PHILIPPINE SCIENCE HIGH SCHOOL WESTERN VISAYAS
Doña Lawaan H. Lopez Campus
Iloilo City

BETEL NUT (*Areca catechu*) EXTRACT AS FABRIC DYE, ITS QUALITATIVE ANALYSIS

A Research Paper Presented to the
Faculty of the Philippine Science High School Western Visayas
Iloilo City

In Partial Fulfillment
of the Requirements in
Science Research II

By

Eric Anthony C. Arances
Adrian T. Bacolod
Edmund D. Orata

February 2000

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APPROVAL SHEET

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Abstract

Experiments were conducted to analyze the qualitative properties of betel nut extract as fabric dye. For the dye extraction, betel nut was readied for water extraction and simmered for half an hour, and was set aside for dye application. Then a cloth was pretreated and applied with the potassium dichromate mordant ($K_2Cr_2O_7$). The cloth was dyed with the betel nut extract. The experiment was conducted three times to ensure the accuracy of results, including the dyeing using commercial dye. The results would indicate the quality of the dye compared to synthetic dyes. Both cloths underwent washing test. Results showed that betel nut extract as fabric dye, using potassium dichromate, had color fastness and color intensity qualities comparable to that of the commercial dye. And that, betel nut extract as fabric dye has a potential of becoming a better alternative for this commercial synthetic dye.

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BETEL NUT (*Areca catechu*) EXTRACT AS FABRIC DYE,

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Chapter 1

Introduction to the Study

Background of the Study

Until the mid-19th century, all dyes were derived from the leaves, twigs, roots, berries, or flowers of various plants or from animal substances (Grolier Encyclopedia of Knowledge, 1995). Tyrian purple, used by the Phoenicians in the 15th century, was produced from certain varieties of crushed sea snails. Another snail variety, the banded dye-murex, was discovered in the 1980s to be the source of hyacinthine purple, a blue-purple dye known in Biblical Hebrew as tekhelet and employed up to 3600 years ago for dyeing ritual prayer shawls. The use of indigo as long ago as 3000 BC has been documented, synthetic indigo is still an important dye because it is exceptionally fast.

Most of the natural dye sources were wild collected (www.sni.net). Only a few, such as wood, indigo, madder, and cochineal were intensively cultivated. As synthetic dyes were developed, beginning with synthetic indigo in 1897, reliance on natural dye sources diminished. And by 1914, only 4% of the indigo produced was extracted from plants.

Historically, dyed textiles were symbols of status and, because of their expense, reserved only for the wealthiest. Some of the earliest records of textile dyes come from artifacts entombed with the Egyptian pharaohs. Early dye sources probably included plants, animals, and mineral extracts. These extracts produced a variety of muted shades from plant and mineral sources to the deep blues of indigo, and Tyrian purple, the most prestigious and costly dye from a Mediterranean shellfish. As the New World was discovered additional dyes were introduced. Cochineal, a Central American insect and rich source of red dye, became nearly as valuable a trade item as precious metals (www.sni.net).

Dyeing can be as simple as primitive housewife squeezing berries or as a complex as the great factories of the modern dye industry (Young People Science Encyclopedia, 1987). Whatever the case, the basic principles from definite chemical situations that can be complex. Dyes color almost all manufactured products especially in textile products. Local manufacturers use imported synthetic dye for their product, which is very expensive.

A renewed interest in natural dyes is fueled by a pro-environment consumer aware of the ecological liabilities of the dye industry, and by increasingly strict effluent regulations (www.sni.net). Natural dyes represent a virtually no impact alternative to conventional dye methodologies. Clearly, natural dyes and naturally dyed clothing will never completely replace synthetic dyes in the textile industry but offer a sound alternative.

The researchers hoped to bring back the use of natural dyes instead of synthetic dyes to help boost the industry of textile. There are lots of advantages using natural dyes just like producing a natural dye is safer and less complicated than producing its artificial counterpart, which undergoes a complex and expensive processes.

Figure 1 shows the relationship between the variables in the study.

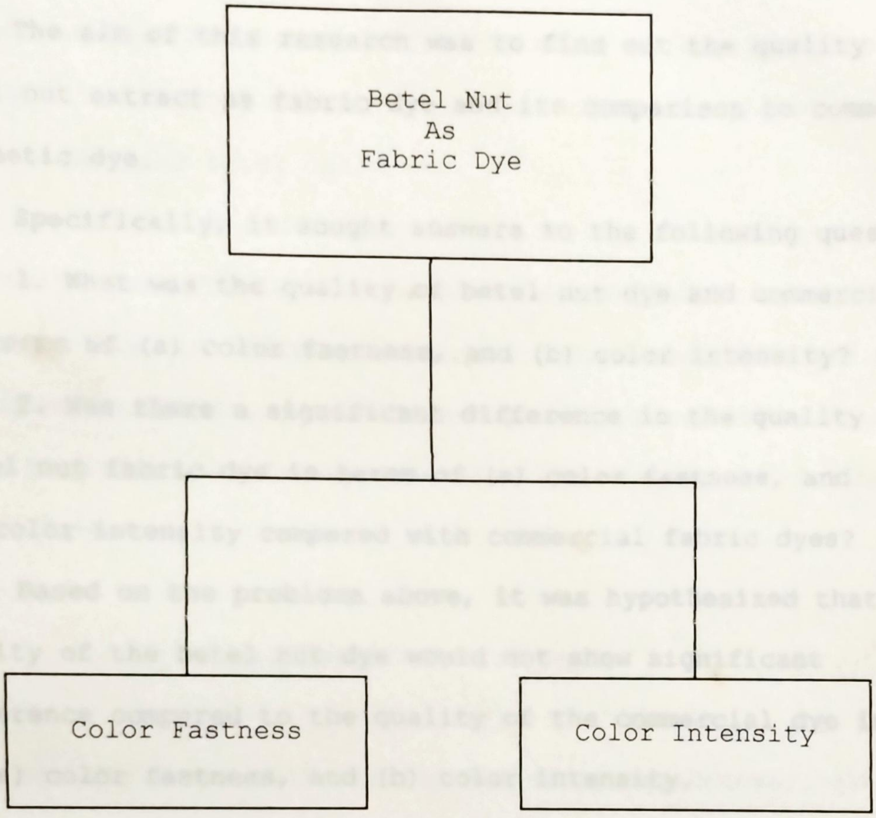

Figure 1. Color Fastness and Color Intensity Testing of Betel Nut Fabric Dye.

Statement and of the Problem and the Hypothesis

The aim of this research was to find out the quality of betel nut extract as fabric dye and its comparison to commercial synthetic dye.

Specifically, it sought answers to the following questions:

1. What was the quality of betel nut dye and commercial dye in terms of (a) color fastness, and (b) color intensity?

2. Was there a significant difference in the quality of the betel nut fabric dye in terms of (a) color fastness, and (b) color intensity compared with commercial fabric dyes?

Based on the problems above, it was hypothesized that the quality of the betel nut dye would not show significant difference compared to the quality of the commercial dye in terms of (a) color fastness, and (b) color intensity.

Significance of the Study

Dye comes from various sources. Any pure substance that can stain your dress may become a source of fabric dye. One example is betel nut which is very abundant in the Philippines.

It is being chewed by old women, together with some mixtures, for their own purposes of chewing it. As could be noticed, the mixture stains their teeth where the color primarily comes from the betel nut. That was why the researchers thought of another way possible for betel nut's use.

As for the significance of this study, it sought an alternative use for betel nut, which was as fabric dye to help boost the textile industry. Synthetic dyes cost much and have ecological liabilities. That was why, the researchers hoped to bring back the use of less expensive and environment-friendly fabric dyes.

Definition of Terms

For the purpose of clarity and single-mindedness, the following terms were defined conceptually and operationally:

Betel nut- is the dried, ripe seed of the palm tree *Areca catechu* (Palmae), a native of Ceylon and Malaya. The nuts, slightly larger than a chestnut, have a faint odor when broken open and a somewhat acrid taste (Infopedia CD, 1995).

In this study, the term meant as defined.

Extract- is a method of separating the constituents of a mixture utilizing preferential solubility of one or more components in a second phase (Microsoft Encarta, 1999).

In this study the term meant the juice of betel nut after water extraction.

Dye- is a colored substance, also called a dyestuff, which imparts more or less permanent color to other materials (Grolier Encyclopedia of Knowledge, 1995).

In this study the term meant the product dye from betel nut to be subjected to testing.

Synthetic [dye]- is something resulting from synthesis rather than occurring naturally (Infopedia CD, 1999).

In this study the term referred to the commercial dye.

Commercial dye- is being marketed (Infopedia CD, 1999).

In this study the term meant the commercial dye that would provide comparison with the betel nut dye in terms of color fastness and intensity.

Qualitative Analysis- is the assessment of the quality of anything in terms of the applicable criteria (English Desk Dictionary, 1983).

In this study the term referred to the subjective rating of the (a) color fastness, and (b) color intensity of the fabric dye.

Fastness- is the ability of a certain substance to stick to a material and resist itself from being washed off the material (Infopedia CD, 1994).

In this study the term meant the ability of the dye to resist from being washed off the cloth.

Intensity- having a quality in a high degree (The English Desk Dictionary, 1983).

In this study the term referred to the sharpness or adhesion of the color of the dye.

Scope and Delimitation

Betel nuts were taken from Ibajay, Aklan. It was ensured that the fruit was just on the peak of its ripeness.

In the conduct of the experiment, the most common kind of mordant, potassium dichromate ($K_2Cr_2O_7$), was used. Potassium dichromate was used also since its color (orange) is the closest color similar to the color of the betel nut extract, which is brick red.

Also, another kind of dye, the commercial dye, was used. The type of cloth used was cotton. For each dye, the betel nut and commercial, there were 3 replicates.

The conduct of the experiment was done in the research lab of Philippine Science High School Western Visayas. After the conduct of the experiment, the cloths were subjected to qualitative analysis. Five persons were asked for the analysis on the cloth. To avoid bias, every second person to enter the lab was asked to subjectively analyze the cloth.

Chapter 2

Review of Related Literature

Dye

Dyes are chemical substances that posses the property of selective light absorption, and therefore appear colored. It is a substance that is used to impart color to other materials such as textiles, paper, and plastics. This color must be reasonably resistant to removal by rubbing the action of water, soap, solvents, and other detergent products; and to chemical and physical alteration through the action of light, heat, gas fumes, or the action of chemicals to which it may normally be subjected. Dyes are usually applied for these purposes by processes of dyeing. Formerly obtained from various natural sources, dyes are now almost entirely produced by chemical synthesis.

Dyes are generally water-soluble, although some are soluble only during application, after which they become insoluble. The mechanism by which soluble colored substances enter the internal structure of fibers and there become fixed has been variously explained in terms of physical and chemical concepts of times when the explanations were given. It is said to be an adsorption phenomenon, a salt formation, a quasi-chemical union caused by hydrogen bonding, or an either linkage, and in some cases it is considered to be a true solution effect. The end result, however, is that the dye has imparted a color (not necessarily that of the solid dye itself) to the fiber which is more or less resistant to washing or removal by similar mechanical operations. The dye is said to be fixed on and have affinity for the material it has colored. The material is designated as the substrate. If the color is quite resistant to washing and light, it is called a fast color, if the color is easily removed or fades quickly, it is a fugitive dye (McGraw-Hill Inc., 1995).

A good dye gives a color that is fast. Fast means it resists fading by water, light, perspiration, and other factors. A dye must be soluble in some solvent or from some soluble compound so it can be applied to the material to be colored. After the material is colored, the dye must be insoluble so that it is fast. Dyes become insoluble by either combining with the material, by being absorbed by the material, or by being used with mordant.

Hydrogen peroxide is the general oxidizing agent in making dyes. Manganese chloride and iron-copper sulfate are other mordant, which can be used in textile dyeing (Bato Balani, 1996-97).

The choice of dyestuffs depends on the physical and chemical nature of the fiber. Fibers such as wool, nylon and silk contain NH_2^+ groups. Thus, the dyes used contain negative groups such as the sulfonate groups as dye items, and thus the dyes used may be fiber reactive, forming covalent bonds, or direct, forming hydrogen bonds with these groups. Other cotton dyes such as vat and naphtols are instead converted to insoluble derivatives in the fiber (McGraw-Hill Encyclopedia of Science and Technology, 1987).

A dye must have an affinity for the substance it colors; that is, it must enter and adhere to the interior of the fiber. Natural dyestuffs usually have no affinity for cellulose fibers such as cotton of flax and can be used only with the aid of mordant. The effect of the mordant is to make the dye wash-fast and light-fast (Grolier Encyclopedia of Knowledge, 1995).

There are great variety of dyes and many methods of dyeing. The same dye does not react the same way with all fibers. Not can all fibers be dyed under the same conditions.

Dye may be classified in various ways: according to color; origin (natural-from vegetable and animal matter or synthetic); chemical structure (the most precise); kinds of materials to which they are applied (cloth, papers, leather plastic, food, biological specimens, etc.); and method of application (use most frequently by the practical dyes) (McGraw-Hill Encyclopedia of Knowledge, 1995). The method of classification takes into account the different types of textile fibers. These comprise cellulosic (cotton, flax, viscose, and rayon), cellulose derivatives (cellulose acetate), protein (wool, silk, casein, and groundnut protein), and purely synthetic fibers (nylons, Terylene, and acrylic polymers). For each class of fibers, only a limited range of dyes may be successfully applied (New Age Encyclopedia, 1983).

Dye Classifications

Basic dyes. The majority of the early synthetic dyes belong to this class, e.g. mauveine and magenta. Other important examples are methylene and rhodamines. They include many dyes, which give clear, vivid dyeing of great beauty, but many of them are easily faded by light. Partly for this reason they have now become less popular. They have a natural affinity for protein fibers, to which they are applied from a slightly acid dyebath, the dyes combining with acidic groups in the fiber. They also have an affinity for impure cellulose fibers such as jute and hemp, but not for pure cellulose (e.g. cotton). A mordant, a substance used to impregnate the fiber and which will unite with the dye, is then required, the most common being tannic acid fixed with tartar emetic (New Age Encyclopedia, 1983).

Acid dyes. These contain an acidic group and have a natural affinity for protein fibers and nylon, which contain basic groups with which the dyes combine. Applied from an acidic solution, the dyes are subdivided into groups according to the degree of acidity required. Those that are applied from the weakest acid solution have the strongest affinity and have the best fastness to washing and similar treatments. They are known as acid milling dyes. The others, which are applied from stronger acid solutions, are known as leveling dyes, since their poorer fastness permits level dyeing to be readily obtained (New Age Encyclopedia).

Mordant dyes. This is a class of dyes which are applied with the aid of a second substance (known as the mordant) which is not a dye but which combines with the dye to form a more complex and less soluble molecule, often known as a lake. Mordant are usually metal-containing oxides or hydroxides (e.g. chromium, copper, aluminum, and iron), and these form lakes with essentially acidic dyes. For basic dyes complex acids (e.g. tannic) are used as mordant, but basic dyes are not normally classified as mordant dyes. The majority of the natural coloring matters belong to this group. They may be regarded as true mordant dyes, since they have no affinity unless the mordant is first present on the fiber. This distinguishes them from the modern synthetic mordant dyes which also behave as normal acid dyes, the purpose of the mordant (usually a compound of chromium) being principally to improve the fastness properties. Among important natural mordant dyes is alizarin, obtained from the root of the madder plant but now manufactured synthetically from anthraquinone. Its most important application was on an aluminum mordant to produce the famous Turkey red. On other metal mordant differently colored dyeing are obtained (e.g. tin-pink, iron-violet, chromium-puce). Logwood, obtained campeachy wood, is the only natural mordant dye still used commercially. Applied on a suitable mordant, e.g. iron or copper, it produces dense black shades. Synthetic mordant dyes (chrome colors) are used for the production of fast dyeing on wool. The mordant (usually a dichromate or chromate) may be applied before, together with, or after the dye, which is itself applied in much the same way as an acid dye (New Age Encyclopedia, 1983).

Dyes may be divided into two categories: natural and synthetic. Natural dyes are those obtained from plants, animals, and minerals. The dyeing process is divided into four basic categories: pretreatment of cloths, direct extraction, mordanting, and vat or leuce dyeing. The process to be used is mordanting, wherein dyes are fixed to the material by the addition of a mordant (Bato Balani, 1996-97).

Thousands of synthetic dyes are in use. Coal tar is the basic source of these products. Coal tar is fractionally distilled to produce substances like benzene, naphthalene, and anthracene from which dyes are made.

The action of the dye depends upon the chemical nature of the fiber and the dye itself. Acid dyes color fibers that have basic nature. Basic dyes color fibers that have an acidic nature. Cotton and linen must be made either acidic or basic by mordanting before dyeing. Both acidic and basic dyes color silk and wool directly.

Dyeing

Dyeing may be defined as the process of coloring textile fibers and other substances so that the coloring matter becomes an integral part of the fiber or substance rather than a surface coating. Dyes or dyestuffs are chemical compounds, chiefly organic, which have a chemical or physical affinity for fibers. They tend to retain their color in the fiber under exposure to sunlight, water, detergents, and wear. Pigments are insoluble coloring compounds (Infopedia CD, 1994).

Indirect Dyeing

Today indirect dyeing is practiced mainly as a craft. The simplest method involves the pretreatment of the fabric with a fixing solution called a mordant, followed by immersion in a dye bath. Formerly tannin was used as a mordant because it allowed the use of basic dyes with cotton and other cellulose fabrics. Today this process is used for coloring such novelties as straw decorations and dried flowers. The classic mordant dyeing process involves three steps: treatment of the fabric with a solution containing the salt of a metal; a second bath containing ammonia; and a dye bath. Ammonia acting on salt produces insoluble metal hydroxides, which remain in the fibers and react with the dye solution to produce stable, insoluble colored compounds known as lakes. In a more generally used technique, chrome-dyeing of wool, the fabric is directly colored with a soluble dye and then treated with sodium dichromate, which combines with the dye to form a chrome lake in the fibers. The dichromate can also be applied before the dye or simultaneously with it. The chrome enhances a dye's fastness on wool, on nylon, and on silk (Infopedia CD, 1994).

True dyeing covers mechanism in which molecules of material to be dyed become involved by various means with the molecules of the coloring matter or small aggregates thereof. There is some overlapping between true dyeing and other methods of coloring which are called dyeing in the industry. Products that are commonly dyed include textile fibers, plastic fibers, anodized aluminum, fur, wood, paper, leather, and some foodstuffs (Mc-Graw Hill Encyclopedia of Knowledge, 1995).

When affinity is involved, dyeing is an exothermic process (Mc-Graw Hill Encyclopedia of Knowledge). More dye will be absorbed by a fiber or film at low temperature. However, the rate of dyeing increases geometrically, whereas maximum dye absorption decreases only arithmetically with rise in temperature. Since maximum dye absorption is rarely necessary or desirable, the trend in modern practice is toward dyeing at high temperature and short times.

Dyeing is accomplished by dissolving or dispersing the colorant in a suitable vehicle (usually water) and bringing this system into contact with the material to be dyed. Although many dye molecules or aggregates may adhere to the material surface when they meet, dyeing does not occur until the adhering dye particles migrate within the fibers or films. All dyeing processes are designed to accomplish ultimately penetration of the undyed substance by the colorant (Mc-Graw Hill Encyclopedia of Knowledge, 1995).

Mordant

A dye must have an affinity for the substances that it colors; that is, it must enter and adhere to the interior of the fiber. Natural dyestuffs usually have no affinity for cellulosic fibers such as cotton or flax and can be used only with the aid of a mordant (a substance that attracts and fixes the dye in the fiber). Mordant has been used since ancient times and was usually solutions of metal salts or alum (potassium aluminum sulfate). Modern mordant uses chromium salts primarily. The effect of the mordant is to make the dye wash-fast (Grolier Encyclopedia of Knowledge, 1995).

Betel Nut

The betel nut, also called Pugua or Mama'on by Guamanians, are 'palm nuts' from the areca tree. The tree resembles a thin coconut palm tree. These hard nuts are chewed casually like chewing gum by islanders and are a permanent feature of the cultures of the Pacific. Nut chewing is definitely an acquired habit more commonly passed down from grandparents (called guelo) to grandchildren.

Frequently, it is chewed with the betel leaf, a fresh green peppery tasting condiment. The leaf is called pupulu and different species from each island are different in taste. Betel nuts are chewed and harvested by millions of people from India, Vietnam, Sri Lanka, Indonesia, the Philippines, Marianas, American Samoa, Beleau, Bangladesh. The trees are found growing in moist ground and produce prodigious clusters of green fleshy nuts, which mature into yellow and then brown hard nuts.

Depending on species, the nut sizes vary from thumbnail to fist size and the kernel (nut) is surrounded by husk. Chamorros or Guamanians have been consuming betel nut or pugua for thousands of years as evidenced by archeology. The activity is a cultural link to the past lifestyles of early chamorros.

Islanders prefer the hard reddish nut variety called "ugam" for its fine granular texture. When the red pugua nut is not in season, the course white variety changanga is eaten as an appropriate alternative. The nut is sliced using a specialized cutter called "tiheras pugua". Citizens of Micronesia (Islanders from the "Freely associated Island Nations" which occupy an area larger than the U.S.) also partake in this custom but many prefer a different soft betel nut species, which is succulent and gelatinous.

For the seasoned chewer, 'amaska' i.e. the chewing tobacco brand 'Mickey Twist' is mixed with the nut and the leaf. For the brave at heart, 'afuk' or lime powder is also incorporated into the chewing experience. Lime is an alkaline white powder residue that results from cooking coral over an intense bonfire for several days.

Chewing pugua is an age-old tradition. Islanders do not comprehend why they chew it alone in combination with other additives. It is a part of being Chamorro and is an inherent feature of social gatherings or fellowship that imbues the spirit of family goodwill to strangers.

Stern and Hanson, of Forsyth Institute for Advanced Research, Boston, (New Age Encyclopedia, 1983) analyzed the microscopic and chemical nature of prehistoric betel-stained teeth from Guam. While betel-chewing (Areca nut, sprinkled with slaked lime and wrapped in Piper betel leaf which produces a very bitter and sharp tasting chewable poultice) results in heavily stained and worn teeth, it prevents cavities from forming.

Their investigation revealed that structural and elemental changes occur in the enamel of betel-stained teeth of Chamorus Thousands of years ago which results in anti-cavity properties of betel chewing. The cultural habit endures to this day.

History

By the 1930's it was estimated that at least 20,000,000 people chewed betel nuts in India alone (www.sni.net, 1998). Each betel palm produces about 250 seeds or nuts per year, and millions of these trees are under cultivation. It is one of the world's most popular plants, with the leaf used in paper for rolling tobacco. The regular use of betel nut will, in time, stain the smooth, gums, and teeth a deep red. Asian betel nut chewers, however, are quite proud of these stains. The Malayan technique for using betel nut is to mix a mashed or powdered nut, some catechu gum from the Malayan acacia tree (Acacia catechu), a pinch of burnt lime, and a dash of nutmeg, cardamom, or turmeric for flavor. This mash is then rolled up in a leaf from the betel vine (Piper chavica betel). These rolls are sold on the streets or in the markets as candy.

Chapter 3

Research Design and Methodology

The aim of this research was to find out the quality of betel nut extract as fabric dye and its comparison to the commercial dye. It specifically determined the significant difference in the quality of the betel nut fabric dye, in terms of color fastness and color intensity compared to the commercial fabric dye.

It was hypothesized that the quality of the betel nut dye did not show significant difference compared to the quality of the commercial dye in terms of (a) color fastness, and (b) color intensity.

Materials and Equipment

The materials used were 150 grams of betel nut, cloth, potassium dichromate ($K_2Cr_2O_7$), soda ash, and filter paper. The equipment needed were 200-ml beakers, 500-ml beaker, stove.

Methods and Procedure

Dye Extraction

About 150g-betel nut was obtained and placed in a beaker, ready for water extraction. A 500-ml beaker was filled with water and placed on a stove. The betel nut was simmered for about an hour. Water was gradually added to maintain the volume of the solution. Occasional stirring was also done. After the extraction, the solution was filtered, using a filter paper and the liquid was poured into a beaker. The liquid dye was set aside to be used later in the dye application.

Pretreatment

Soda ash (sodium carbonate), weighing 0.50 gram, was diluted in 75ml of water. A piece of cloth, weighing two and a half grams, was immersed in the soda ash solution and was made to boil for 15 minutes. The solution was decanted and the cloth was washed thoroughly with hot water, then with tap water. Pretreatment was done for purpose of conditioning the cloth for dyeing.

Dye Application

Fifty milliliters of the liquid dye was needed for every gram of the textile material. The cloth was placed in separate beakers containing the liquid dye. The solution was boiled for about an hour with frequent stirring to attain even dyeing. The dyed material was removed from the dye solution, squeezed, and then washed with tap water to remove the excess dye solution.

Application of Mordant

A beaker, containing 20-ml of water, was placed on the stove. Half a gram of potassium dichromate ($K_2Cr_2O_7$) was added to one beaker. The potassium dichromate served as mordant that will fix the dye in the cloth, thus making the cloth more colorfast. Temperature remained constant while boiling for 15 minutes. The cloth was occasionally checked to ensure even distribution of the mordant. The dye alone would be washed away easily through the color fastness test.

The experiment was conducted three times to ensure no bias, thus producing three cloths. Also, another piece of cloth was used for dyeing using a synthetic dye. This was also done three times. This was used for the comparison of betel nut fabric dye and the commercial synthetic dye.

Color Fastness Through Washing Test

A cloth was placed in a soap solution. The solution with the cloth was constantly stirred for 30 minutes. This was done at room temperature. After the required time, the cloths were air-dried, and analyzed.

Five persons were asked for the subjective analysis on the cloth. In determining the fastness of the dye, the following standards, set by the researchers, were used after the washing test:

Color Fastness Test

Description	Rating
0-10% faded	10
11-20% faded	9
21-30% faded	8
31-40% faded	7
41-50% faded	6
51-60% faded	5
61-70% faded	4
71-80% faded	3
81-90% faded	2
91-100% faded	1

Color Intensity Test

Description	Rating
91-100% similar to the original color	10
81-90%	9
71-80%	8
61-70%	7
51-60%	6
41-50%	5
31-40%	4
21-30%	3
11-20%	2
0-10%	1

The methods used in this study were developed and improved by the researchers to obtain better results.

Statistical Testing

The mean and the t-test were used as descriptive and inferential statistics, respectively.

The mean was used to determine the average results of the color fastness and intensity tests.

The t-test, set 0.05 α level of significance, was used to determine the significant difference in the mean obtained from the results of color fastness and color intensity tests of each fabric dye.

Chapter 4

Results

The aim of this research was to find out the quality of betel nut extract as fabric dye and its comparison to the commercial dye. It specifically determined the significant difference in the quality of the betel nut fabric dye, in terms of color fastness and color intensity compared to the commercial fabric dye.

It was hypothesized that the quality of the betel nut dye did not show significant difference compared to the quality of the commercial dye in terms of (a) color fastness, and (b) color intensity.

Color Fastness of Betel Nut Dye and Commercial Dye

Table 1 shows the different ratings of different respondents on the betel nut dye and the commercial dye. It also shows that the first cloth of the betel nut dye was rated 9 by four persons and one person rated it 8, thus having a mean of 8.80. The second cloth was rated 8 by three persons and 9 by two persons yielding a mean of 8.40. The third cloth was rated 9 by three persons and 8 by two persons, thus obtaining a mean of

8.60. Therefore, the betel nut dye was rated 8.60 for its color fastness.

Table 1

Color Fastness Rating of Betel Nut Dye and Commercial Dye

Color Fastness Test	Betel Nut Dye			Commercial Dye		
	Cloth 1	Cloth 2	Cloth 3	Cloth 1	Cloth 2	Cloth 3
Person 1	8	9	9	9	9	9
Person 2	9	8	9	9	8	9
Person 3	9	8	8	9	9	8
Person 4	9	9	8	9	9	9
Person 5	9	8	9	9	9	8
Mean	8.80	8.40	8.60	9.00	8.80	8.60
	8.60			**8.80**		

Table 1 also shows that the first cloth of the commercial dye was rated 9 by all persons. The second cloth was rated 9 by four persons and 8 by one persons yielding a mean of 8.80, while the third cloth was rated 9 by three persons and 8 by two persons, thus having a mean of 8.60. Therefore, the commercial dye was rated 8.80 for its color fastness.

Color Intensity of Betel Nut Dye and Commercial Dye

Table 2 shows the ratings for the color intensity of the betel nut dye and the commercial dye. It shows that the first cloth dyed with betel nut dye was rated 9 by all respondents.

The second cloth as well as the third cloth was rated by three persons and 9 by two other persons, yielding a mean of 8.40. For the commercial dye, the first cloth was rated 9 by all persons. The second cloth was rated 9 by four persons and 8 by just one person producing a mean of 8.80, and the third cloth was rated 9 by three persons and 8 by two persons, yielding a mean of 8.60.

Table 2

Color Intensity Rating of Betel Nut Dye and Commercial Dye

Color Intensity	Betel Nut Dye			Commercial Dye		
	Cloth 1	Cloth 2	Cloth 3	Cloth 1	Cloth 2	Cloth 3
Person 1	9	8	9	9	9	9
Person 2	9	8	9	9	8	9
Person 3	9	8	8	9	9	8
Person 4	9	9	8	9	9	9
Person 5	9	9	8	9	9	8
Mean	8.80	8.40	8.60	9.00	8.80	8.60
	8.60			**8.80**		

Differences in the Color Fastness and Color Intensity of Betel Nut Dye and Commercial Dye

Table 3 shows the difference between the mean of the betel nut dye and the commercial dye in terms of color fastness and color intensity, and the computed t-value and the corresponding tabular t-value.

Table 3

t-value for the Difference Between Two Mean Ratings of the Betel Nut Dye and the Commercial Dye for Color Fastness and Color Intensity

Ratings	Betel Nut Dye	Commercial Dye	Difference	Computed t-value	Tabular t-value
Fastness	8.60	8.80	0.20	1.89	2.13
Intensity	8.60	8.80	0.20	1.89	2.13

Since the computed t-value (1.89 for both color fastness and intensity) was less than the tabular t-value (2.13 for both color fastness and intensity), it showed that the difference between the ratings of the two dyes, in terms of color fastness and intensity, was not significant. This meant that the color fastness and color intensity of the betel nut dye is comparable to the commercial dye.

Chapter 5

Summary, Findings, Conclusion, and Recommendation

Summary

The aim of this research was to find out the quality of betel nut extract as fabric dye and its comparison to commercial synthetic dye.

Specifically, it would seek answers to the following questions:

1. What was the quality of betel nut dye and commercial dye in terms of (a) color fastness, and (b) color intensity?

2. Was there a significant difference in the quality of the betel nut fabric dye in terms of (a) color fastness, and (b) color intensity compared with commercial fabric dyes?

Based on the problems above, it was hypothesized that the quality of the betel nut dye would not show significant difference compared to the quality of the commercial dye in terms of (a) color fastness, and (b) color intensity.

Findings

1. The betel nut as fabric dye was rated 8.60 for its color fastness and also 8.60 for its color intensity. The commercial dye was rated 8.80 for both its color fastness and intensity.

2. Results of t-test showed that there was no significant different in the qualitative rating of the two dyes. It showed that the color fastness and intensity of the two dyes are comparable.

Conclusion

Betel nut extract as fabric dye had color fastness and color intensity qualities comparable to that of the commercial dye. And that, betel nut extract as fabric dye has a potential of becoming a good alternative for this commercial dye synthetic dye.

Recommendations

In the study, cotton was used as the test cloth, so it is advised to use other types of cloths to be dyed. For the liquid dye itself, the ratio of betel nut to water may be increased to obtain greater concentration to find out whether it will produce a more intense color. Also, other types of mordant are recommended to be used since in this study only one mordant was used. For the experiment, time may be lengthened to obtain better results.

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