-91097
Telegrams & Cables: University, Cape
Our Ref: VTE/IAP/V.1/160

University of Cape Coast
Coast Cape Coast
4th December, 2020

The Director
Ghana Standard Board
UCC

Dear Sir/Madam

INTRODUCTORY LETTER

We have the pleasure of introducing to you Salam Abubakari who is an M.Phil student of this Department and working on the thesis topic "Analysis of colourfastness and strength of Smock Fabrics from Selected Traditional Areas in Northern Ghana".

Currently, she is at the data collection stage of her research work and we would be most grateful if you could give her the necessary assistance from your outfit to enable her progress with the collection of data.

Thank you.

Yours Faithfully,

Dr. Augustina Araba Amissah
HEAD OF DEPARTMENT

APPENDIX H

CONSENT FORM FOR WEAVERS OF SMOCK FABRICS

University of Cape Coast

Faculty of Educational Education

Department Vocational and Technical Education

I am student from the University of Cape Coast Pursuing an M.Phil. degree in Home Economics (Clothing and Textiles).

I am collecting samples of smock fabrics from three traditional areas to undertake my thesis in the University.

Smock samples taken from you is confidential and no identity of yours will be made known to anyone.

Please sign on the spaces provided to indicate your readiness to offer a sample of your woven smock fabrics.

Y1 ………………….

Y2 ………………….

Y3 ………………….

D1 ………………….

D2 ………………….

D3 ………………….

W1 ………………….

W2 ………………….

W3 ………………….