COMPARISON OF EFFECTS OF IMPORTED STEARIN (STEARICACID) AND LOCALLY MADE STEARIC ACID FROM COCONUT

AS

AN ADDITIVE IN CANDLE WAX PRODUCTION

BY

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MATRIC NO: 2004/18547EH

DEPARTMENT OF CHEMICAL ENGINEERING,

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FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

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A RESEARCH PROJECT SUBMITTED TO THE DEPARTMENT OF CHEMICAL ENGINEERING, SCHOOL OF ENGINEERING AND ENGINEERING TECHNOLOGY,

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NIGER STATE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BARCHELOR OF ENGINEERING (B. ENG) DEGREE IN CHEMICAL ENGINEERING

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CERTIFICATION

This is to certify that, this project, "Comparison of Effects of Imported Stearin (Stearic Acid) and locally made stearic acid from Coconut as an addictive in Candle wax production" was carried out by YUSUF JAMIU KOLAWOLE, in partial fulfillment of the requirement for the award of Bachelor of Engineering (B.Eng) degree in Chemical engineering

.... 13/11/09 ....

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Project Supervisor

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Head of Department

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External Examiner Date

DECLARATION

I YUSUF JAMIU KOLAWOLE, declare that this project is a result of my personal research work and has not been presented elsewhere for the award of any certificate under supervision of Engr. A.G. Isah.

[signature] .... 18/09/09 ....

Student signature Date

DEDICATION

This research project is dedicated to Almighty Allah. "The creator of the heaven and earth and the whole universe", "The Omnipresent"," "The Omnipotent" "The Omniscient", who spares my life from the beginning of my existence till now. And also to my loving brother NURUDEEN TAIYE YUSUF of blessed memory (may his gentle soul rest in perfect peace)

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ABSTRACT

This research project is focus on the evaluation and comparision of the effects of imported stearin (stearic acid) and locally extracted stearic acid from coconut as an additive in candle wax production. During the course of this research experiment, burning rate of each of the candle wax was studied after the addition of different quantities of imported stearic acid and locally extracted stearic acid. The result of this research project shows that the burning rate of candle wax using imported stearic acid as an additive makes the candle wax burns slower, sag less, smoking of the fuel reduction while burning, more opaque and glossier than locally extracted stearic acid. 10.0g of imported stearic acid and 100g of paraffin wax was harder, opaque, and glossier than 10g of locally extracted stearic acid from coconut and 100g of paraffin wax. From the result, the candle wax produced with the addition of stearic acid as an additive is economically viable.

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CHAPTER ONE

1.0 INTRODUCTION

The word "candle" comes from a Latin term meaning "torch" or "bright. candle is simply defined as a waxy substance that will bring continuous heat source to melt the substance and burn the vapors as it evaporates.

previously before electricity been domesticated, the candle was a common source of illumination and heating source, ahead of the mid 19th century, candles were commonly made from tallow (a by product of beef-fat rendering). Candles made from gel, soy, beeswax, and vegetable products are also available. (Robert, 1982)

The candle was developed independently in many countries like the Egyptians and Cretans who made their candles from beeswax, as early as 3000BC.Besides In Rome around the first century, candles were made out of tallow and the pith of rushes. The candle was widespread in northern Europe, and olive oil lamps more common in southern Europe and around the Mediterranean Sea.

The early candle was made from various natural fat, tallow, and wax. In the 18th century, spermaceti, oil produced by the sperm whale, which was used to produce a better candle, which are expensive. Late in the 18th century, colza oil and rapeseed oil came into use as much cheaper substitutes. Paraffin was first distilled in 1830, and transformed candle- making, as it was an economical material which produced a high- quality, odorless candle that burned rationally cleaned. The industry was wrecked soon after, however, by the distillation of kerosene (confusingly called paraffin). This superb fuel for lamps gave the candle its present status as a mostly decorative item.

In 1829, William Wilson of price's candles invested in 1,000 acres (4km) of coconut plantation in srilanka. His intention was to make candles from coconut oil later he tried palm oil from palm trees. An inadvertent discovery swept all his dreams aside when his brother George Wilson, distilled the first petroleum oil in 1854. 1n 1919, lever brothers procured price's candles and in 1922, a joint- owned company called "Candles

LTD" was formed. By 1991, the last lingering owner of "Candles LTD" was shell Oil Company, who vends off the candle- making part of business.

Before the domestication of electricity, the candle was a common source of lighting, and later in addition to the oil lamp. Due to local availability and the cost of resources, for several centuries up to the 19th century the candle was more common in Northern Europe, and olive oil lamps more common to Southern Europe and around the Mediterranean Sea.

Today, candles are most commonly used for their aesthetic value, particularly to set a soft, warm, or romantic ambiance, and as alternate for electrical power, and also as insecticide for killing and impediment of some dangerous insects such as mosquitoes, bedbugs, ants, termites, etc. Candles were also helpful for urgent illumination during electrical power failures. The scented candle is common in aromatherapy.

Candle was also used to light fires. Other use of candles includes the following points listed below:

RELIGION: Candle is used in the religious ceremonies of many different faiths.

KWANZAA: The candle is also used in celebration of Kwanzaa, which is an African American holiday which runs from December 26 to January 1.

SIKHISM: The candle is used in Sikhism on Diwali, the festival of light

UNITARIAN UNIVERSALISM: A common element of worship in many Unitarian Universalist churches and fellowships in the lighting of candles of joy and concern.

However, in a developing economy like Nigeria where power shortages are rampant, the use of candles is still one of the most popular household lighting means. The demand for candles for various purposes aside from its traditional usage is on increases. A candle is now made in various shape and sizes, including the new popular scintillating aroma candles. Candle making has become a thriving industry and one can observe the mushrooming of candle shop selling ready-to-make candles, moulds, wax, wick, essential oil and other requirement of the enterprises.

1.1 AIMS AND OBJECTIVES

The aims and objectives of this research project is to compare the effects of different proportions of imported stearic acid and locally made stearic acid on paraffin wax as additive in candle wax production also to maximize quality and minimize the cost of candle wax production. The aims also include promotion of locally made materials as one of the aims and objectives of vision 20: 2020

1.2 SCOPE

This project research will be restricted to only locally made stearic acid and imported stearic acid as the additives and paraffin wax as the active ingredients for candle wax production.

1.3 JUSTIFICATION

Over the years, there have been candle wax products that burn at a very rapid pace which results economic in justification. This research work on solving such problem as it helps to investigate the requirements for the production of a candle wax that burns for a longer period which will no doubt bring a lot of benefits to Nigerians and Africans in general, as candles serves as suitable alternative to the electric source of lighting and also supplement the effect of electric power failure.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 CANDLE

Spermaceti, 1750, shows that oil that comes from sperm whale was used to provide very expensive candles. By 1800, a much cheaper substitute was discovered, Colza oil, derived from Brassica campestris, and related oil derived from rape seed, yielded candles that produce clear, smokeless flames.

Michel-Eugene Chevreul ,(1786-1889), outline for the first time that tallow or animal fat consisted of various fatty acids one of the fatty acids he recognized was stearin(stearic acid). In 1825 "Chevreul" and "Joseph Gay Lussac" patented a process for candle making from crude stearic and in 1854, paraffin combined with stearic acid to make it stronger and this process drastically improved the quality of candles.

Joseph Sampson et al, 1790 was granted a United States patent for a new method of candle making (this was the second patent ever granted by the United States). In 1834, Joseph Morgan began to industrialize the production of candles. He invented a machine to make 1,500 candles per hour from a mould.

In 1830 Laurent distilled paraffin from Schist, and Dumas, obtained paraffin from coal tar in 1835.In 1850 James Young filled a patent to produced paraffin from coal after which paraffin could be used to generate inexpensive candles of high quality.

George Wilson, 1854, discovered the first distilled petroleum oil. In 1919 Lever Brothers acquired price's candles and in 1922, a joint-owned company called "candles LTD" was created. By 1991, the left behind owner of "candles LTD" was Shell Oil Company, who vend off the candle-making part of business.

The European candle Association (1997) and Schwind and Hossempour(1994) keened out that without using Lead wicks, consumers are also bared to concentration of organic chemicals in candle emissions. It was concluded that there is no health hazard associated with candle burning even when a terrible case of 50 candles burning for 5 hours in 30m 3 rooms is presumed. Candles with Lead wicks have the latent to generate indoor airborne lead concentrations of health concern. It is also possible for consumers to inadvertently buy candles containing lead wick cores and repetitively exposes themselves to harmful amounts of lead through regular candle burning.

Kareem, 2006, shows that sachet water, a cause of environmental dilemma because of their incapability to decay, can be bowed into candles, shoe polish, Lubricating grease, Filter aid, and most essentially, a substance that absorbs oil from water -oil spill sobbing waters.

According to European candle association, (1997), candles are illumination source usually consisting of an internal wick which rises through the centre of column of solid fuel. The major additives in the production of candle are stearin .Stearin is regarded as fat; it is a whole crystalline solid at ordinary temperature and is insoluble in water and very slightly soluble in alcohol. It is found in many hard fats and oils, e.g. tallow, butter fats, cotton seed oil, coconut oil, and olive oil.

Wick is made from cotton strands. It has the duty of absorbing the fuel in the fuel in the burning zone. It structure is dependent on the type, the diameter and the production method of the candle. Preferably the wick is braided from cotton fibers.

The wick is prepared to ensure that the fuel will not extinguish the flame and to provide for an even burn with a tranquil flame. The braiding also exerts a crucial influenced on the optimal burning and lighting of the wick. The top of the wick has to bend to the outmost rim.

Where the oxygen flows into the reaction zone, this will give a complete burning. If the tip of the wick stays in the flame then it burns imperfectly and a soot mushroom is created. If the wick is too weak, then it cannot absorb the melted wax in the burning pool, this will cause the burning pool to overflow and the candle to drip, if the wick is too strong, it will absorb all the melted wax and thus, makes the burning pool constantly empty. This will give an imperfect burning since; the flame will be big and smoky and candles burns faster. The most common type of wicks used with candles wax is cotton, zinc core, and coated wicks.

More colors and shapes are always created and are essential for a good candle. The dyes for dipping and for the complete dying are technically distinguished from one another. Dyes that are used mainly for dipping are based from original pigments. Normally only the outer candles are coated while the cores remain white/ plane.

The advantage of pigment base built dyes is that it is non fading and does not bleeding the packaging. Dyes for candle making are available in liquid.

There are different wicks for candle wax production (i.e. flat braid, square braid, cored wick and tabbed wick) .

Kamal, 2008, shows that the burning of the fuel takes place in several distinct regions (as proofed by the various colors that can be seen within the candle's flame). Within the bluer, hotter regions, hydrogen is being separated from the fuels and burn to water vapor. The brighter, yellowier part of the flame is the remaining carbon soot being oxidized to form carbon dioxide. As the mass of the solid fuel is melted and consumed, the candle grows shorter. Portions of the wick that are not evaporating the liquid fuel are ideally consumed in the flame, limiting the exposed length of the wick and keeping the temperature and the rate of fuel consumption even(www.candlewhiz.com)

2.2 TYPES OF CANDLE

Candle whiz, (1995) outline different types of candles depending on types of wax, shape, and additive being used for their productions which are alighted below:

1. Container candles
2. Hurricane candles
3. Luminaries candles
4. Gel candles
5. Pillar candles
6. Taper candles

7. Oil candles

8. Sand candles

9. Floater candles

10. Sculpted candles

11. Molded / Novelty (free standing) candles

12. Tart / Melt candles

13. Votive candles

14. Tea light candles

15. Layered candles

(1) CONTAINER CANDLES

Any candle that is poured into a container of any type, such as jars, glasses, tins, etc. container candles create a large pool of molten wax. Because they "contain" the wax, they are non-messy and very popular. They are also known for giving off a strong scent, which is due to their melt pools.

(2) HURRICANE CANDLES

Candle shell mold used for dried flowers and other decoration leaves the centre of the mold hollow to be filled with wax not containing the flowers. The outside shell doesn't burn so the flowers don't flat into the flame. These can be refilled over and over, or you can insert a votive or tea light candle in the shell.

(3) LUMINARIES CANDLES

Candle lanterns usually made with a votive cup set inside a paper bag full of sand, and used to line a driveway or sidewalk.

(4) GEL CANDLES

Clear and translucent candles made of candle gel, candle gel is a patented material comprised of mineral oil and polymer resin.

(5) PILLAR CANDLES

A free standing candle usually round and tall like a cylinder, but can be made in other shapes such as square, hexagon, triangle, star, heart, etc. These are made in metal, acrylic, or latex molds and are meant to be burned as a flat holder.

(6) TAPER CANDLES

Taper candles are tall, skinny candles that require a special fitting taper candle holder. They are either made in a mold, or they can be made by the traditional method of dipping a length of wick into hot molten wax. Another method is to roll a sheet of bees wax around a wick, forming a taper. The most common size is ½ or 7/8 inches in diameter and either 9 or 12 inches tall.

(7) OIL CANDLES

Glass container filled with liquid paraffin fuel, burned with a fiber glass wick

(8) SAND CANDLES

Free standing candle with an outer shell made by sand and wax. Damp sand forms the mould after which hot wax is poured to make this type of candle.

(9) FLOATER CANDLES

A small candle shaped with a rounded or tapered bottom so it floats in water. Floaters must be designed to core burn so that the wax stays contained and doesn't run into the water.

(10) SCULPTED CANDLES.

Made from a pliable wax and hand formed to resemble an object or character.

(11) MOLDED / NOVELTY (FREE STANDING) CANDLES

These are irregularly-shaped, free standing candles made by molding, sculpting or pouring into a shaped mold. Many are made to be burned, and many are used more for decoration and are not meant to be burnt.

(12)TART /MELT CANDLES

Small disc of scented wax used to melt in a tart burner or potpourri. These are usually round 2.5" scalloped and fluted, but can also come in other shapes such as hearts, leaves, stars, etc.

(13) VOLTIVE CANDLES

These are small pillar shaped candles that are usually about 1 ½ inch in diameter and 2-3 inches high. They are designed to burned in a glass votive cup because they are made to completely liquefy when burning, essentially becoming a small container candle. A candle flame must have a pool of fuel (molten wax) to draw from, so if you burn a votive on a flat holder or a plate, the burning time will be shorter because the candle will loose its shape and basically become a puddle, drowning out the wick, the tighter fitting glass cups work best.

(14) TEA LIGHT CANDLES

Tea lights are like small votives used to warm pots of potpourri and to heat foods. The fit are poured in small metal or plastic tea light cups and are usually sold in packages of 10 or 12.

(15) LAYERED CANDLES

Pillars or Containers that are layered in two or more different

2.3 *CANDLE SOOT*

According to Krause, 1999, Black soot deposition (B S D) is referred to as ghosting, carbon tracking, carbon tracing, and dirty house syndrome.

Black soot is the product of the incomplete combustion of carbon-containing fuels. Complete combustion would result in a blue flame and would produce negligible amounts of soot and carbon-monoxide. Until recently, the source of the black soot in homes was unknown.

Through researches and recent experiments, it is now discovered that frequent burning of candle is one of the sources of black soot. The amount of soot produced can vary greatly from candle to candle. One type of candle can produced as much as 100 times more soot than another type For example, elemental carbon emission rates varied from less than 40 to 3,370g candle burned in a study of sooting behavior in candles).The type of soot may also vary through primarily composed of elemental carbon, candle soot may include Phthalates, Lead, and Volatiles substances such as Benzene, and Toluene

Fine et al, 1999, said Scented candles are the major source of candle soot deposition. Most candle wax paraffin is saturated hydrocarbons and is liquid at room temperature. The lower the carbon to hydrogen ratio, the less soot is produced by the flame. There fore, waxes that has more fragrances in them produces more soot. In other words, candles labeled “super scented” are those that are soft to the touch and are more likely to generate soot.

Vigil, 1998, pointed out that situation in which a candle is burned can also impact its sooting potential. A small and stable flame has a lower emission rate than a large flickering flame with visible black particle emissions (Fine et al., 1999.) Thus, a forced air flow around the flame can also cause sporadic sooting behavior. Stephen et al., 2000, reported that candles in glass containers produce more soot because the container causes unsteady airflow and disturbs the flame shape. They also describe that candles are extinguished by oxygen deprivation, or blowing out the candle produced more soot than those extinguished by cutting off the tip of the wick. Cutting the wick eliminates the emissions produced by a smoldering candle.

When soot builds up in air, it eventually deposits onto surfaces due to one of four factors. First, the particles may randomly collide with a surface. Second, soot particles can be circulated by passing through home air- conditioning filters. Third, soot can gain enough mass to become subject to gravity. Homes with BSD often have carpets stained from soot deposition. Finally, the particles are attracted to electrically charged surfaces such as freezers, vertical plastic blinds, television sets, and computers.

When soot is air borne, it is subject to inhalation. The particles can potentially penetrate the deepest areas of the lungs, the lower respiratory tract and alveoli.

2.4 STEARIC ACID (STEARIN)

Nicore Leoeuf –Little,2002, reported that stearic acid which is also known as stearin, is a long-chain fatty acid often used in making candles. Its primary property is to raise the melting point of the wax mixture, making the resulting candle harder and more durable.

The derivation of stearin from rendered animal fat aided the industry's transition from tallow to paraffin. Paraffin became popular because it cost less to produce and burned cleaner than tallow. However, it's lower melting point-between 120 and 140 degrees Fahrenheit –caused problems. The hardening effect of stearin, with its melting point of up to 160 degrees Fahrenheit, made paraffin a much more viable option.

Stearin abridges the production of molded candles. A mixtures of stearin and paraffin will shrink as it cools, allowing the creations of candles to easily pop free of their molds.

Robert, 1998, said variety of visual effects can be attained with stearin. A lower ratio can result in an attractive, but not always desired, snowflake effect in higher proportions. To increase the glossy finish of stearin- paraffin taper smashed the candle in cool water immediately after it has finished dipping. The resulting glossed look comes from stearin's crystalline structure.

One modus operandi in which stearin is very useful is over dipping. This process involves concluding of a normal candle production by dipping it in a separate high melting point wax. This will form a firm outer shell which will have more opposition to melting. As the candle burns the outer shell remains, containing the softer molten wax inside. This modus operandi not only reduces melting, it extends the life of the candle.

Dada, 2007, said Stearin powder can usually be found in the same stores that sell paraffin and bees wax. It can also be made from vegetable oil, coconut, and as from tallow, so it is now reliant on individual choice and substantial factors to prefer to circumvent animal by product and it will take benefit of this useful additives.

2.5 *COCONUT*

Maharishi Ayurveda, 2008, said Coconut has a long history of use as both a food and as a medicine throughout the world. It holds a high place of respect in Ayurvedic medicine in India. Ayurvedic literature is full of praise for the coconut. The Council of Maharishi Ayurveda Physicians considers coconut a divine plant in the Vedic tradition. Whenever a sacred ceremony is performed, a coconut must grace the occasion. Thus, the coconut enjoys a hallowed status in the Vedic tradition. Ayurveda's revered ancient healer, Sushruta, noted that coconuts strengthen muscles, the cardiovascular system, cleanse the urinary tract, and the seven body tissues. Coconut improves the complexion and is considered a wound healer; especially effective in preventing the formation of scars when applied topically many populations within the tropics have used coconut for generations and recognize its healing value. In folk remedies around the world coconut is use to treat a wide assortment of ailments among which include asthma, burns, cachexia, calculus, colds, constipation, cough, debility, dropsy, dysentery, fever, flu, gonorrhea, hemoptysis, jaundice, nausea, phthisis, pregnancy, rash, scabies, scurvy, sore throat, stomachache, swelling, syphilis, toothache, tuberculosis.

2.5.1 TYPES OF OIL FROM COCONUT

The Asian and pacific coconut community (A.P.C.C), (2008), outline four different types of oil from coconut

Virgin coconut oil

Virgin coconut oil is produced from fresh coconuts (rather than dried, as in copra) with minimal processing so that it retains a slight coconut flavor and aroma. Virgin coconut oil is regarded as the highest quality coconut oil and is preferred for food preparation and home medicinal use.

RBD Coconut Oil

Coconuts sundried in Kozhikode, Kerala for making copra, which is used for making coconut oil

RBD stands for "refined, bleached, and deodorized." RBD oil is usually made from copra (dried coconut kernel). Copra can be made by smoke drying, sun drying, or kiln drying. The dried copra is then placed in a powerful hydraulic press with added heat and the oil is extracted. This yields up practically all the oil present, amounting to more than 60% of the dry weight of the coconut. This "crude" coconut oil is not suitable for consumption because it contains contaminants and must be refined with further heating and filtering. Another method for extraction of a "high quality" coconut oil involves the enzymatic action of alpha-amylase, polygalacturonases and proteases on diluted coconut paste. Unlike virgin coconut oil, refined coconut oil has no coconut taste or aroma. RBD oil is used for home cooking, commercial food processing, and cosmetic, industrial, and pharmaceutical purposes.

Hydrogenated Coconut Oil

RBD coconut oil can be processed further into partially or fully hydrogenated oil to increase its melting point. Since virgin and RBD coconut oils melt at 76°F (24°C) foods, such as chocolate, tend to melt in warm climates. A higher melting point is desirable in these warm climates so the oil is hydrogenated. The melting point of hydrogenated coconut oil is 97-104°F (36-40°C).

In the process of hydrogenation, unsaturated fats (monounsaturated and polyunsaturated fatty acids) are bombarded with hydrogen atoms to make them more saturated. Coconut oil contains only 6% monounsaturated and 2% polyunsaturated fatty acids. In this process some of these are transformed into Tran's fatty acids.

Fractionated Coconut Oil

Fractionated coconut oil is a fraction of the whole oil, in which the long-chain fatty acids are removed so that only medium chain saturated fatty acids remain. Lauric acid, a 12 carbon chain fatty acid, is often removed as well because of its high value for industrial and medical purposes. Fractionated coconut oil may also be referred to as caprylic/capric triglyceride oil or medium chain triglyceride (MCT) oil because it is primarily the medium chain caprylic (8 carbons) and capric (10 carbons) acids that make up the bulk of the oil.

MCT oil is most frequently used for medical applications and special diet.

2.5.2 *Physical properties of coconut*

According to Ayurveda, 2008, Coconut is uniquely different from most other dietary and for this reason, has found use in a multitude of applications in food, medicine, and industry. What make coconut different from most other dietary are the basic building blocks or fatty acids making up the dietary. Coconut is composed predominately of a special group of fat molecules known as medium chain fatty acids (MCFA). The majority of fats in the human diet are composed almost entirely of long chain fatty acids (LCFA).

The primary difference between MCFA and LCFA is the size of the molecule, or more precisely, the length of the carbon chain that makes up the backbone of the fatty acid. MCFA have a chain length of 6 to 12 carbons. LCFA contain 14 or more carbons. Therefore, the physiological effects of the MCFA in coconut are significantly different from those of the LCFA that are more commonly found in the diet.

MCFA and LCFA can also be classified as saturated, monounsaturated, or polyunsaturated fatty acids. Coconut contains 92% saturated fatty acids. All of the MCFA in coconut are saturated. They, however, are very much different chemically from the long chain saturated fatty acids found in animal fat and other vegetable. Because coconut has a high amount of saturated fatty acids it also has a relatively high melting point. Above 76°F (24°C) .Coconut is very heat stable so it makes an excellent cooking and frying. It has a smoke point of about 360°F (180°C). Because of its stability it is slow to oxidize and thus resistant to rancidity, lasting up to two years due to high saturated fat content.

Fatty Acid	**Saturation**	**Carbons**	**Percent**
Caproic	Saturated	6	0.5
Caprylic	Saturated	8	7.8
Capric	Saturated	10	6.7
Lauric	Saturated	12	47.5
Myristic	Saturated	14	18.1

Palmitic	Saturated	16	8.8
Stearic	Saturated	18	2.6
Arachidic	Saturated	20	0.1
Oleic	Monounsaturated	18	6.2
Linoleic	Polyunaturated	18	1.6

Coconut contains approximately 92.1% saturated fatty acids, 6.2% monounsaturated fatty acids, 1.6% polyunsaturated fatty acids. The above numbers are averages based on samples taken. Numbers can vary slightly depending on age of the coconut, growing conditions, and variety.

2.6 *WAXES*

According to Williams, 2002, wax is generally refers to as a substance that is plastic solid at ambient temperature and on being subjected to moderately elevated temperatures it becomes a low viscosity liquid. Because it is plastic, wax usually deforms under pressure without the application of heat. The chemical composition of waxes is complex: they usually contain a broad variety of molecular weight species and reaction functional groups, although some classes of mineral and synthetic waxes are totally hydrocarbon compounds.

Different types of wax within each group namely:

1. Insect and animal waxes
2. Soy waxes
3. Gel waxes
4. Mineral waxes
5. Vegetable waxes
6. Synthetic waxes

1. INSECT AND ANIMAL WAXES: Beeswax – white and yellow bee wax have been known for over 2000 years Beeswax is secreted by bees. E.g. Apis mellifera, A.dorsata, A.flores, and A.indica, and used to construct the combs in which bees store their honey. The wax is harvest by removing the honey and melting the comb in boiling water; the melted product is filtered and cast into cakes. The yellow beeswax can be bleached with oxidizing agent, e.g. peroxide or sunlight, to white beeswax, a product much favored in candle wax production. Beeswax is naturally aromatic, so it is rare that one would add fragrance.

2. SOY WAXES: Soy candle wax is one of the newest candle waxes. It is becoming popular because it is a renewable resource, biodegradable, can be melted in the microwave, and it is great for North American farmers. The waxes are very soft, so it can be used in a container, and add lots of hardener and use either a larger wick or paper-cored wick.

3. GEL WAXES: Gel candle wax is used in those candles where there are bubbles within the wax. Gel candle wax is made from a combination of processed mineral oil and a gelling agent. It is clear and has a rubbery texture, but when scooping it out it looks like hair gel.

Gel wax candles are one of the most dangerous types of candle to make because it is very difficult to heat in a double boiler to reach its melting point.

4. MINERAL WAXES: Mineral waxes include montan waxes, peat waxes, ozokerite and ceresin waxes, and petroleum waxes.

A paraffin wax is a petroleum wax consisting principally of normal alkanes, paraffin is a by-product of the petroleum industry. Paraffin is what our every day candles are made from, paraffin is a white and semi-transparent and it produces an odorless smoke.

5. VEGETABLE WAXES: The aerial surfaces of utmost all multicellular plants are covered by a layer of wax. With the advent of more sensitive analytical tools, e.g. gas-liquid chromatography and mass spectrometry, investigations of the character of a particular wax many species has been undertaken. However, only a very few extent species, primarily those in semiarid climates, produce waxes in such quantities that commercial recovery is economically feasible.

Vegetable Waxes include Candelilla, Carnauba, Japan wax, Ouricury wax, Douglas-Firbark wax, Rico-Barn wax, Castor wax, Bayberry wax, and Jojoba wax.

Bayberry candle wax was discovered by early American colonists who were looking for an alternative to tallow, which gave off tons of soot, air pollutants and a somewhat unpleasant smell. Bayberry candle wax comes from the bayberry shrub which produces very decorative bluish grey tinged barriers.

6. SYNTHETIC WAXES: Synthetic waxes include Polyethylene waxes, Fischer-Tropsch waxes, chemically modified hydrocarbon waxes, and substituted amide waxes.

But for this research project, Paraffin wax is used because of its availability and ease of use as include in the factors to be considered when embark on a research project.

2.6.1 CHEMICAL COMPOSITION AND PROPERTIES OF WAXES

McGraw Hill, 1982, said the most typical chemical constituent of natural waxes as a group is the esters of long-chain fatty alcohols and acids. Petroleum waxes and certain other mineral waxes, however consists of hydrocarbons. Aliphatic or open chain structures with relatively little branching or side chains can be considered typical for both ester and hydrocarbon waxes. It could be said that the functional element found in waxes are carbon, hydrogen, and oxygen.

Other compound that could be found in waxes are hydrocarbon, alkyl, esters, primary alcohols, acids, ketones, aldehyde, secondary alcohols, hydroxyl acids, lactones, acetols diols, dicarbonxylic acids, do-ketones, polyester etc.

2.6.2 *WAX APPLICATIONS AND USES*

Beneath are catalog of the most applications and uses of waxes, since it is practically not viable to mention all the various applications a wax can be used for.

S/no	Wax application	Uses
1	Asphalt and bitumen	Regulates compactness and augments durability
2	Candles	Base component, energy for controlled ignition
3	Adhesive and Glues	Regulates stickiness, surge and settling time.
4	Electric cables	Seal gaps between
5	Food wrappers	Avert outflow, protects from dryness

CHAPTER THREE

3.0 MATERIALS AND METHODOLOGY

3.1.0 *APPARATUS AND MATERIALS*

MATERIALS \CHEMICALS	SOURCE	COMMENTS
Heating mantle	Chemical laboratory	Heat supply
Melting can (Double boiler)	Chemical laboratory	Reactor
Weighing balance	Chemical laboratory	Sample(s) measuring equipments
Thermometer	Chemical laboratory	Temperature Reader
Stirrer	Chemical laboratory	Mixer
Mould	Chemical stock market	100ml
Water-bath	Chemical laboratory	-
Scissors	Chemical laboratory	-
Beaker	Chemical stock market	100ml and 200ml
Wick	Chemical stock market	0
Paraffin wax	Chemical stock market	500g
Imported Stearin (steric acid)	Imported	60g
Locally made stearin (stearic acid) from coconut	Sample collected from NARICT	60g
Knife	Chemical stock market	-
Spoons	Chemical stock market	-

3.1.1 *MOULD PREPARATION AND WICKING*

The inside of the mould was made clean, A quantity of wick chosen to suit the mould was cut at least 12cm longer than the length of the mould, after which the wick was threaded through the hole made in the base of the mould and secured knot tried. A wick holder was positioned across the apex of the mould and the wick secured to it. It was ensured that the wick was centered in order for the candle to burn uniformly. The mould was warmed to improve the candle finishing.

3.2.0 *EXPERIMENTAL PROCEDURE*

These steps involves for the experimental procedure of production of candle wax using imported stearic acid and locally made stearic acid from coconut as an additive respectively are slated below:

100g of paraffin wax was measured and poured into the top of the double boiler and the base pan was filled with water to approximately 1/3 of its volume. The medium setting was on a heating mantle, and the water beings to boil rapidly, and then the heat was reduced to a moderate boil to prevent wax from splashing into the container.

The paraffin wax was melted to a temperature of 67oc. This is due to the type of mould used (plastic mould) which is 4.7 in diameter, in order to get the required temperature (67oc), the thermometer was hollow into the paraffin wax to confirm the temperature, but get in touch with was avoided between the thermometer and base of the pan.

The wick is prepared. This is done by placing the required length of wick into the paraffin melted wax until it starts to release bubbles. This means that it has engrossed enough wax. Afterwards, the wick was carefully removed (not with fingers i.e. the wax is hot and instead use an old knitting needle) and pulled tights then placed to dry. The basis for doing this is that the pinnacle of the wick (top of candle) is well waxed and will be easier to light. Also, it makes threading it through the wick hole in the mould much simpler.

Once the wick is firm (only takes a couple of minutes) it was inserted through the tiny hole at the pinnacle of the mould and pulled through. It was then secured around a pencil or wick support at the untie end of the mould. The tiny hole was plugged with a mould seal to stop the wax from leaking out.

As the desired temperature is reached, the additives were added for this experimental research analysis 5.0g of stearic acid was added to 100g of paraffin wax. When the stearic acid has completely dissolved, color and fragrance could be added if required.

The sides of the mould were tapped several times before the candle wax sets. This is done to discharge the trapped air bubbles that will blot the surface of the finished candle.

The tiny holes in the candle around the wick were poked after the wax has set to a tacky consistency. This will help to avert large air pockets inside the finished candle that can be fire hazard.

The setting of this experiment was left for a few hours. And the candle was placed in a water bath to cool more rapidly. It was firmly ensured that the water is profound sufficient to go all the way up the mould. It was also ensured that the water is not getting into the setting wax.

All above procedures were repeated with 0g, 5g, 10g, 15g, and 20g of stearic acid against the same quantity of paraffin wax (i.e. 100g for each). And the candles produced in each case were named A, B, C, D, and E respectively.

And also the same procedures were repeated with 5g, 10g, 15g, 20g, of locally made stearic acid as an additive against imported stearic acid and 100g of paraffin wax. And the candles produced in each case were named F, G, H, and I respectivel

3.2.1 *EXPERIMENTAL PROCEDURE OF DETERMINE BURNING RATE*

Each candle sample (A, B, C, D, E, F, G, H, and I,) were placed disjointedly on a work bench at room temperature (+27oc). The total height of each candle from the apex of the wax to the surface of the work bench was measured with measuring tape and recorded as H (o).

The wick end of each candle wax was simultaneously ignited and the height above the surface of the workbench at every interval of time (say ten minutes) was recorded as H(t).

The total time taken for each candle wax to burn completely (burning rate) observed.

CHAPTER FOUR

4.0 RESULT AND DISCUSSION

4.1 Result

Table 4.1: Stearic acid content in each candle sample

S/N	SAMPLE	MATERIAL CONTENT OF THE SAMPLES
1	A	100g of paraffin wax
2	B	5g of imported stearic acid
3	C	10g of imported stearic acid
4	D	15g of imported stearic acid
5	E	20g of imported stearic acid
6	F	5g of locally extracted stearic acid
7	G	10g of locally extracted stearic ac id
8	H	15g of locally extracted stearic acid
9	I	20g of locally extracted stearic acid

Table 4.2: Experimental measurement of burning rate with their height variation

TIME (min)	SAMPLES CORRESPONDING HEIGHT H(cm)								
	Sample A	Sample B	Sample C	Sample D	Sample E	Sample F	Sample G	Sample H	Sample I
0	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
10	4.50	5.50	5.90	6.00	6.10	5.30	5.40	5.70	6.00
20	3.20	4.30	4.90	5.50	5.80	4.10	4.20	5.20	5.70
30	2.30	3.30	4.10	5.10	5.40	3.50	3.60	4.90	5.30
40	1.10	3.00	3.30	4.60	5.00	2.80	2.90	4.40	4.90
50	0.00	2.10	2.60	4.10	4.60	1.90	2.00	3.90	4.50
60	-	1.00	2.00	3.60	4.20	0.00	1.00	3.50	4.10
70	-	0.00	1.30	3.10	3.80	-	0.00	2.90	3.70
80	-	-	0.60	2.60	3.40	-	-	2.40	3.30
90	-	-	0.00	2.00	3.00	-	-	1.80	2.90
100	-	-	-	1.50	2.60	-	-	1.40	2.50
110	-	-	-	0.80	2.20	-	-	0.70	2.10
120	-	-	-	0.00	1.80	-	-	0.00	1.70
130	-	-	-	-	1.40	-	-	-	1.30
140	-	-	-	-	1.00	-	-	-	0.90
150	-	-	-	-	0.60	-	-	-	0.00
160	-	-	-	-	0.00	-	-	-	-

4.2 DISCUSSION OF RESULTS

Kamal(2008), reported from his research that candle wax produced from paraffin wax and stearic acid were harder, opaque, and glossier, than those produced without stearic acid, sample (A) was therefore produced without stearic acid. This is done so that we can investigate the effect of stearic acid on the candle wax produced and also to justify kamal result. From the result of table 4.1.2(sample B) it was observed that because of the addition of stearic acid, the candle wax produced were harder, opaque and more glossier than sample A which concur with Kamal report.

Kareem (2006), also reported from his own findings that the more the quantity of stearic acid in a candle wax the higher the melting point to justify this conclusion sample B, C, D, E, were produced.

From Table 4.1.1, it was observed that the time taken for the candle wax to burn is not longer compared to other sample (that is their burning rate is faster because of low melting point which is as a result of 0g of stearic acid), while for sample C burning rate is longer than sample B due to effect of 10g of stearic acid and sample D is longer than sample C because of 15g of stearic acid and also sample E burning rate is longer than sample D due to 20g of stearic acid.

Manufacturer Association of Nigeria(man), observed that candles produced from imported stearic acid were harder, shrink together, and lesser illumination than those produced from locally extracted stearic acid though their basics for this conclusion is not sound but the conclusion was correct as it agrees with our findings base on the result of sample F, G, H, AND I, as it was observed that their burning rate was slightly higher than sample ,C,D, E respectively due to effects of some impurities presents in locally extracted stearic acid. Which implies that effects of imported stearic acid as it affects the burning rate of candles wax is slightly higher than locally extracted stearic acid from coconut.

CHAPTER FIVE

5.0 CONCLUSSIONS AND RECOMMENDATIONS

5.1 *CONCLUSSION*

The result of this research has shown that stearin (stearic acid) used as an additive in the production of candle wax has an effect on its melting point which in turn is the determine factor of the burning rate of candle wax and also that imported stearic acid has a greater effect on the burning rate of candle wax than locally made stearic acid.

In conclusion, the course experimental analysis has established that increase in the amount of stearin in paraffin wax leads to reduced burning rate of candle wax and also that using locally extracted stearin as an additive in candle wax is economically viable because of the availability in the country despite the slight lower effect on burning rate of candle wax than imported stearin.

5.2 RECOMMENDATION

It is recommended that, future research work should continued in this line, so as to find the accurate proportion of locally made stearic acid to be used for maximum illumination and reduction in burning rate in candle produced.

It is also recommended that further research should be carry out on costing so as to encourage the use locally extracted stearic acid as an additive in candle wax production in other to promote locally made materials which in turn reduced the import to export ratio of the country

Finally, it is recommended that the department should adequately equip

The laboratory with necessary equipments and apparatus to enable students perform their practical work properly. This is in order to avoid them moving from one laboratory to another, which will in one way or the other affect their research

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