PRODUCTION OF A NO-LYE HAIR RELAXER USING LITHIUM HYDROXIDE

BY

SENU PRISCILLA TINUKE

2003/15091EH

DEPARTMENT OF CHEMICAL ENGINEERING

SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY

FEDERAL UNIVERSITY OF TECHNOLOGY

MINNA – NIGER STATE, NIGERIA

A FINAL YEAR PROJECT WORK PRESENTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR AN AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN CHEMICAL ENGINEERING DEPARTMENT OF THE FEDERAL UNIVERSITY OF TECHNOLOGY MINNA NIGER STATE, NIGERIA.

NOVEMBER 2008.

DEDICATION

This project work is dedicated to my heavenly father Jehovah God who has granted me success in all my endeavours and to my late father Mr. Matthew Senu.

DECLARATION

I, SENU P. T. 2003/15091EH DO DECLARE THAT THIS PROJECT RESEARCH WORK-PRODUCTION OF A NO-LYE HAIR RELAXER USING LITHIUM HYDROXIDE IS AN ORIGINAL WORK OF MINE AND WAS NOT COPIED.

HOWEVER, I RECEIVED USEFUL INFORMATION FROM PUBLISHED AND UNPUBLISHED SOURCES ON THE TOPIC AND DUE ACKNOWLEDGEMENT AND REFERENCE IS GIVEN THEM.

SENU PRISCILLA .T.		03/11/08
STUDENT	SIGNATURE	DATE

CERTIFICATION

This is to certify that this project was carried out by Senu T. Priscilla with registration number 2003/15091EH in the Department of Chemical Engineering, Federal University of Technology, Minna.

Signature 03/11/08

SUPERVISOR DATE

(ENGR. JOSEPH OKAFOR)

Signature ....

PROJECT COORDINATOR DATE

(ENGR. MOSES OLUTOYE)

Signature ....

HEAD OF DEPARTMENT DATE

(DR. M.O. EDOGA)

Signature ....

EXTERNAL SUPERVISOR DATE

AKNOWLEDGEMENT

First and foremost, I would like to express my sincere and profound gratitude to Jehovah God for his mercies.

To my supervisor, Engr. Okafor, I say thank you for your patience, support and contribution to my work.

My special thanks goes to my dear mother Mrs. Mercy Senu and my loving sister Mrs. Joy Disu I could not have gone this far without both of you.

I also want to say thank you to my siblings, Endurance, Lydia, Jephthah and Stephen for their loving support.

I must thank my uncle, Mr. Jacob Senu for his loving care and assistance.

To my cousin, Toyin Senu, I say a big thank you for your moral support and assistance with my typing.

At this point, I must say thank you to all my lecturers who contributed to this work; my neighbours Iyere, Bayo and Abdul; my friends Gloria, Peace, Muzeze, Momoh, Lucky, Chucks Morino, Tony, Afolabi and all those who have been there for me.

ABSTRACT

The project involves the production of nine samples of a no-lye hair relaxer using lithium hydroxide and analysis of the relaxer samples produced.

The samples were produced by varying the composition of the active ingredients-lithium carbonate and calcium hydroxide- while keeping the composition of the other ingredients constant. The hair relaxer samples we characterized by carrying out pH test, alkalinity test, thermal stability, patch test, determination of specific gravity and salon test. In carrying out the salon test, questionnaires were distributed to individuals who were willing to test the relaxer samples on their hair and commenting on the effect of the hair relaxer on their hair.

From the analysis of the relaxer samples, the sample with an equal composition of lithium carbonate and calcium hydroxide gave the bet relaxer composition conforming to the requirement specified by the Standard Organization of Nigeria.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER ONE

1.0 INTRODUCTION

1.1 THE HUMAN HAIR

The human hair fiber is a keratinous material which is comprised of proteins. Many of the polypeptides in hair fibers are bonded together by disulfide bonds (--s- -s--). A disulfide bond may be formed from the reaction of the two sulfhydryl groups (--SH--) one on each of the two cysteine residues which result in the formation of a cystine residue. While there may be other types of bond between the polypeptides in hair fibers such as ionic bonds, the permanent curling and shape of the hair is essentially dependent on the disulfide bonds of cystine residues. (Schoon, 1993)

Straightening or relaxing the curls of very curly hair may increase the manageability and the ease of styling such hair. In today's market, there is an increasing demand for hair care products referred to as "hair relaxers" which can relax or straighten naturally curly or kinky.

1.2 HAIR RELAXERS

A relaxer is a type of lotion or cream which straightens hair by chemically relaxing the natural curls. The active agent in the manufacture of hair relaxers is usually a strong alkali; however, some formulations are based on ammonium thioglycolate. (Khahil, 1985)

1.3 LANTHIONIZATION

Generally hair relaxing processes are chemical processes which may alter the aforementioned disulfide bonds between polypeptides in hair fibers and may form lanthionine residues thus the term "lanthionizing" is used when one refers to the relaxing or straightening of keratin fibers by hydroxide ions.

For example, hair fibers may be relaxed or straightened by disrupting the disulfide bonds of the hair fibers with an alkaline reducing agent. The chemical disruption of disulfide bond with such an agent

is generally combined with mechanical straightening of the hair, such as combing, and straightening generally occur due to changes in the relative positions of neighbouring polypeptide chains within the hair fiber.

1.4 GENERAL USAGE

Hair relaxing or lanthionization is performed by a professional cosmetologist in a salon or at home by the individual consumer. As with hair dye, the treated portion of the hair moves away from the scalp as the new growth of untreated hair sprouts up from the roots requiring periodic treatment (about every six weeks) to maintain a consistent appearance. The relaxer is applied to the roots of the hair and remains in place for a "cooking" interval, during which it alters the hair texture by a process of controlled damage to the protein structure. The hair can be significantly weakened by the physical overlap of successive application or by a single excessive one leading to brittleness, breakage or even widespread alopecia (baldness). When the relaxer has worked to the desired degree, the hair is rinsed clean with water. Regardless of the formula, relaxers are always alkaline to some degree so it is prudent to neutralize or even slightly acidify the hair with a suitable shampoo immediately. The prompt use of hair conditioner is also important in order to replace some of the natural oils that were stripped away by the process.

1.5 "BASE" AND "NO BASE" FORMULAS

Relaxers may be labeled as "base" or "no base". The base refers to a preliminary coating of jelly onto the scalp to protect it from being irritated or burned by the relaxer cream. "No base" cream have a lower concentration and may be applied directly to the hair roots without requiring the protective base layer. (Balsam, 1972)

1.6 OBJECTIVES

The objectives of this project work are:

1. To produce a no-lye hair relaxer using lithium hydroxide as an alternative to sodium hydroxide (lye)

2. To determine the possible combinations of the active ingredients-lithium carbonate and calcium hydroxide-that would yield the best lithium hydroxide hair relaxer.

3. To carry out analysis on the relaxers produced to ascertain their conformity to standard.

1.7 SCOPE OF THE RESEARCH WORK

1. Varying the composition of the active ingredients.

2. Subjecting the relaxer samples to salon test, pH test, determination of specific gravity, alkalinity, thermal stability and patch test.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 ORIGIN OF HAIR RELAXER

Hair relaxer was accidentally discovered by Garrett Morgan in 1909. Morgan opened a tailoring shop selling coats, suites and dresses. While working in his shop, he came upon the discovery of hair relaxer. He noticed that the needles of a sewing machine moved so fast that its friction often scorched the thread of the woolen material. He thus set out to develop a liquid that would provide a useful polish to the needle, reducing friction. When his wife called him to dinner, he wiped the liquid from his hands unto a piece of pony-fur cloth. When he returned to his workshop, he saw that the fibers on the cloth were standing straight up. He theorized that the fluid had actually straightened the fiber. In order to confirm his theory, he decided to apply some of the fluid to the hair of a neighbour's dog. The fluid straightened the dog's hair so much that the neighbour, not recognizing his own dog, chased the animal away. Morgan then decided to try the fluid on himself, to small portion is hair at first, and then to his entire hair. He was successful and had invented the first human hair straightener which is now called hair relaxer. (Zviak, 1986)

2.2 TYPES OF HAIR RELAXERS

2.2.1 LYE RELAXERS

A lye relaxer consists of sodium hydroxide (or lye) mixed with water, petroleum jelly, mineral oil and emulsifiers to create a creamy consistency. Lye relaxers are very caustic and adversely affect the condition of the hair leaving it brittle and harsh to touch. Additionally, prolonged or unnecessary exposure of hair to such a strong alkali can weaken, break or dissolve the hair. All these side effects lead to the formulation of no-lye relaxers. (Balsam, 1972)

2.2.2 NO-LYE RELAXERS

No-lye relaxers are of three main types. One type operates on the same general principle as the lye relaxers but uses a slightly weaker alkaline agent such as potassium hydroxide, lithium hydroxide or guanidine hydroxide.

Another type of no-lye relaxer uses ammonium thioglycolate, which is also known as perm salt for its use in permanent waves. Perm salt is a chemically reducing agent which selectively weakens the hair's cysteine bonds instead of disrupting the entire protein, but it strips out the natural oils even more thoroughly than the alkali hydroxide products.

Lastly, in most relaxers sold for home us, the active agents are ammonium sulfite and ammonium bisulphate. These also selectively reduce the cysteine bonds, but are much weaker and work more slowly, never the less their mild action minimizes but does not entirely eliminate irritation to the skin. (Balsam, 1972)

2.3 METHODS OF PODUCING A NO-LYE HAIR RELAXER USING LITHIUM HYDROXIDE

2.3.1 PRODUCTION WITH COMMERCIAL LITHIUM HYDROXIDE

For hair relaxers produced with commercial lithium hydroxide, the order of addition, formulation, reaction time and temperature are critical parameters affecting the composition and performance of the relaxer. As a result of these limitations, the following method would be used in producing the hair relaxer in this project work.

2.3.2 PRODUCTION WITH LITHIUM HYDROXIDE OBTAINED FROM THE REACTION OF LITHIUM CARBONATE AND CALCIUM HYDROXIDE

Relaxers produced with the above composition as the key ingredient result in an improvement in the composition of lithium hydroxide relaxers. In this case, the above mentioned parameters do not affect the composition and performance of the relaxer. (Balsam, 1972)

2.4 HAIR RELAXER COMPOSITIONS

Most hair relaxer compositions presently known are highly alkaline oil-in-water emulsions which derive their chemical reactivity from either alkali metal hydroxide, quaternary ammonium hydroxide or guanidinium hydroxide dissolved or suspended in the water phase of these hair treatment formulations such that the pH values of these emulsions are in the range of 12 to 14. It is generally accepted that it is the hydroxide ion which is the alkaline chemical specie common to all three of the above classes that is the essential active ingredient in these strong base relaxers. The aforementioned hair relaxer compositions have two principal defects namely:

1. Because of their high alkalinity, all can potentially cause scalp irritation and injury during relaxer treatment.

2. Because all are strong base relaxers capable of dissolving hair keratin, all can over process the hair causing irreversible damage to the fibrous keratin structure leading to air breakage.

These defects can be eliminated as follows:

1. The scalp irritation potential of chemical relaxers has been reduced through the formulation of better cosmetic emulsion containing high level of skin protecting oils such as petrolatum and mineral oil.

2. The problem of over processing is reduced or even eliminated by adjusting the concentration of

the active ingredient to an optimal effective level; then it is up to the user to carefully time the treatment and stop the process when the hair is straight and before it is damaged. (Balsam, 1972)

Although lithium is classified in the periodic chart as an alkali metal, in many respects it is grossly different from sodium and potassium. In fact in all salt forming reactions, the ionic bond between lithium and oxygen are so strong that these salt bonds behave to a large extent like covalent bonds rather than ionic bonds. For example lithium stearate is only minimally soluble in water only up to about 1.5gm per 100gm of water, while sodium and potassium carbonates are extremely soluble in water.

If the Li-O bond of LiOH is more like a covalent bond than an ionic one, then a secondary equilibrium can be established whereby hydroxide ions abstract protons from undissociated LiOH molecule to produce LiO specie (ithoate) according to the following equation:

$LiOH + OH \rightarrow LiO + H2O$

$K_y = [LiOH]\,[OH]$

The dissociation of LiOH can be described as:

$3LiOH \rightarrow 2Li^{+} + OH + LiO + HO$

$K_{yi} = [LiOH]^3$

An assumption can be made that k_{yi} describes a solution of lithium hydroxide in water and k_y is the dissociation constant determined to have a value of 1.2. Based on this assumption, numerical values for k_{yi} and k_y are calculated to be 0.263 and 17.35 respectively. When these dissociation constants were used to calculate the pH of aqueous solutions that were one molar in lithium hydroxide, the equations predicted that the pH was 12.99, which agrees well with the experimental determined value of 13.01. The complete description of all the soluble species in a one molar lithium hydroxide solution is as follows:

OH=0.143 molar

LiO=0.357 molar

LiOH=0.144 molar

Li^+=0.499 molar pH=12.99

The one molar lithium hydroxide solution described above was compared to an analogous one molar sodium hydroxide solution whose soluble species are as follows:

OH=0.804 molar

NaOH=0.195 molar

Na^+=0.804 molar pH=13.75

Clearly the concentration of hydroxide ion in a one molar lithium hydroxide solution is lower by a factor of more than 5 than the hydroxide concentration of an analogous sodium hydroxide solution. (Balsam, 1972)

2.5 INGREDIENTS

The lithium hydroxide hair relaxer is composed of three parts: A, B and C. The formulation is given bellow.

PART A (Oil phase)

Emulsifying wax

Cetyl alcohol

Lanolin

Petrolatum

Paraffin wax

Laneth-20

PART B (Aqueous phase)

Water

Propylene glycol

Lithium carbonate

Calcium hydroxide

PART C

Conditioner

Perfume

2.5.1 DETAILED DESCRIPTION OF THE ABOVE LISTED INGREDIENTS

2.5.1.1 Emulsifying Wax

Emulsifying wax is a cosmetic emulsifying ingredient. The ingredient is often followed by the initial NF, indicating that it conforms to the specifications of the National Formulary. Emulsifying wax is created when a wax material (either a vegetable wax of some kind or a petroleum-based wax) is treated with a detergent (typically sodium dodecyl sulfate or polysorbates) to cause it to make oil and water bind together into a smooth emulsion. (Balsam, 1972)

Uses

It is used for blending creams, lotions and other texture and consistency of the final product without leaving a greasy film on the skin after application. It can also be used as a thickener. (Balsam, 1972)

2.5.1.2 Cetyl Alcohol

Cetyl alcohol, also known as 1-hexadecanol and palmity alcohol, is a solid organic compound and a

member of the alcohol class of compounds. Its chemical formula is $CH_3(CH_2)_{15}$ OH. At room temperature cetyl alcohol takes the form of a waxy white solid or flakes. It belongs to the group of fatty alcohols. Cetyl alcohol is produced from vegetable oils such as palm oil and coconut oil or it is gotten as an end-product of the petroleum industry. [Booth, 1862]

Properties

Molar Mass 242.44g/mol

Density 0.819g/cm^3

Melting point 49-51°c

Boiling point 189°c [Booth, 1862]

Uses

Cetyl alcohol is used in the cosmetic industry as a surfactant in shampoos, or as an emollient, emulsifier or thickening agent in the manufacture of creams and lotions. It is also employed as a lubricant for nuts and bolts. [Booth, 1852]

2.5.1.3 Lanolin

Lanolin is chiefly a mixture of cholestrol and the esters of several fatty acids. It is a greasy yellow substance secreted by the sebaceous glands of wool bearing animals such as Sheep.

Uses

1. Lanolin is used commercially in many products ranging from rust-preventive coating to cosmetics to lubricants.
2. Medical grade lanolin is used as a cream to smoothen skin. It is pure, hypoallergenic and bacteriostatic. In this form it is used by some mothers on sore and cracked nipples. This grade of lanolin can also be used to treat chapped lips, diaper rash, dry skin, itchy skin, rough feet, minor cuts, minor burns and skin abrasions.

3. Lanolin is often used as a raw material for producing vitamin D3 [Balsam, 1972]

2.5.1.4 Petrolatum (Petroleum jelly)

Petrolatum, petroleum jelly is a semi-solid mixture of hydrocarbons (with carbon numbers mainly higher than 25).

Physical Properties

Petrolatum is flammable, having a melting point usually ranging from a little below to a few degrees above 37°c. it is colourless or of a pale yellow colour when not highly distilled, translucent, and devoid of taste and smell when pure. It does not oxidize on exposure to the air, and is not readily acted on by chemical agents. It is insoluble in water. It is soluble in chloroform, benzene, carbon disulfide and oil of turpentine.

Uses

Petroleum jelly is effective in accelerating wound healing stems from its sealing effect on cuts and burns, which inhibits germs from getting into the wound and keeps the injured area supple by preventing the skins moisture from evaporating. It is also used for myriad of ailments and cosmetic uses. [Balsam, 1972]

2.5.1.5 Mineral oil

Mineral oil is a by-product in the distillation of petroleum to produce gasoline. It is transparent, colourless oil composed mainly of alkanes and cyclic paraffins, related to white petrolatum. It has a density of about 0.8g/cm^3. Mineral oil is a substance of relatively low value, and it is produced in very large quantities. There are three basic classes of mineral oil:

- Paraffinic oils, based on n-alkanes
- Naphthenic oils, based on cycloalkanes
- Aromatic oils, based on aromatic hydrocarbons

Applications

Mineral oil is applied in the following areas:

Cosmetics

Mineral oil is a commonly-found ingredient in baby lotions, cold creams, ointments and low grade cosmetics as an alternative to more expensive oils. It is also used to remove make up and temporary tattoos.

Mechanical and Industrial

Because it does not absorb water from air, mineral oil can be used as an automotive aviation, and bicycle brake fluid. It is used in textile industry and as a coolant in electric components as it does not conduct electricity. [Balsam, 1972]

2.5.1.6 Propylene glycol

Propylene glycol known also by the systematic name propane-1, 2-diol, is an organic compound, usually a faint sweet, odourless and coloureless viscous liquid that is hygroscopic and miscible with water, acetone and chloroform. Industrially it is produced by propylene oxide hydration. Propylene glycol can also be converted from glycerol, a biodiesel by product.

Chirality

Propylene glycol contains an asymmetrical carbon atom, so it exists in two stereo isomers. Pure optical isomers can be obtained by hydration of optically pure propylene oxide. [Booth, 1862]

Applications

Propylene glycol is used:

- As a moisturizer in medicines, cosmetics, food, tooth-paste, mouthwash, and tobacco products.

- As a solvent for food colours and flavourings.
- As a carrier in fragrance oils.
- As a less toxic antifreeze.
- As a coolant in liquid cooling systems.
- As the main ingredient in deodorant sticks [Booth, 1850]

2.5.1.7 Lithium Carbonate

Lithium carbonate is a chemical compound with the formula Li_2CO_3.

Properties

Like all other inorganic carbonates, L_2CO_3 is polymeric. It is slightly soluble in water: only 1.33grams dissolve in 100ml at room temperature. Its solubility decreases at higher temperatures. Its apparent solubility increases ten fold under a mild pressure of carbon dioxide; this effect is due to the formation of the metastable bicarbonate:

$Li_2CO_3 + CO_2 + H_2O \rightarrow LiHCO_3$

Other properties are:

Molar Mass 73.8909g/mol

Density 2.11g/cm^3

Melting point 723°c

Boiling point 1310°c [Ulrich, 2005]

Applications

Lithium carbonate is an important industrial chemical. Glasses derived from Li_2CO_3 are useful in

Oven ware. Cement sets more readily and rapidly when prepared with Li_2CO_3. It is used in the production of most lithium-ion battery cathodes. [Wiley, 2005]

2.5.1.8 Calcium Hydroxide

Calcium hydroxide, traditionally called slaked lime, is a chemical compound with chemical formula $Ca(OH)_2$. It is a colourless crystal or white powder obtained when calcium oxide is mixed or slaked with water. It can also be precipitated by mixing an aqueous solution of sodium hydroxide. The name of the natural mineral is portlandite. A suspension of fine calcium hydroxide particle in water is called milk of lime. The solution is called is called lime water and it turns milky, if carbon dioxide is passed through, due to precipitation of calcium carbonate. [Booth, 1850]

Properties

Molar Mass 74.093g/mol

Density 2.211g/cm^3

Melting point 512°c (decomposes)

Solubility in water 0.815g/100cm^3

Basicity P^H = 12.0-12.5

(pK_b) [Booth, 1850]

Uses

Because of its strong basic properties, calcium hydroxide has many uses:

- A flocculant, in water and sewage treatment and improvement of acid soils.
- An alkali used as a lye substitute in a no-lye hair relaxer.
- An ingredient in baby formula milk.
- A chemical reagent.
- In the tanning industry for neutralization of acid.
- In the petroleum refining industry for the manufacture of additives to oils.

- For preparation of dry mixes for painting and decorating.
- In manufacturing mixes for pesticides.
- In dentistry, it is used as a dressing in paste form used for anti-microbial effect during a dental root canal procedure. [Booth, 1850]

2.5.1.9 Hair Conditioner

Hair conditioner is a hair care product that alters the texture and appearance of human hair. Conditioners are frequently acidic, as low p^H protonates the amino acids, providing the hair with positive charge and thus more hydrogen bonds between the Keratin scales, giving the hair a more compact structure. [Balsam, 1972]

Types

1. Pack conditioners, are heavy and thick, with a high content of surfactants to bind to the hair structure and glue the hair surface scales together. These are usually applied to the hair for a longer time.
2. Leave-in conditioners are thinner and have different surfactants which add only a little material to the hair.
3. Ordinary conditioners, combining some aspects of both pack and leave-in ones.

2.6 REQUIREMENT FOR HAIR RELAXERS

According to the Nigerian Industrial Standard (NIS), the following are the requirements to be met by a standard hair relaxer:

1. Physical characteristics
2. The hair relaxer should be in form of a smooth cream and may be suitably perfumed.
3. It should be a homogenous emulsion without visible breakage when stored at ambient temperature for not less than eighteen months from the date of manufacture.

4. The hair relaxer should contain such proportions of constituent chemicals that would ensure good result on the hair without damage to scalp and the hair cell when applied according to manufacture instructions.
5. It should comply with the requirements given in the table below:

TABLE 1: SPECIFICATION FOR HAIR RELAXERS [NIS]

S/N	Characteristics	Requirement
1.	Physical texture	Homogeneous and smooth without particles
2.	Odour	Not offensive
3.	Specific gravity at 27 $\pm$ 2°c	0.88-1.05
4.	Viscosity at 27 $\pm$ 2°c	0.5 *10^6
5.	Thermal stability at 50°c for 24 hours	No separation
6.	P^H of 10% solution at 27 $\pm$ 2°c	10-12.0
7.	Alkalinity	1.5-2.0%
8.	Dermatological safety requirement	Absence of reaction
9.	Saloon test	
1.	Straightening ability	Able to straighten.
2.	Evenness of straightening	Homogeneous straightening.
3.	Least scalp irritation	Tolerable level of sensation.
4.	Glossiness of hair after rinsing	Glossing not affecting colour of hair.
5.	Degree of burns	Minimal.

CHAPTER 3

3.0 PRODUCTION OF HAIR RELAXER SAMPLES.

Apparatus:

i. Heating mantle
ii. Beakers
iii. Stirrer
iv. Thermometer
v. Water bath
vi. Weighing balance
vii. Measuring cylinder

Ingredients:

PART A (oil phase)

i. Emulsifying wax
ii. Cetyl alcohol
iii. Lanolin
iv. Petrolatum
v. Paraffin wax
vi. Laneth-20

PART B (aqueous phase)

i. Water
ii. Propylene glycol
iii. Lithium carbonate
iv. Calcium hydroxide

PART C

i. Conditioner

ii. Perfume

3.1 PROCEDURE: The mass of each ingredient is given in appendix D

1. All the ingredients in part A were weighed and put in a beaker.
2. The beaker was placed on the heating mantle set to 85°c and its content was continuously stirred until the temperature reached 85°c.
3. The ingredient in part B were placed in another beaker measuring and heated to 85°c while stirring.
4. When both phase had reached their targeted temperatures, the hot oil phase (part A) was added to the aqueous phase (part B) and the two phases were homogenized by stirring for 15 minutes to form a uniformly dispersed oil-in-water emulsion.
5. The emulsion was then cooled to 45°c using a water bath.
6. The perfume and conditioner (part C) was then added and the finished cream was cooled to room temperature with slow agitation. [Balsam, 1972]

3.2 CHARACTERIZATION OF RELAXER SAMPLES PRODUCED

3.2.1 DETERMINATION OF SPECIFIC GRAVITY.

Apparatus:

i. Weighing balance

ii. Thermometer

iii. Beaker

iv. Water bath

Procedure:

1. 15ml of sample was put into a 25ml beaker.
2. The temperature of the sample was taken with a 100°c thermometer.
3. When the sample was above 25°c it was cooled with a water bath until it was just below 25°c.
4. Another 25ml beaker was weighed empty.
5. The weighed beaker (m_1) was then filled with 10ml of water and weighed again (m_2).
6. The beaker was emptied and dried thereafter 10ml of the cooled sample was put in it and weighed (m_3).

Calculations:

Specific gravity = (mass of sample) / (mass of equal volume of water)

$= (m_3 - m_1) / (m_2 - m_1)$

Where, m_1 = mass of empty beaker

m_2 = mass of beaker with water

m_3 = mass of beaker with the sample.

3.2.2 P^H DETERMINATION.

Apparatus:

i. P^H meter with glass electrode.
ii. Beaker.
iii. Stirrer.
iv. Measuring cylinder.
v. Weighing balance.

Reagents:

i. Butter solution P^H 7 and 9.

ii. Distilled water.

Procedure:

1. 2g of sample was weighed and put into the beaker.
2. 18ml of distilled water was also weighed and poured into the beaker.
3. The contents of the beaker were stirrer to form a solution.
4. The P^H of the resulting solution was determined by immersing the P^H electrode into the solution in the beaker.

3.2.3 DETERMINATION OF THERMAL STABILITY

Apparatus:

i. Heating mantle.

ii. Beaker.

Procedure:

1. 10g of sample was placed in a beaker.

2. The temperature of the heating mantle was set to 50°c and beaker was placed on it.

3. The sample was heated at 50°c for 50 minutes and observed for separation.

3.2.4 DETERMINATION OF ALKALINITY (AS % LiOH)

Apparatus:

i. Conical flask.

ii. Burette.

iii. Weighing balance.

iv. Spatula.

v. Ting-stand and clamp/holder.

vi. Magnetic stirrer and stirring bar.

Reagent:

1. 0.1N Hydrochloric acid.

2. Phenolphthalein solution.

Procedure:

1. Pour the standard acid solution into the burette and record initial reading of the acid.
2. Weigh the empty conical flask on a weighing balance to obtain the tare weight (T).
3. Add 5g of sample to the conical flask being careful not to allow sample to adhere to the sides of the flask. Equally weigh the conical flask and the sample on the weighing balance to obtain the gross weight (G).
4. Add 50ml of dispersing solution into the flask containing the sample and heat up to 60^{o}c for complete dissolution and separation of the petroleum jelly and subsequent release of lithium hydroxide into the solution. [SON]
5. The magnetic stirrer is then used to homogenize the mixture.
6. When the sample is evenly dispersed into the solution, add one or two drops of phenolphthalein solution as indicator.
7. Titrate the lithium hydroxide in solution with 0.1N hydrochloric acid in the burette until the colour changes from pink to colourless.
8. Record the titre value (V) on the burette reading.
9. Calculate the percentage content of the lithium hydroxide in the sample as follows:

Calculations:

$$(\%\ LiOH) = (V \times 0.004 \times F\ (0.1N\ HCl) \times 100) / ((G - T)$$

Where, (G – T) = the net weight of sample in grams.

V = volume of acid used in titration

F = factor of 0.1N HCl

N = normality of hydrochloric acid

0.04 = equivalent weight of LiOH of each ml of 0.1N HCl used [Ref]

3.2.5 DERMATOLOGICAL TEST

3.2.5.1 PATCH TEST

This establishes whether the sample of cosmetics is responsible for the dermatological upset to the user.

Patch preparation

The preparation for the application of the sample for the test should follow a pre-test of the volunteer's hair texture and the scalp (i.e. the hair soil) for sensitive or normal type.

Procedure

1. The relaxer is applied to the hair of the volunteer and the dermatological upset is observed.
2. If any reactions occur it will be necessary to review the composition very carefully as to the probable cause of the reaction.
3. If no reaction occurs it signifies that the product is safe for public use.

3.2.5.2 SALON TEST

The relaxer sample is applied to the hair of the volunteers for not more than twenty-five minutes and the test sites are examined for the following:

- Straightening ability
- Evenness of straightening
- Irritation to scalp
- Glossiness of hair after rinsing
- Degree of burns

After normal applications to the volunteer's hair and rinsing, the volunteer's hair and scalp should be examined for 2 hours. If the hair scalp peels off leaving scar after application, the formulation is suspected bad and the sample failed the test but if otherwise, the sample passed the test.

CHAPTER FOUR

4.0 EXPERIMENTAL RESULTS

TABLE 2

S/N	Samples	Specific gravity	P^H	Thermal stability at 50°c for 1 hour	% Alkalinity	Patch test Observation
1.	A	1.08	13.03	No separation	2.67	Severe reaction
2.	B	1.08	12.85	No separation	2.40	Severe reaction
3.	C	1.07	11.75	No separation	2.27	Slight reaction
4.	D	1.08	11.00	No separation	2.13	Slight reaction
5.	E	1.04	10.72	No separation	1.87	No reaction
6.	F	1.04	9.21	No separation	1.73	No reaction
7.	G	1.03	9.07	No separation	1.33	No reaction
8.	H	1.03	8.35	No separation	1.07	No reaction
9.	I	1.04	8.16	No separation	0.93	No reaction

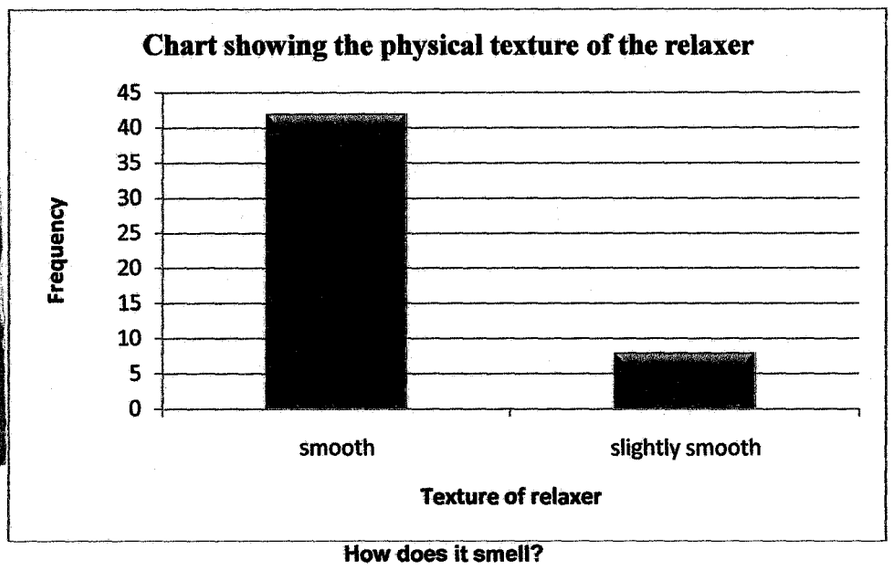
SALON TEST RESULT

The salon test result was obtained after applying the relaxer on the hair of 50 individuals for each sample and giving them questionnaires to fill commenting on the effect of the hair relaxer on their hair. A sample of the questionnaire is shown in appendix G

Result for sample A

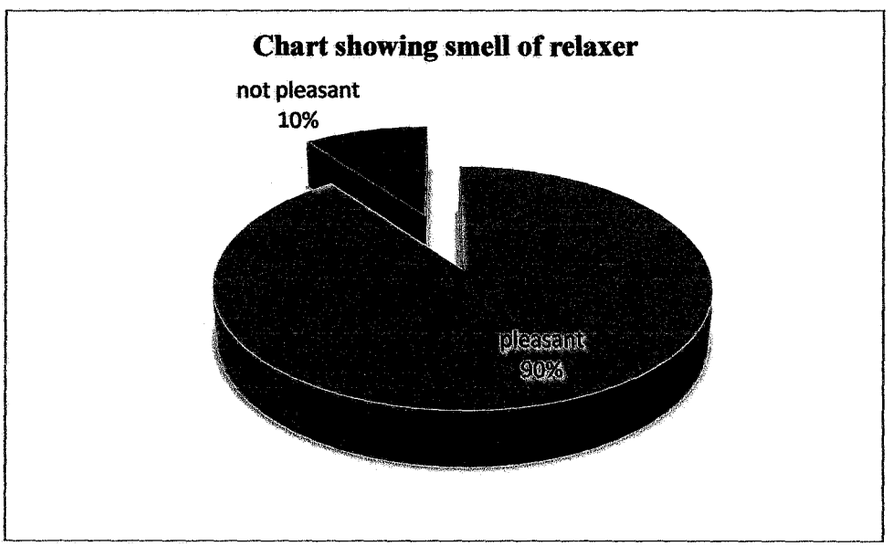
What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	42	84.0	84.0	84.0
slightly smooth	8	16.0	16.0	100.0
Total	50	100.0	100.0	



How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	45	90.0	90.0	90.0
not pleasant	5	10.0	10.0	100.0
Total	50	100.0	100.0	



Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Did the relaxer burn your hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

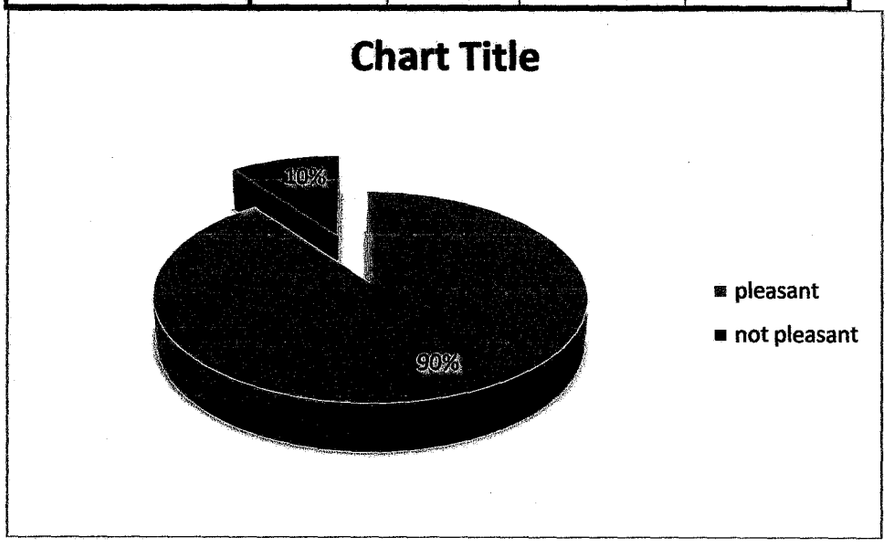
Result for sample B

What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	50	100.0	100.0	100.0

How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	45	90.0	90.0	90.0
not pleasant	5	10.0	10.0	100.0
Total	50	100.0	100.0	



Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	50	100.0	100.0	100.0

Did the relaxer burn your hair?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	yes	50	100.0	100.0	100.0

Result for sample C

What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
1.00	50	100.0	100.0	100.0

How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
1.00	50	100.0	100.0	100.0

Was the relaxer able to straighten the hair?

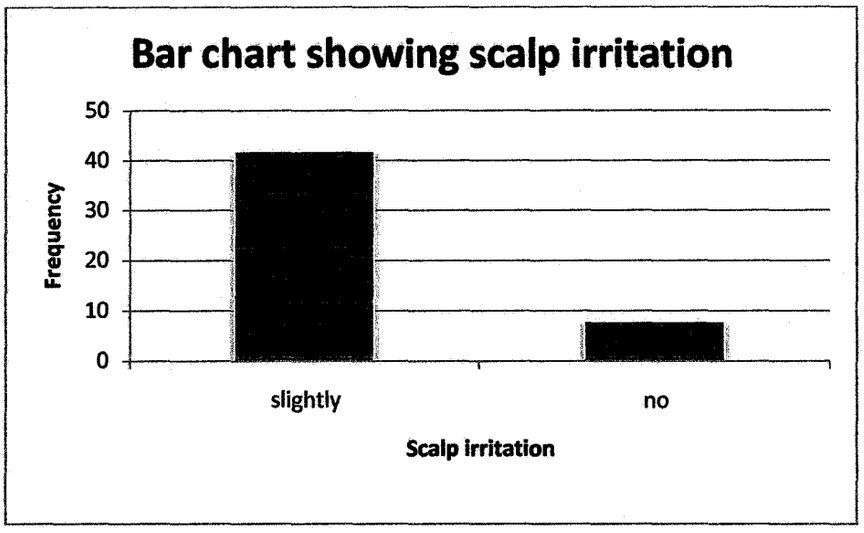
	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	42	84.0	84.0	84.0
no	8	16.0	16.0	100.0
Total	50	100.0	100.0	



Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

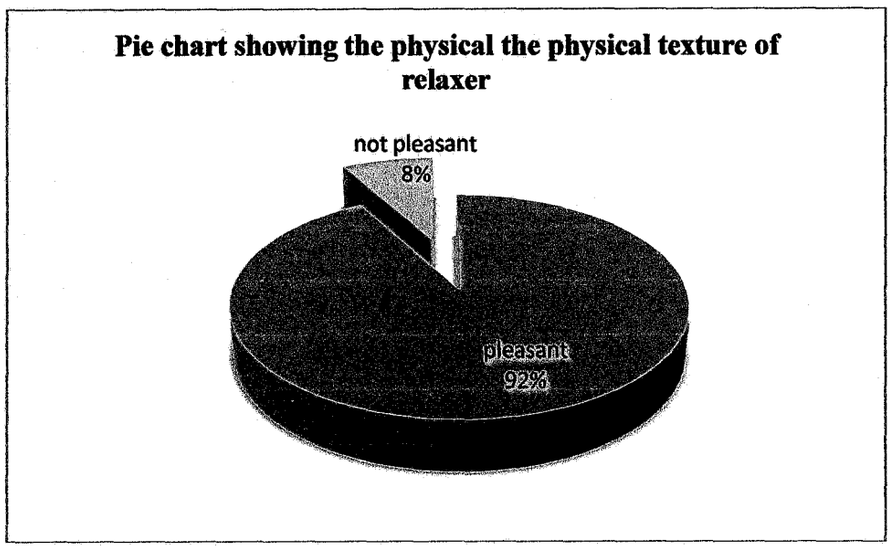
Did the relaxer burn your hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	50	100.0	100.0	100.0

Result for sample D

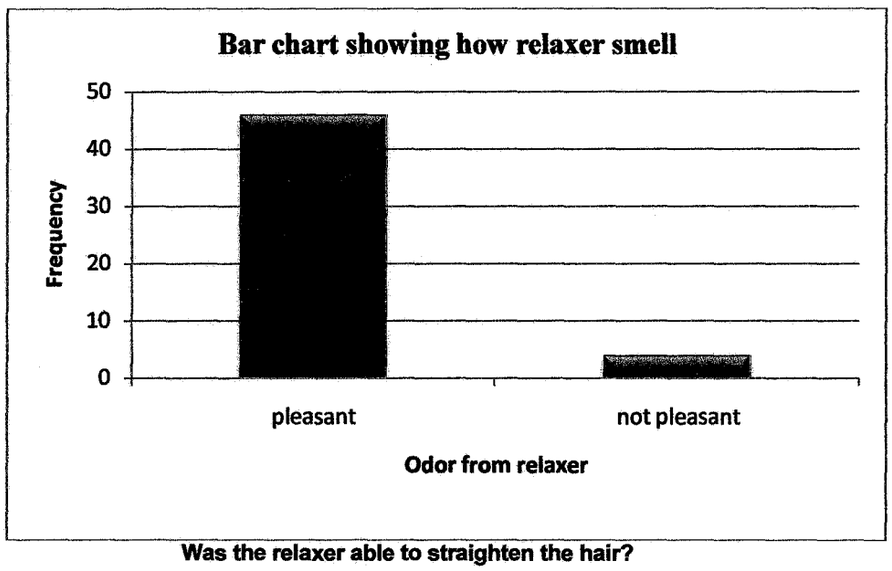
What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	45	90.0	90.0	90.0
slightly smooth	5	10.0	10.0	100.0
Total	50	100.0	100.0	



How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	46	92.0	92.0	92.0
not pleasant	4	8.0	8.0	100.0
Total	50	100.0	100.0	



Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Result for sample E

What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	50	100.0	100.0	100.0

How does it smell?

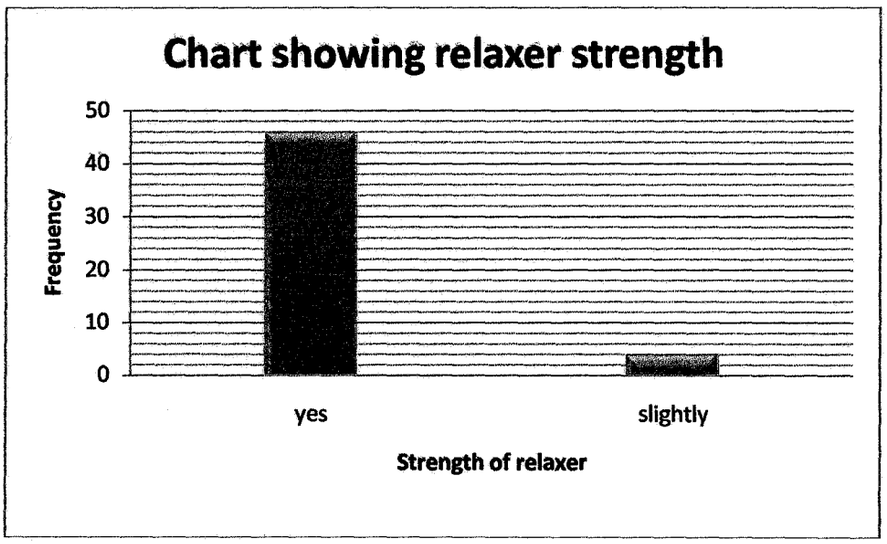
	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	50	100.0	100.0	100.0

Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	46	92.0	92.0	92.0
slightly	4	8.0	8.0	100.0
Total	50	100.0	100.0	



Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Did the relaxer burn your hair?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	no	50	100.0	100.0	100.0

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	50	100.0	100.0	100.0

Did the relaxer burn your hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	50	100.0	100.0	100.0

Result for sample F

What is the physical texture of the relaxer?

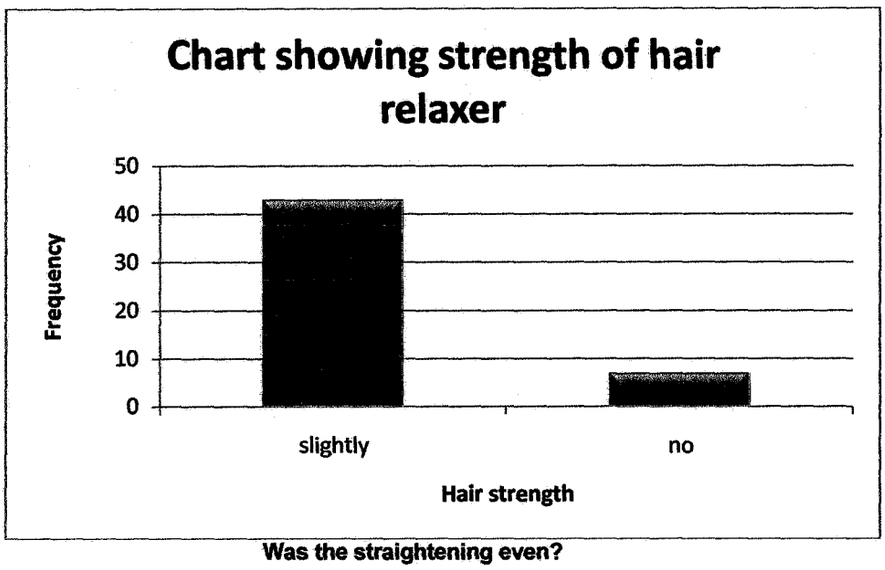
	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	50	100.0	100.0	100.0

How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	50	100.0	100.0	100.0

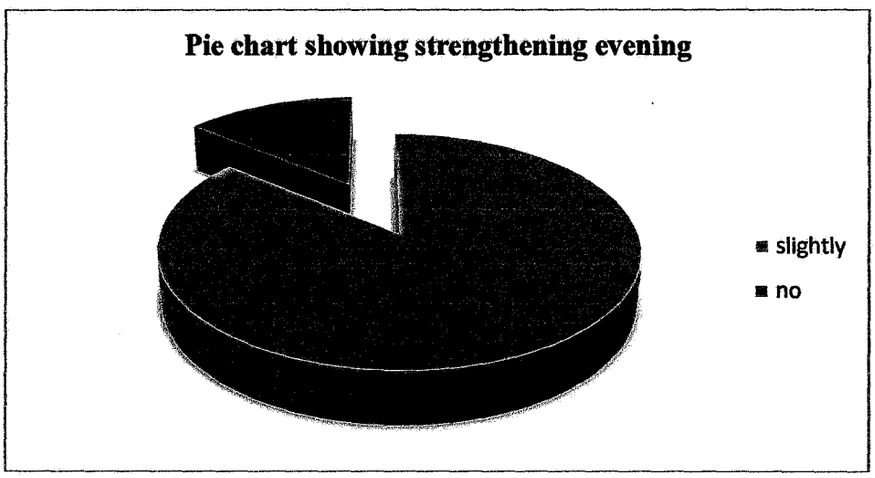
Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	45	90.0	90.0	90.0
slightly	5	10.0	10.0	100.0
Total	50	100.0	100.0	



Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
slightly	43	86.0	86.0	86.0
no	7	14.0	14.0	100.0
Total	50	100.0	100.0	



Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Did the relaxer burn your hair

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

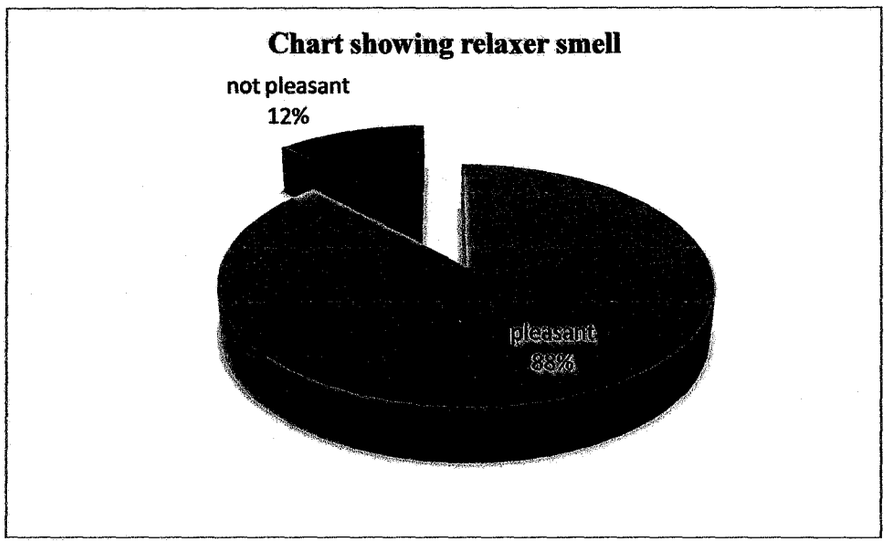
Result for sample G

What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	50	100.0	100.0	100.0

How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	44	88.0	88.0	88.0
not pleasant	6	12.0	12.0	100.0
Total	50	100.0	100.0	



Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Did the relaxer burn your hair?

	Frequency	Percent	Valid Percent	Cumulative Percent

no	50	100.0	100.0	100.0

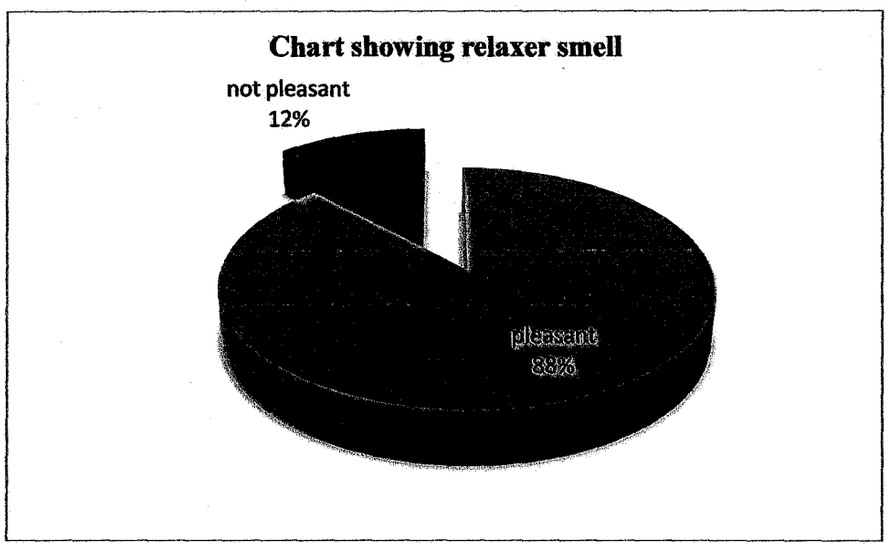
Result for sample H

What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	50	100.0	100.0	100.0

How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	44	88.0	88.0	88.0
not pleasant	6	12.0	12.0	100.0
Total	50	100.0	100.0	



Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Did the relaxer burn your hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

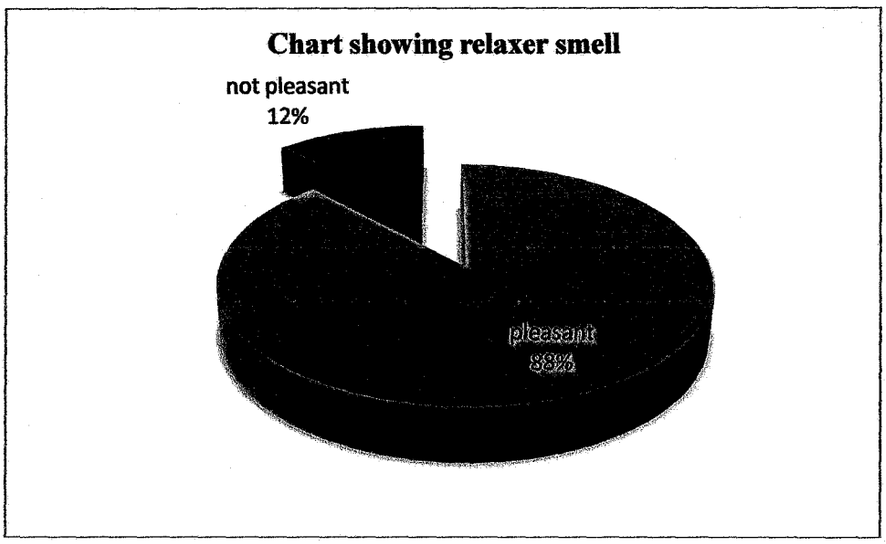
Result for sample I

What is the physical texture of the relaxer?

	Frequency	Percent	Valid Percent	Cumulative Percent
smooth	50	100.0	100.0	100.0

How does it smell?

	Frequency	Percent	Valid Percent	Cumulative Percent
pleasant	44	88.0	88.0	88.0
not pleasant	6	12.0	12.0	100.0
Total	50	100.0	100.0	



Was the relaxer able to straighten the hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the straightening even?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Did it result to scalp irritation?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

Was the hair glossy after rinsing?

	Frequency	Percent	Valid Percent	Cumulative Percent
yes	50	100.0	100.0	100.0

Did the relaxer burn your hair?

	Frequency	Percent	Valid Percent	Cumulative Percent
no	50	100.0	100.0	100.0

A summary of the above data is given in table 3 as shown bellow

TABLE 3: SALON TEST RESULT

Samples	Straightening Ability	Evenness of Straightening	Scalp irritation	Glossiness of hair after rinsing	Degree of burns
A	Not able to straighten	-	Severe sensation	Not affecting colour of hair	Severe
B	Not able to straighten	-	Severe sensation	Not affecting colour of hair	Severe
C	Able to straighten	Very uneven Straightening	Mild sensation	Not glossy	Minimal
D	Able to straighten	Uneven Straightening	Mild sensation	Glossy not affecting colour of hair	Minimal
E	Able to straighten	Homogeneous Straightening	No sensation	Glossy not affecting colour of hair	None
F	Able to straighten	Uneven Straightening	No sensation	Glossy not affecting colour of hair	None
G	Not able to straighten	-	No sensation	Glossy not affecting colour of hair	None
H	Not able to straighten	-	No sensation	Glossy not affecting colour of hair	None
I	Not able to straighten	-	No sensation	Glossy not affecting colour of hair	None

4.1 DISCUSSION OF RESULT

The result of specific gravity as shown in COLUMN 1 of TABLE 2 shows that the specific gravity of the relaxer sample decreases as the mass of calcium hydroxide decreases and that of lithium carbonate increases. This is due to the fact that the density of calcium hydroxide ($2.211 g/cm^3$) is greater than that of lithium carbonate ($2.11 g/cm^3$) as such; calcium hydroxide is denser than Lithium carbonate.

From COLUMN 2, it is seen that the pH of the sample decreases with a decrease in the calcium hydroxide content. This is because calcium hydroxide is a base having a pH between the ranges of 12.0 to 12.5. On the other hand, lithium carbonate is a salt with neutral pH.

COLUMN 3 shows no variation in the thermal stability of the entire relaxer sample when subjected to a temperature of 50°c for one hour. This is because all the relaxer samples have equal content of emulsifying wax which makes oil and water bind together into a smooth emulsion.

The alkalinity as seen in COLUMN 4 decreases as the calcium hydroxide content decreases. This is because $Ca(OH)_2$ is a base.

COLUMN 5 shows the patch test result. For sample A and B, there was severe reaction on the scalp when applied to a portion of the hair. Samples C and D reacted slightly while samples E to I exhibited no reactions at all.

The salon test shown in TABLE 3 shows the straightening ability, evenness of straightening, scalp irritation, glossiness of hair after rinsing and degree of burns observed when each sample was applied to the hair. From this table, we could see that sample E gave the best result because it contains an equal quantity of lithium carbonate and calcium hydroxide.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

For this research project, a no-lye hair relaxer has been produced using lithium hydroxide obtained from the reaction between lithium carbonate and calcium hydroxide. Nine samples of the relaxer were produced by varying the lithium carbonate and calcium hydroxide content.

The result obtained shows that when the calcium hydroxide content is in excess (quantity) to that of lithium carbonate, the relaxer produced is harsh on the scalp and hair. On the other hand, when lithium carbonate is in excess quantity the relaxer produced is too weak to straighten the hair strands.

The result also shows that an equal amount of lithium carbonate and calcium hydroxide gives the best formulation for a lithium hydroxide hair relaxer as it meets all the specification for hair relaxer as stipulated by the Standard Organization of Nigeria (SON).

5.2 RECOMMENDATION

It is recommended that alternative sources for obtaining the lithium hydroxide used for the production of the hair relaxer should be sourced. For example, the double decomposition of lithium sulfate and barium hydroxide solution.

$$Li_2SO_4 + Ba(OH)_2 \longrightarrow BaSO_4 + 2LiOH$$

It is also recommended that other ingredients used in production process be varied and the effect of their variation observed. These ingredients include petrolatum, propylene glycol, lanolin and so on.

Finally, it recommended that apart from lithium hydroxide, other active alkaline ingredients such as guanidine hydroxide be used in the production of hair relaxer.

REFERENCES

Balsam, M.S., (1972), Cosmetic Science and Technology, Interscience, New York, pp. 15, 16, 25, 30, 31, 77, 105, 106, 192, 193, 201-204.

Booth, J. C., (1850), Encyclopedia of Chemistry Practical and Theoretical, Springer, Japan. pp. 128-130, 428, 429, 994-996.

Khalil et al., (1983), Stable Hair Relaxer, Miranol Chemical Co., New York, pp. 85

Schoon, Douglas D., (1993), Hair Structure and Chemistry Simplified, Revised edition, Mildy Publishing Co, pp.191-192.

Wiley-VCH, (2005), Ullmann's Enyclopedia of Indutrial Chemistry; 6th Ed Wiley, New York, pp. 77 and 78.

Zviac, C., (1986), The Science of Hair care, Marcel Dekker, New York, pp.22.

Nigerian Industrial Standard (NIS), (2004)

Standard for Hair Relaxer

Standard Organisation of Nigeria (SON)

13/14 Victoria Arobieke Street.

Off Admirlity way

Lekki Peninul Scheme,

Lekki, Lagos Nigeria.

APPENDIX A

CALCULATIONS OF PERCENTAGE ALKALINITY

$$\% \text{ LiOH} = \frac{V \times 0.004 \times F\ (0.1N\ HCl) \times 100}{(G-T)}$$

(G-T) = net weight of sample in grams

G = weight of conical flask with sample = 61g

T = weight of empty conical flask = 58g

(G-T) = (61-58)g = 3g

V = volume of acid used in titration

F = factor of 0.1M HCl = 1.00

0.004 = equivalent weight of LiOH for each mL of 0.1M HCl used.

SAMPLE A

V = 20mL

$$\%\text{LiOH} = \frac{20 \times 0.004 \times 1 \times 100}{3} = 2.67\%$$

SAMPLE B

V = 18mL

$$\% \text{ LiOH} = \frac{18 \times 0.004 \times 1 \times 100}{3} = 2.4\%$$

SAMPLE C

V = 17mL

$$\%LiOH = \frac{17 \times 0.004 \times 1 \times 100}{3} = 2.27\%$$

SAMPLE D

V = 16mL

$$\%LiOH = \frac{16 \times 0.004 \times 1 \times 100}{3} = 2.13\%$$

SAMPLE E

V = 14mL

$$\%LiOH = \frac{14 \times 0.004 \times 1 \times 100}{3} = 1.87\%$$

SAMPLE F

V = 13mL

$$\%LiOH = \frac{13 \times 0.004 \times 1 \times 100}{3} = 1.73\%$$

SAMPLE G

V = 10mL

$$\%LiOH = \frac{10 \times 0.004 \times 1 \times 100}{3} = 1.33\%$$

SAMPLE H

V = 8mL

$$\%LiOH = \frac{8 \times 0.004 \times 1 \times 100}{3} = 1.07\%$$

SAMPLE I

V = 7mL

$$\%LiOH = \frac{7 \times 0.004 \times 1 \times 100}{3} = 0.93\%$$

APPENDIX B

TABLE 4: WEIGHT PERCENT OF EACH SAMPLE

PART A (OIL PHASE)	Samples weight percent (%)								
Emulsifying wax	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
Cetyl alcohol	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Lanolin	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Petrolatum	15.38	15.38	15.38	15.38	15.38	15.38	15.38	15.38	15.38
Parafin wax	17.32	17.32	17.32	17.32	17.32	17.32	17.32	17.32	17.32
Laneth-20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
PART B (AQUEOUS PHASE) water	41.40	41.40	41.40	41.40	41.40	41.40	41.40	41.40	41.40
Propylene glycol	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60	6.60
Lithium Carbonate	2.00	2.20	2.40	2.60	2.80	2.80	2.80	2.80	2.80
Calcium Hydroxide	2.80	2.80	2.80	2.80	2.80	2.60	2.40	2.20	2.00
PART C conditioner	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Perfume	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30

APPENDIX C

CALCULATIONS FOR THE WEIGHT OF SAMPLES IN GRAMS

Taking a basis of 200g, the weight percent for emulsifying wax, cetyl alcohol, lanolin, petrolatum, paraffin wax, laneth – 20, water, propylene glycol, conditioner and perfume are the same in all samples.

Weight % of emulsifying wax = 8.00%

8.00 / 100 x 200g = 16g

Weight % of cetyl alcohol = 0.80%

0.80 / 100 x 200g = 1.6g

Weight % of lanolin = 2.20%

2.20 / 100 x 200g =4.40g

Weight % of petrolatum = 15.38%

15.38 / 100 x 200g = 30.76g

Weight % of paraffin wax = 17.32%

17.32 / 100 x 200g = 34.64g

Weight % of laneth – 20 = 1.2 %

1.2 / 100 x 200g = 2.4g

Weight % of water = 41.40%

41.40 / 100 x 200g = 82.8g

Density of water = $1.0g/cm^3$

Density =

$1.0g/cm^3 = 82.8g / 1.0g/cm^3$

Converting cm^3 to mL

$82.8cm^3$	1L
	$1000cm^3$

$= 82.8 \times 10^{-3}$ L

= 82.8mL

Weight % of propylene glycol = 6.60%

6.60 x 200g = 13.2g

100

Density of propylene glycol = $1.036g/cm^3$

Volume = mass / density

$13.2g / 1.036g / cm^3$

$12.74cm^3$

$12.74cm^3$	1L
	$1000cm^3$

$= 12.74 \times 10^{-3}$L

= 12.74mL

Weight % of conditioner = 2.00%

2.00 / 100 x 200g = 4g

Weight % of perfume = 0.30%

0.30 / 100 x 200g = o.6g

The mass of calcium hydroxide and lithium carbonate in each sample is as follows:

Sample A

Weight % of lithium carbonate = 2.00%

2.00 / 100 x 200g = 4g

Weight % of calcium hydroxide = 2.80%

2.80 / 100 x 200g = 5.6g

Sample B

Weight % of lithium carbonate = 2.20%

2.20 / 100 x 200g = 4.4g

Weight % of calcium hydroxide = 2.80%

2.80 / 100 x 200 = 5.6g

Sample C

Weight % of lithium carbonate = 2.40%

2.40 / 100 x 200g = 4.8g

Weight % of calcium hydroxide = 2.80%

2.80 / 100 x 200g = 5.6g

Sample D

Weight % of lithium carbonate = 2.60%

2.60 / 100 x 200g = 5.2g

Weight % of calcium hydroxide = 2.80%

2.80 / 100 x 200g = 5.6g

Sample E

Weight % of lithium carbonate = 2.80%

2.80 / 100 x 200g = 5.6g

Weight % calcium hydroxide = 2.80%

2.80 / 100 x 200g = 5.6g

Sample F

Weight % of lithium carbonate = 2.80%

2.80 / 100 x 200g = 5.6g

Weight % calcium hydroxide = 2.60%

2.60% 100 x 200g = 5.2g

Sample G

Weight % of lithium carbonate = 2.80%

2.80 / 100 x 200g = 5.6g

Weight % calcium hydroxide = 2.40%

2.40 /100 x 200g = 4.8g

Sample H

Weight % of lithium carbonate = 2.80%

2.80 / 100 x 200g = 5.6g

Weight % calcium hydroxide = 2.20%

2.20 /100 x 200g = 4.4g

Sample I

Weight % of lithium carbonate = 2.80%

2.80 / 100 x 200g = 5.6g

Weight % calcium hydroxide = 2.00%

2.00 /100 x 200g = 4g

APPENDIX D

TABLE 5: MASS OF SAMPLES

PART A (OIL PHASE)	Samples weight percent (%)								
Emulsifying wax	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00	16.00
Cetyl alcohol	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60	1.60
Lanolin	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
Petrolatum	30.76	30.76	30.76	30.76	30.76	30.76	30.76	30.76	30.76
Parafin wax	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64	34.64
Laneth-20	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
PART B (AQUEOUS PHASE)									
water	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80	82.80
Propylene glycol	13.20	13.20	13.20	13.20	13.20	13.20	13.20	13.20	13.20
Lithium Carbonate	4.00	4.20	4.80	5.20	5.60	5.60	5.60	5.60	5.60
Calcium Hydroxide	5.60	5.60	5.60	5.60	5.60	5.20	4.80	4.40	4.0
PART C									
conditioner	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Perfume	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60

APPENDIX E

SPECIFIC GRAVITY CALCULATIONS

Specific gravity = mass of sample / mass of equal volume of water

Mass of empty container = 2.4g

Mass of water in container = 9.5g

Mass of water = 9.5g – 2.4g = 7.1g

Sample A

Mass of sample in container = 10.1g

Mass of sample = (10.1- 2.4) g= 7.6g

Specific gravity = 7.6g / 7.1g = 1.08

Sample B

Specific gravity = 7.7g / 7.1g = 1.08

Sample C

Specific gravity = 7.6g / 7.1g =1.07

Sample D

Specific gravity = 7.7 g / 7.1g = 1.08

Sample E

Specific gravity = 7.4g / 7.1g = 1.04

Sample F

Specific gravity = 7.4g / 7.1g = 1.04

Sample G

Specific gravity = 7.3g / 7.1g = 1.03

Sample H

Specific gravity = 7.3g / 7.1g = 1.03

Sample I

Specific gravity = 7.4g / 7.1g = 1.04

APPENDIX F

PREPARATION OF STANDARD SOLUTION OF 0.1M HCl

Specific gravity of HCl = 1.18

Molecular weight = 36.5

% purity = 35.4%

Molarity =specific gravity x % purity x 10

Molecular weight

$$= \frac{1.18 \times 35.4 \times 10}{36.5}$$

= 11.44M

For dilution to 0.1M we use dilution formula

$C_1V_1 = C_2V_2$

$C_1 = 11.44M$

$V_1 = ?$

$C_2 = 0.1M$

$V_2 = 500mL$

$V_1 = C_2V_2/C_1$

$$= \frac{0.1 \times 500}{11.44}$$

= 4.37mL Which means that 4.37mL was taken and diluted to 500mL.

APPENDIX G

QUESTIONNAIRE SAMPLE

Department of Chemical Engineering,

School of Engineering and Engineering Technology,

Federal University of Technology Minna,

P.M.B 65,

Minna.

QUESTIONNAIRE ON THE EFFECT OF THE HAIR RELAXER PRODUCED IN MY PROJECT WORK ON THE HUMAN HAIR

Dear Respondent,

I am a final year student of the department of chemical Engineering of the Federal University of Technology Minna, Niger State. I am conducting a research on the effect of the hair relaxer produced in my project on the human hair. Please kindly complete the questions in the questionnaire after using the hair relaxer. I assure you that every information contained in this questionnaire would be used for the sole purpose stated above.

Thanks for your cooperation

Yours faithfully,

SENU PRISCILLA. T.

SECTION ONE

Occupation: _____

Gender: ☐ Male Female ☐

SECTION TWO

QUESTIONS FOR SAMPLE I

INSTRUCTION(thick as appropriate the following questions after using the product)

1.What is the physical texture of the relaxer? Smooth ☐ Slightly smooth ☐ Not smooth ☐

2. How does it smell? Pleasant ☐ Not pleasant ☐ offensive ☐

3. Was the relaxer able to straighten your hair? Yes ☐ Slightly ☐ No ☐

4. was the straightening even? Yes ☐ Slightly ☐ No ☐

5. Did it result in scalp irritation? Yes ☐ Slightly ☐ No ☐

6. Was the hair glossy after rinsing? Yes ☐ Slightly ☐ No ☐

7. Did the relaxer burn your scalp? Yes ☐ Slightly ☐ No ☐