

Comparative Study of Extracted Indigofera Tinctoria Solvent and Synthetic Indigo Dye Pattern on Cotton Fabric for Entrepreneurial Development in Ilorin west local government area of Kwara state, Nigeria

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Abstract

The study investigated extracted indigofera tinctoria solvent compared with synthetic indigo dye pattern on cotton fabric in Ilorin Nigeria. Specifically, the study extracted dye from indigo leaves and compared it with synthetic indigo dye applied to the same texture of cotton fabric. Four objectives and two hypotheses were formulated and tested at 0.05 level of significant.. Experimental research design was adopted with a population of 150 dyers stratified with 20% to obtain a sample size of 30 dyers. The instrument was sensory score card accessed with 7 point hedonic scale. The data collected was based on appearance, colour brightness, texture, smell, length, finishing and overall acceptability. Data collected was analyzed with mean, standard deviation and t-test. The findings showed a significant difference between fabrics dyed with indigofera tinctoria solvent and synthetic indigo dye on cotton fabric. All results based on sensory score card were accepted. The study concluded that there was a wide range difference in the level of acceptability of extracted Indigofera Tinctoria Solvent and Synthetic Indigo Dye Pattern on Cotton Fabric. It was recommended that the knowledge of indigenous dye should be added to the curriculum of textiles courses as these will broaden the knowledge of students in dyeing of fabric with different plants, animals and minerals that produces dye for entrepreneurial development in Nigeria.

Keywords: Indigofera Tinctoria, Synthetic, Dye, Pattern, Cotton

INTRODUCTION

Indigo dye is the most popular and widely dye used before the introduction of synthetic dying in Nigeria. The source of indigo dye is from the many species of genus of indigofera called “*elu*” among the Yoruba people and it is often grown wildy throughout Nigeria. These varieties of indigofera tinctoria are the most commonly used to produce dark blue colour of great fastness. Anyakoha (2015) described Indigo as a stable vegetable dye which was used for generations in Africa. In West Africa (Nigeria), the Yoruba dyers are still considered the most passionate lovers of indigo according to Balfour (2011). The importance of indigo dyeing in ancient Yoruba land is demonstrated in the uniqueness of the practice almost everywhere, even in the smallest Yoruba villages, Indigo dye consequently remained the commonest, popular and the most extensively used compared to other indigenous dyes and colours.

Indigo is a dyestuff originally extracted from varieties of the indigo and woad plants known throughout the ancient world for its ability to give a deep blue colour to fabrics (Adnan, 2010). According to Gao and Schrire (2017) indigo is an indigenous dye obtained from the fermentation of *Isatis tinctoria*, these plants contain the glucoside indican,

which could be hydrolyzed to glucose and indoxyl, a precursor (precursor substances) colourless of indigo. If the fabric is immersed in a mixture containing fermentation solution indoxyl, then allowed drying in the air, hydroxyl oxidation by air will occur and generate insoluble indigo and blue. Indigo precipitates in the form of cis isomerization experience and of necessity to be the Trans isomer, causing a blue colour. Indigofera leaves are natural blue colour creating a palette that is compatible and blend with each other (Duerr, 2011).

Synthetic dyes are man-made dyes derived from organic or inorganic compound such as Direct, Acid, Basic, Reactive, Mordant, Metal complex, Vat, Sulphure and Disperse dye. Synthetic dyes are classified according to how they are used in the dyeing processes. They contain hazardous chemicals which usually cause adverse health effect to the craftsmen (Adeakin, 2004). It was also reported that the rate of chemical emission in textile industries both traditional and industrial is increasing significantly and this emission is mainly produced due to interrupted processed such as dyeing and equipment leakage (Lee & Wong, 2005). A large amount of vapour and chemicals are emitted into the air in the working environment during production and

these can have a very significant impact on air quality and human health. Synthetic dyes have been widely used as compared to indigenous dyes in the field of textile colourations. These indigenous dyes are more compatible with the environment compared with synthetic dyes because they are eco-friendly, non-toxic, non-allergenic and biodegradable according to Iqbal, Bhatti & Adeel, (2008) and Chandramohan, Saivaraj & Deepa, (2013).

Synthetic dyes described by Kulkarni, Gokhale, Bodake & Pathade, (2011) as an excessive use in the production and application which release vast amounts of waste and unfixed colorants, causing serious health hazards and disturbing the eco-balance of nature used to produce Tie-dye.

Tie-dye is a process of resist dyeing textiles or clothing made from knit or woven fabric, usually from cotton materials of bright colours. Oguntona (2000) described Tie-dye as a method of patterning fabric to prevent dye liquor from penetrating all parts of the fabric. This indicated that the patterning of tie-dye fabric was done in so many ways namely, sewing, tying, knotting, folding, pleating, intention with stone sticks, threads with needle tighten to prevent the penetration of dye into the pattern made on the fabric according to (Alan, 2003). Pattern is an arrangement of design from repeated lines, shapes, or colours on a surface of a fabric. It is a template from which the parts of a garment are traced onto fabric before being dyed.

In light of the above, there is a need to compare the acceptability of both indigenous and synthetics dye patterns on tie-dye fabric and how it could be for Entrepreneurial Development to the society in Ilorin west local government area of Kwara state, Nigeria

JUSTIFICATION

Over the years Indigenous dye made from plant has been the major dye originated in Nigeria and commonly used in the north, east and west of the country before the introduction of synthetic dyes. Today, synthetic dyes are used without taking into consideration the side effect both on the fabric and human. But today, indigenous dye has not been in existence because of the synthetic dye both imported and man-made dyes have taken over the market. This could be because of the duration of the preparation process of the indigenous dye and its effect on the texture and shape of the fabric and it may also be due to the smell that emanated from the fermentation process. Therefore it was established that little or no work has been carried out to compare indigenous (indigo) and synthetic (blue) dye patterns on tie-dye cotton fabric in the recent years. Some researchers such as Nazan, Lale and Sengul (2015) in their study titled Extraction of Indigo from Some *Isatis* species

and Dyeing Standardization Using Low-technology Methods, found out that dye extracted by fermentation with hot water application were optimized with different pH and reducing agents tested for colorfastness which has effects on fabric. Despite this fact, indigenous (indigo) dyes have not been in use by resist dye for small or large scale production of tie-dye in Nigeria. In the light of this trend, it is imperative to investigate the acceptability of fabric dyed with indigo and synthetic dye (blue) and how these dyes can be used for entrepreneurial development in Ilorin west local government area of Kwara state, Nigeria.

OBJECTIVES OF THE STUDY

The broad objective of this study is to compare the acceptability of indigenous and synthetic dye patterns on tie-dye fabrics in Ilorin west, Nigeria.

The specific objectives are:

1. To determine the fabric dyed with indigo leave
2. To determine the acceptability of fabric dyed with indigo leave.
3. To determine the acceptability of fabric dyed with synthetic dye.
4. To compare the differences between natural indigo and synthetic indigo dye.

HYPOTHESES OF THE STUDY

1. There is no significant difference between natural indigo and synthetic indigo dye patterns on tie-dye fabric.
2. There is no significant relationship among natural indigo and synthetic indigo dye patterns on tie-dye fabric.

DESIGN OF THE STUDY

The design is an experimental research design. The population comprised 150 registered dyers stratified with 20% to obtain a sample size of 30 respondents purposively selected for the study. A sensory evaluation score card was used for data collection based on colour brightness, texture, appearance, smell, length, finishing and overall acceptability. A 7 point hedonic scale was used to determine the acceptability of the dyes.

METHOD OF DATA ANALYSIS

The data collected was statistically analyzed with mean, standard deviation, t-test, Pearson product moment correlation (PPMC).

MATERIALS AND METHOD

Materials

Indigofera tinctoria plant was gotten from a farm at pipeline Ilorin, Kwara State. Caustic soda, hydro-sulphite and dye (blue). Alum and cream of tartar were used as synthetic mordant for *Indigofera* leaves got from a farm in Ilorin Kwara State.

Equipment

The equipment used are mortar and pestle, glove, pot, plastic bucket, wooden stick, measuring scale, colander, twine and the apparatus used for the experiments are: plastic bucket, wooden stick, glove, twine, and measuring spoon.

Substrates

Twelve yards of white cotton fabric was divided into two (six yards each) was scoured to remove the starch before dyeing with indigo and synthetic dye.

Method

Extraction method for indigo dye from *indigofera tinctoria* by fermentation

The fresh *indigofera tinctoria* plant was pounded using mortar and pestle, it was been made into balls of 150g each and dried under the sun for three (3) days. Twenty (20) balls of the dried leave were soaked with 3 litres of water in a plastic bucket for seven (7) days for fermentation to take place. Then the dregs were separated out of the bucket and the extract was filtered. The filtered extract was mix with *lye* (an alkaline liquid made by leaching ashes, usually wood ashes). 250g of wood ashes was soaked with 1litre of water for 24 hours, it was sieved to extract the liquid which was then mixed with filtered indigo extract and the fermented indigo was stirred until it became dark blue. Also, local dye 'aro' popularly called by the Yoruba's in Nigeria was added to the solution boiled and the indigo dye was ready to be used.

FLOWCHART

Indigofera tinctoria (indigo leave)

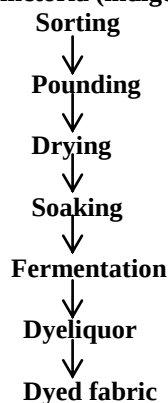


Figure 1: Flow Chart showing the Extraction Process of Indigo Dye

Method of dyeing scoured fabric with synthetic dye

Eight (8) tablespoon of caustic soda, four (4) tablespoon of hydrosulphite and four (4) tablespoon of dye (blue) was put inside a plastic bucket. Two (2) litre of water was boiled and added to the chemicals gently. The scoured tied fabric was put inside dye solution and was left for three (3) hours. It was then removed, untied and dried under a cool temperature before the fabric is been rinsed.



Indigo Extract



Indigo Cake



Indigo Dye

Figure 2: Indigo Extract, Cake and Indigo Dye

RESULT OF SENSORY EVALUATION

Table1 rated all the mean attributes of the fabric with natural indigo dye greater than 4 accepted. The means rated as 6.30, 5.43, 6.13, 5.60, 5.73, 5.90 and 6.27 for colour brightness, smell, appearance, length, texture, finishing and overall acceptability respectively.

Table 1: Mean Rating of Natural Indigo Dye

S/N	QUESTIONS	D.E	D.M	D.S	N.L/N.D	L.S	L.M	L.S	M	S.D	R
1	Colour Brightness	0	0	0	0	2	17	11	6.30	0.596	A
2	Smell	1	1	1	1	8	13	5	5.43	1.406	A
3	Appearance	0	0	1	2	3	10	14	6.13	1.074	A
4	Length	0	0	1	1	11	13	4	5.60	0.894	A
5	Texture	0	1	0	3	4	16	6	5.73	1.112	A
6	Finishing	0	1	1	0	5	14	9	5.90	1.155	A
7	Overall Acceptability	0	0	0	0	6	10	14	6.27	0.785	A

KEY: D.E = Disliked Extremely L.M = Liked Moderately D.M = Dislike Moderately
 L.S = Liked Slightly D.S = Disliked Slightly L.E = Liked Extremely
 N.L/N.D = Neither like nor disliked M = Mean S.D = Standard Deviation R = Remarks

Table 2: Overall Acceptability of Fabric Dyed with Natural Indigo Dye

Scale	Frequency	Percentage (%)
Like Slightly	6	20.0
Like Moderately	10	33.3
Like Extremely	14	46.7
Total	30	100.0

Source: Field work (2018).

Table 2 showed that all the respondents liked the overall appearance of the fabric dyed with natural

indigo dye with 20% of liked slightly, 33.3% liked moderately and 46.7% liked extremely in the bar chart is shown below.

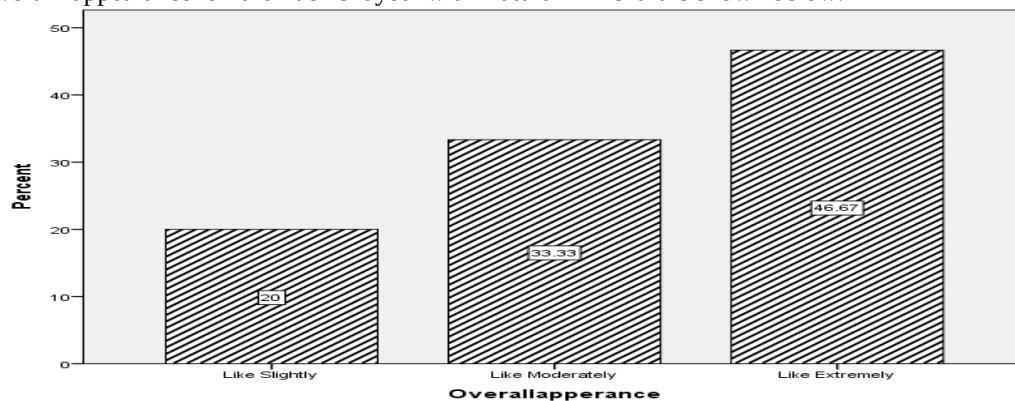


Figure 3: Bar Chart of Respondents on Overall Acceptability of Fabric Dyed with Natural Indigo Dye

FLOW CHAT OF SYNTHETIC DYEING

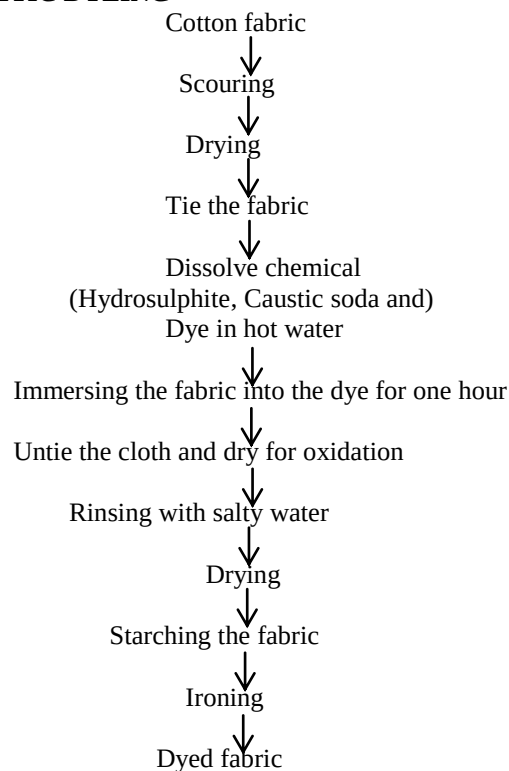


Figure 4: Flow Chart showing the Dyeing Process of Synthetic Dye

Source: (Holme, 2008)

Mean Rating of Synthetic Indigo Dye

Table 3: Mean Rating of Synthetic Indigo Dye (blue)

S/N	QUESTIONS	D.E	D.M	D.S	N.L/ N.D	L.S	L.M	L.E	M	S.D	R
1	Colour Brightness	0	0	0	1	3	15	11	6.20	0.761	A
2	Smell	0	0	0	3	9	12	6	5.70	0.915	A
3	Appearance	0	0	0	1	5	13	11	6.13	0.819	A
4	Length	0	0	1	2	9	16	2	5.53	0.860	A
5	Texture	1	0	0	1	4	16	8	5.90	1.185	A
6	Finishing	1	0	0	0	9	12	8	5.80	1.186	A
7	Overall Acceptability	0	0	0	0	2	16	12	6.33	0.606	A

Table 3 shows that all mean of the attributes considered were greater than 4. This means the colour brightness, smell, appearance, texture, length, finishing and overall appearance were accepted with mean score of 6.20, 5.70, 6.13, 5.53, 5.90, 5.80 and 6.33 respectively.

Table 4: Overall Acceptability of Fabric Dyed with Synthetic Indigo Dye

Scale	Frequency	Percentage (%)
Like Slightly	2	6.7
Like Moderately	16	53.3
Like Extremely	12	40.0
Total	30	100.0

Source: Field work (2018)

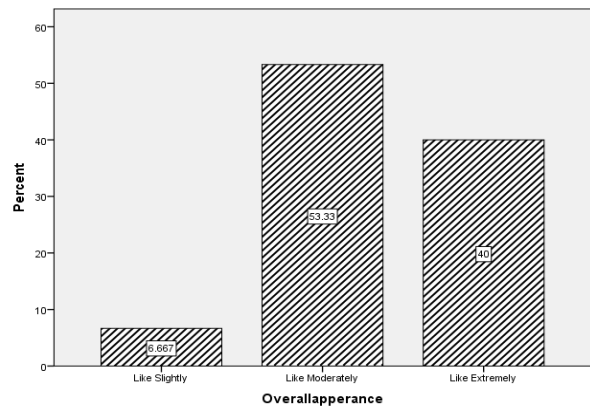


Figure 5: Bar Chart of respondents on overall Acceptability of Fabric Dyed with Synthetic Indigo Dye

Table 4 shows that all the respondents liked the overall acceptability of the fabric dyed with synthetic indigo dye. Below is the bar chart.

Test for Hypotheses

Hypothesis One

Table 5: t-test of Natural Indigo and Synthetic Indigo Dye

Variables	Paired Differences					T	Df	P-value
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Natural Indigo – Synthetic indigo	-.03286	.14303	.05406	-.16514	.09942	-.608	6	.566

DECISION: Table 5 shows that the P-value which is 0.566 is greater than the alpha level of significance which is 0.05. The hypotheses that stated that there is no significant difference between natural indigo and synthetic indigo dye was accepted. Consequently, there is no significant difference between the natural indigo and synthetic indigo dye patterns on tie-dye fabric. To determine which of the dye has a higher acceptability we refer to the table of mean below:

TABLE 6: Means of Natural Indigo and Synthetic Indigo Dye

Paired Samples Statistics				
Variable	Mean	N	Std. Deviation	Std. Error Mean
Natural Indigo	5.9086	7	.33889	.12809
Synthetic indigo	5.9414	7	.28945	.10940

Hypothesis Two

Table 7: Pearson Product Moment Correlation of Fabric Dyed with Natural Indigo and Synthetic Dye

Correlations			
		OSD1	OSD2
OSD1	Pearson Correlation	1	.908**
	P-value		.005
OSD2	Pearson Correlation	.908**	1
	P-value	.005	

** . Correlation is significant at the 0.01 level (2-tailed).

Decision: There is no significant relationship between natural indigo and synthetic indigo dye patterns on tie-dye fabric.

KEY

P < 0.05- H_0 rejected, OSD1= Natural Indigo Dye, OSD2= Synthetic Indigo Dye

result revealed that p-value is less than 0.05 ($p < 0.05$) which rejects the null hypothesis of no significant relationship between natural indigo and synthetic indigo dye patterns on tie-dye fabric.

Table 7 shows Pearson correlation value of 0.908, p-value of 0.005 and observed significant of 0.01. The

Table 8: The Means and Standard Deviation of Each Sample

Sample	Colour Brightness	Smell	Appearance	Length	Texture	Finishing	Overall Acceptability
OSD1	6.30±0.596	5.43±1.406	6.13±1.074	5.60±0.894	5.73±1.112	5.90±1.155	6.27±0.785
OSD2	6.20±0.761	5.70±0.915	6.15±0.8	5.53±0.860	5.90±1.185	5.80±1.185	6.33±0.606

KEY: OSD1= Natural Indigo Dye

OSD2 = Synthetic Indigo Dye

Table 8 shows the smell Sample of OSD2 as the most acceptable with the mean value of 5.70 while for appearance and the texture (touch) Sample OSD2 is the most acceptable with the mean value of 5.90. The finishing Sample OSD1 is the most acceptable with the mean value of 5.90 while sample OSD2 is the most acceptable in terms of overall acceptability with the mean value of 6.33.

DISCUSSION

Indigo dye is a natural dye that is insoluble in water, which needs to be converted to soluble form in an alkali medium for it to be used for dyeing cotton fabrics with marked fastness properties. Dyeing of cotton fabric by the exhaustion method depends on nature of fabric, nature of dye, rate of dyeing and affinity of dye molecules to the fabric. Pretreatment of the grey fabric and reduction of indigo dye to its leuco-form before dyeing improved the levelness and dye uptake of the indigo dye on cotton fabric. The work reported in this study showed that the percentage dye exhaustion increased as time of dyeing increased from 63.90 % to 71.8 % for the time of dyeing of 15 min to 75 min and oxidation of the dye in fibre to water insoluble blue coloured cotton fabric matrix as a result of exposure to atmospheric oxygen after dyeing, gave excellent fastness properties to the dyed cotton fabric.

CONCLUSION

Based on the findings it was concluded that there is a significant difference between indigenous and synthetic dye. Indigenous dye produces very uncommon, soothing and soft shades than the synthetic dye. Most dyers used of synthetic dye because of lack of knowledge about different plants, animals and minerals that yield dye and their extraction process.

RECOMMENDATIONS

Textiles industry should develop effective strategies for incorporating this experiment on plant dye extraction into their core research for developing businesses. This will help to discover more ways of producing and preserving these plant dyes for extensive use instead of buying synthetic dye that may have effect on the fabric and the dyers. The dyes when produced could be a source of wealth creation and entrepreneurial development in Nigeria.

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APPENDIX

EXTRACTION PROCESS OF INDIGOFERA TINCTORIA



Plate 5: Pounding of indigo leaves



Plate 6: Moulding into balls



Balls of *Indigofera tinctoria*



Soaking of *indigofera* for fermentation

DYEING PROCESS OF SYNTHETIC DYE



Mixing of Synthetic Dye



Immersing the fabric into the dye liquor



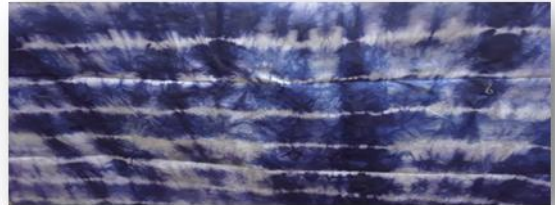
Immersed Fabric in the Dye Liquor



Fabric after dyeing



Natural Indigo Dye



Synthetic Indigo Dye

Source: Field work (2018)