Quest Journals
Journal of Research in Environmental and Earth Sciences
Volume 7 ~ Issue 1 (2021) pp: 68-75
ISSN(Online) :2348-2532
www.questjournals.org

Research Paper

Evaluation Of Salt, Ash And Potash On Fastness Properties Of Colour Extracted From Indian Almond Fruit (*Taminalia Catappa*) On Cotton Fabric.

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ABSTRACT
This study was carried out to compare salts (Copper II Sulphate, Ferrous Sulphate II & Ferrous Sulphate III) with ashe and potash on fastness properties of colour extracted from Indian Almond fruit on cotton fabric. The fruits were dried, grounded, soaked and filtered in water and solvent (ethanol) for proper extraction. The extracted solution was applied to bleach and mercerized cotton fabrics.Fastness properties of the dye to washing, rubbing, light and perspiration was assessed. Mordants (salts,Ashe and potash) were used to dye the fabric samples to get deeper and increased shade. A dyed sample was subjected to washing, perspiration and light fastness test. The degree of staining of the adjacent fabrics was recorded. Finally, results of the tested dyed samples from extract of Indian fruit proved to be fast to all tests carried out, conclusion and recommendations were made. It was recommended that natural dyes are good sources of dye absorption but lack of good mordanting of fiber prevent chrometaphore from photolytic degradation, therefore dyers using natural dyes should maintain good mordanting process on fabrics for better result/colour, also from the study conducted Indian almond fruits showed to be good sources of natural dyes. Dyers, farmers and the general public can utilize it as dyes and also as source of income, also farmers should be encourage to venture into raising Almond trees.

KEYWORDS: *Salts (CuSo4 II, FeSo4 II, FeSo4 III), Ashes, Potash, Fastness Properties of color extract, Indian almond fruits and Cotton fabric*

Received 15 Jan, 2021; Revised: 28 Jan, 2021; Accepted 31 Jan, 2021 © The author(s) 2021. Published with open access at www.questjournals.org

I. INTRODUCTION

Dyes/colour is referred to as any chemical compounds or a substance that is used to add beauty to fabric surface and remain unchanged. It could also be referred to as colour substance which when applied to fabric surface, it remains permanent. The discovery of colors or dyes from vegetables, plants, and sand is not a new thing in the field. Before the end of 19^{th} century, with the exception of few mineral color, virtually all dyes were vegetables ,either extracted from the bark (stem), roots, leaves, flowers and fruits to acts as dyes or coloring agents (Adeel, Ali, Bhatti & Zsila ,2009) . According to Goodarzian & Ekrami ,(2010) natural dyes was in used since 1500 B .C in Egypt, and they further reported that yellow dyes was extracted as early as 2000 B.C from pomegranate in Mesopotamia. Raja, vasugi & kala (2010) stated that dyeing was carried out in India and Middle East over 5000 years ago .This was supported by Vankar, Shanker, & Samudrika (2008) that mahonia napaulensis DC.(taming Berberidaceae) produces natural dye from its stem which has been used for dyeing textiles by the Apatanis(Arunachal Pradesh India) since ancient times. Padma (2000) stated that insects were also used as a source of red colors which was extracted from dried insects and the dyes was mainly used on natural fibers. Due to the tedious nature of extraction of dyestuff from the raw materials, it also gives low color value and long dyeing times which makes the cost of natural dyeing considerably higher than dyeing with synthetic dyes .This brought about the decreased to large extent after the discovery of synthetic dyes1856,(Goodarzian & Ekram, 2010). The wide and commercial used of synthetic dyes impart strong colors, brilliant shade and have fastness to washing, light, rubbing and perspiration, though causes carcinogenicity and inhibition of benthic photosynthesis to plants and the environment(Adeel *et al*; 2009). Mansur (2013) &Ekang (2016), also have similar opinion that synthetic dyes are synthesized from petro-chemical sources through hazardous chemical processes which pose a threat to human health and environment.

However, with the world wide concern over the use of eco-friendly dyestuff and biodegradable materials, the use of natural dyes has once again gained interest (Goodarzian & Ekrami, 2010).Also according to Adeel *et al*, 2009; Pruthi *et al*, 2007; Saha & Dutta, 2012); natural dyes have better biodegradability and generally have higher compatibility with the environment, because they are non toxic, non-allergic to skin, non-carcingenic, easily available and renewable. There has also been an increasing trend towards replacement of synthetic dyes with colorants by the natural colorants in the last 20 years because of safety and their developments and utilization is attracting more and more attention (Sharf & Bhattacharyal,2010).The continuous increasing in markets for natural colorants makes it worthwhile to search for and develop new or alternatives sources of colorants or dyes (Zin & Moe, 2005).Color fastness is the resistances of materials to change its color characteristics or extent of transfer of its colorants to adjacent white materials in touch (Samanta and Agarwal,2009). Generally light fastness, rubbing fastness, washing fastness and perspiration fastnesses are the color fastness considered for textiles fibers. Germany was the first to take an initiative to put ban on numerous synthetic dyes specifically the azo dyes for their manufacturing and application, Netherland, India and some other countries also followed the ban (Patel, & Agarwal 2011, Almahy *et al* 2013). In the same vein, Vankar *et al*,(2009); Samantha and Agarwal,(2009) identified the global concern over the use of an eco-friendly and biodegradable natural materials such as Indian almond (*Taminalia Catappa*) in Africa, Western Sahara and in Nigeria in particular. The tree grows to 35 m (115 ft) tall, with an upright, symmetrical crown and horizontal branches. *Terminalia catappa* has corky, light fruit that are dispersed by water. The seed within the fruit is edible when fully ripe, tasting almost like almond. As the tree gets older, its crown becomes more flattened to form a spreading, vase shape. Its branches are distinctively arranged in tiers. The leaves are large, 15–25 cm (5.9–9.8 inch) long and 10–14 cm (3.9–5.5 inch) broad, ovoid, glossy dark green, and leathery. They are dry-season deciduous; before falling, they turn pinkish-reddish oryellow-brown, due to pigments such as violaxanthin, lutein, and zeaxanthin. The trees are monoecious, with distinct male and female flowers on the same tree. Both are 1 cm (0.39 inch) in diameter, white to greenish, inconspicuous with no petals; they are produced on auxiliary or terminal spikes. The fruit is a drupe 5–7 cm (2.0–2.8 inch) long and 3–5.5 cm (1.2–2.2 inch) broad, green at first, then yellow and finally red when ripe, containing a single seed

Statement of the Problem

Synthetic dyes or colorants' production or processes, causes a lot of damages to our environment and plants in terms of growth and good yields, it is toxic to human body causing skin cancer, this also coincides with Nigerian problems of scarcity of dyes which is confronting dyers, creating unemployment opportunity and high cost of importation. The major setback of many natural dyes is their poor fastness properties, which are metallic salts, which produces affinity between the fabric and the dyes, the salt cannot have damages on our environment, eco-friendly and achieved similar results like the synthetic dyes. The quality of the colorant and the availability of the plant is of great interest. The problems encountered with natural dyes in textile dyeing are color yield, complexibility of dyeing processes, reproducibility results, limited shades, blending problems and inadequate fastness properties. It is against this background that this study set out to compare salts and potash, ashes on fastness properties of colour extracted from Indian almond fruits on cotton fabrics.

II. OBJECTIVES OF THE STUDY

The major objective of this study is to

i. identify the effect of salt, ash and potash on fastness properties of colour extracted from Indian almond fruit (Taminalia catappa) on cotton fabric.

ii. Examine colour fastness, shade, brilliancy of Indian almond fruit to enhance quick adaptation for dyeing industries.

iii. Determine the availability of the fruit (Indian almond), its acceptability to dyeing industries.

iv. Assess the colour chromatography of the almond fruits.

III. MATERIALS AND METHODS

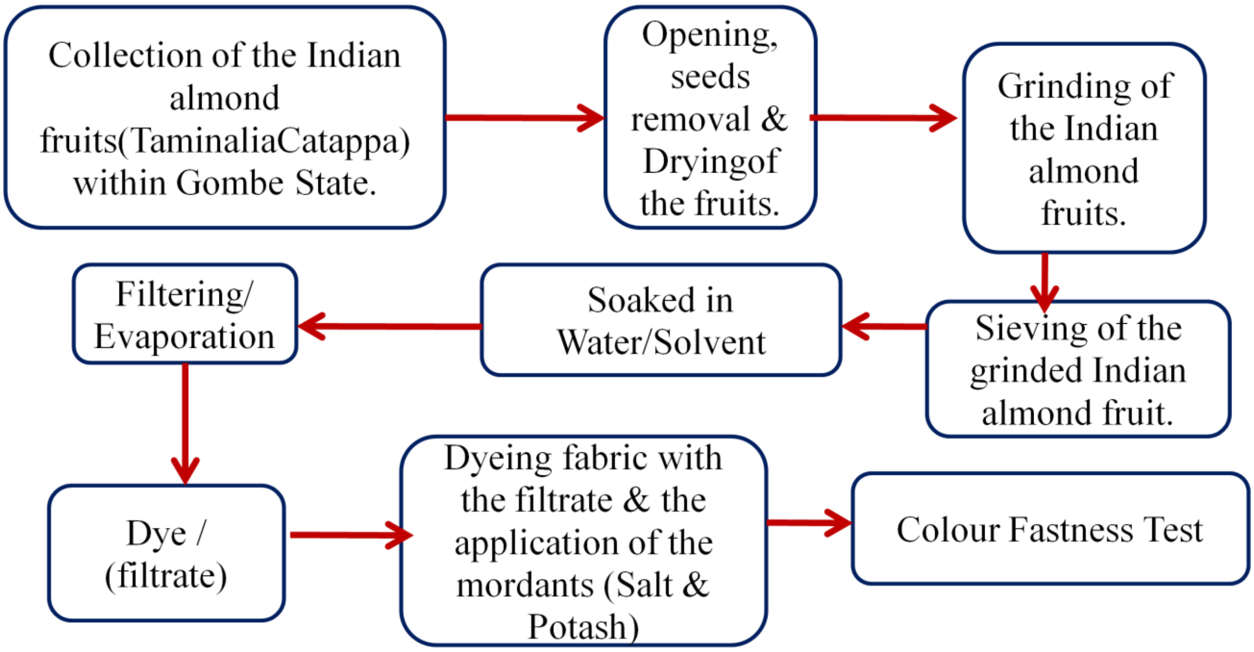
3.1 Research design

The method adapted for this study was laboratory experimental research. According to Lordrick *et al* (2015) laboratory experimental research involves systematic or planned observations and measures of the associations between independence and dependence variables are recovered and later analyzed using appropriate procedures. Lordrick *et al* (2015) posited that, for ethical reasons, human beings are usually not involved as subject in many laboratory experimental studies.

The sample for this research was Indian almond fruit (*Taminilia Catappa*). Reasonable amount of the fruits were gathered from the tree by the researchers. The materials required as samples were mercerized/bleached cotton fabrics, pots/conical flasks, chemicals such as, copper sulphate II, Ferrous Sulphate II, & III, methanol, ethanol, potash and Ash.

The fruits gathered were opened, the seeds removed and shade dried. It was ground into powder; sieved, weighted and soaked in distill water, methanol and ethanol separately over night to improve extraction. The solutions were filtered using filter paper accordingly, the extracts were then measured using measuring cylinder.200mls of the mordant (salts,Ash & potash) solvent were measured using the measuring cylinder and poured in to the container/flask containing the colour extracts and the fabric was immersed to absorb the colour extract, for strong binding of the colour into the fabric.

***3.2* Diagram showing the extraction of colour pigment from Indian almond fruits (Taminalia Catappa)**



3.3 Procedure for colour chromatography.

A solution of Isopropyl alcohol and distil water were mixed and poured into a chromatography tank and allowed to equilibrate. The powder of the sample (Indian almond fruit) was dissolved into distil water, methanol, and ethanol separately to obtained the colour extract over 48hours,the solution of the sample was spatted on a whattman paper on the base line drawn, which was allowed to dry for 5-10 minutes, it was then introduced into the saturated chromatography tank, for the chromatography to take place for an hour. The paper from the tank was removed and allowed to dry and then spread with a solution of anisaldehyde, which was later kept in an oven at 100^{o}C for 3 minutes to obtained the final result.

***3.4* Dyeing procedure**

In line the procedure of Lordrick, *et al*, (2015) 200mls of the mordant was measured using the measuring cylinder. This was added, according to mordanting process (pre-mordanting, simultaneous modanting & post-mordanting) on the 2.5g extract from the Indian almond fruits into the beaker and then stirred. The beakers were placed on the heating mantles and the 5g fabric (wetted with water in order to obtain maximum take-up and leveling) were immersed and dyeing continued for a recorded time (60—90 minutes) with intermitting stirring. The beakers were removed from the heating mantles and the samples were removed, squeezed, and dried immediately after dyeing. The dyed samples were then washed in hot solution of detergent before rinsing with tap water then dried.

The dried samples were cut into pieces of 10cm x 4cm and sandwiched into fabrics which were exposed to tests for washing, light, rubbing and perspiration fastness tests, any excellent to good fastness according to the rated standard value below was considered as good fastness colour/ dye.

***3.5* Data analysis**

Data was analysed based on the grading of scale using the standard colour rating by the researchers. Colour fastnesses to washing of the dyed fabric were determined as per MS ISO: 764-1987 American Association of Textile Chemists and Colourists (AATCC) methods using washing fastness machine. The wash fastness rating was assessed using grey scale as per ISO-105-A02 (loss of colour shade/depth) and ISO-105-A03 (extent of staining), (Samanta & Agarwal, 2009).

IV. RESULT AND DISCUSSION

The three mordanting methods namely; pre-mordanting, simultaneous mordanting and post-mordanting dyeing used, (Chandramohan & Saravanan, 2011) indicated that After dyeing, dyed fabrics were then subjected to colour fastness test on washing, exposure to light, rubbing, and perspiration. The tested samples were evaluated using grey scale and the results were established based on the graded value obtained (1-8) (Pruthi *et al*., 2007; Jothi, 2008).

Colour fastness to washing of the dyed fabrics samples was determined as per MS ISO: 764-1987 American Association of Textile Chemists and Colourists (AATCC) methods using washing fastness machine. The wash fastness rating was assessed using grey scale as per ISO-105-A02 (loss of colour shade/depth) and ISO-105-A03 (extent of staining), (Samanta & Agarwal, 2009). This study adopted the standard Textile technology grades values; colour fastness to washing minimum >3, maximum ≤ 4, exposure to light, minimum >5, above 5-8maximum rubbing (wet & dry) minimum =3, maximum =4, perspiration test minimum >3, maximum <4, this implies that from 4 -7 excellent to good, 3-4 average, 2-3 fair, 1-2 poor

Therefore the exposure to light showed excellent to good (6-5,& 4-3) for all the treated samples, good rubbing fastness was exhibited by the fabrics dyed using the dye extract from Indian Almond. Complexing the fibre with mordants has the effect of insolubility of the dye making it colour fast (Adeel *et al, 2009*). This means if the fibres were not made well, the effect can be that, dye extract on the fabric can be dissolved. Therefore, the instability on the fastness results on all the treatments can be as a result of inability of having good complexes of the fibre with the mordant applied, as shown in (Tables 1a, 1b &1c). Rubbing fastness test samples showed excellent to good (4-5 & 3-4) on all the treated samples, there was no colour change and very negligible staining.

Ferrous sulphate and copper sulphate expressed the ability of forming co-ordination on the fibres. The mordants occupied the un-occupied site of the fibre on interaction with the fibre, thus a ternary complex is formed by the salt (mordant) on which one site is the fibre and the other site is with the dye (Jothi, 2008).

Perspiration fastness test shows excellent to good (4-5), fairly good (3-4) for both acidic and alkaline fruit extracts, but showed no colour change and very negligible colour staining on almost all the treated samples in acidic and alkaline media. (Vankar *et al*, 2009; Samanta & Agarwal,2009),

Table 1: Fastness grades of Indian almond fruit on cotton fabrics at dyeing time of 30 minutes of 100^{o}C temperature in aqueous solution.

Mordanting Method	**Type of Mordant Used**	**Tamalania Catappa Fruit**								
		Cotton								
		Light Grades	Washing		Rubbing		Perspiration			
			Grades		Grades		Grades			
					Dry	Wet	Acidic		Alkaline	
			CC	CS	CC	C C	CC	CS	CC	CS
Pre-Mordanting	A	6	4	5	5	4-5	2	2	4	4
	B	3	4	5	4-5	5	5	5	4	4
	C	6	1	4	4-5	4-5	5	5	4	4
	D	6	1	5	2	3	1	1	3	3
	E	5	4	5	4	4-5	1	1	3	3
Simultaneou s Mordanting	A	7	2	5	2-3	3	1	1	5	5
	B	3	3	5	4	4-5	5	5	4	4
	C	3	3	5	3	4-5	4	4	5	5
	D	6	4	5	4	4-5	2	2	4	4
	E	6	2	5	4-5	4	2	2	5	5
Post-Mordanting	A	4	4	5	4-5	4-5	1	1	2	2
	B	3	4	5	4	4	2	2	5	5
	C	6	423	5	5	4	5	5	3	3
	D	5		5	4	4-5	1	1	5	5
	E	6		5	4-5	4-5	2	2	5	5

Key: A- Copper (II) Sulphate CC- Colour Change
B- Iron (II) Sulphate CS- Colour Staining
C-- Iron (III) Sulphate
D---potash

E---Ash

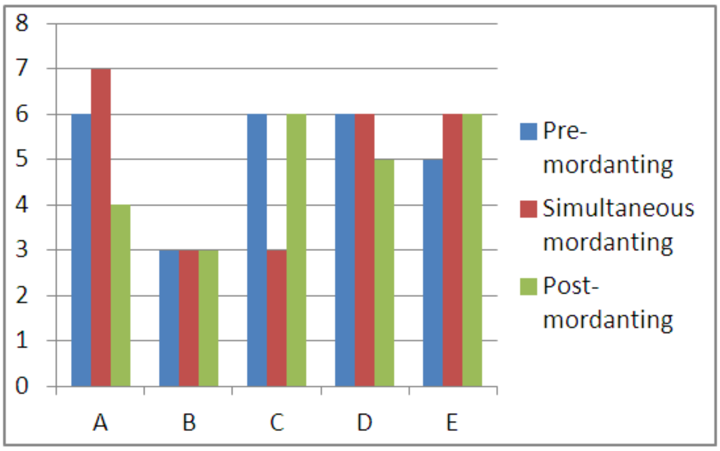


Figure 1: Light fastness graph test result on cotton fabric.

A, B, C, D, & E are mordants.

From the above figure, it can be observed that all three mordanting methods showed good roles especially in A, C, D & E, an excellent to good fastness can be seen. This can be supported that, strong co-coordination tendency of ferrous sulphate and copper sulphates can enhance the interaction between the fibric and the dye resulting in high dye uptake (Padma, 2000).

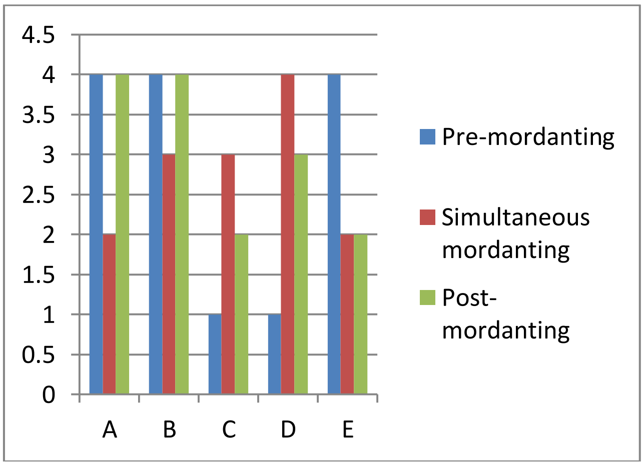


Figure 2: Washing fastness graph test result on cotton fabric.

A, B, C, D, & E are mordants

From the above figure it can be seen that all the mordants played a vital role during the dyeing process specifically the mordanting process in pre and post-mordant in mordants A,B,C, D & E respectively,

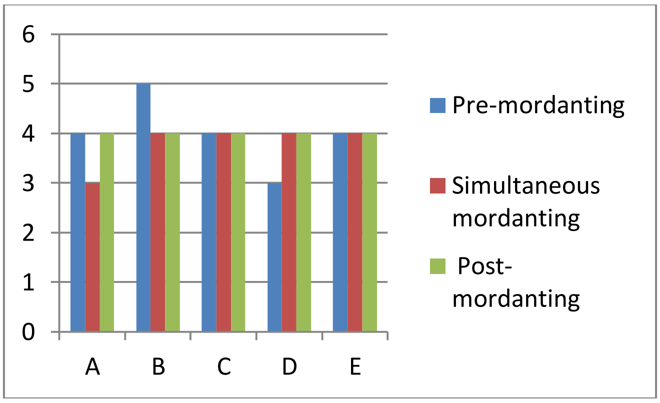


Figure3: Rubbing fastness graph test result on cotton fabric.

A, B, C, D, & E are mordants

From the graph above it can be observed that only the pre-mordant in mordant B has the highest bonding between the fibric and the dye.

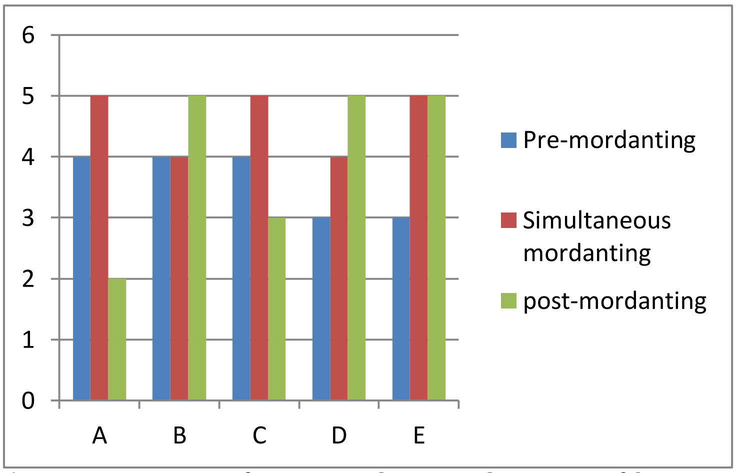


Figure 4: Perspiration fastness graph test result on cotton fabric.

A, B, C, D, & E are mordants

Similarly in this above graph only simultaneous and post-mordants of all the mordants showed excellent and good properties while the pre-mordant exhibited lower levels.The simultaneous mordanting in mordant A, C, & D, have the highest binding while B & E shows fair linkage. However, there was good co-ordination by the mordants between the fabric and the dye extract.

All the mordants showed very good results in all the mordanting processes except for pre-mordanting in mordant E, This can be supported by the statement that, strong co-ordination by the mordant can enhance the interaction between the fabric and the dye, resulting in high dye absorption.

This is in line with the work of Vankar (2009), that mordant applied have good affinity between the fabric and the dye. It can be observed that the extraction in aqueous combination, dyed cotton fabrics samples were subjected to colour light, washing rubbing fastness exhibited good and fairly good result (4-5, 4, & 3) without colour change and negligible colour staining. Samanta and Agarwal (2009) work implies that good diffusion rate of dye create good affinity of mordant between the fabric and the dye. The grade value (7-4). Rubbing fastness was also excellent to good (5 & 4-5).Similarly, in perspiration fastness tests were also excellent to fairly well.

While Table 1 extracted in the methanol medium combination dye on cotton fabric samples; for washing fastness test was excellent to fairly well (4-5& 3-4), no colour change and staining,light exhibited excellent result (7, 6 &5-6), on cotton.

Rubbing fastness revealed excellent (5 & 4-5) results on cotton fabric samples; no colour change and staining.

The colour fastness test on perspiration test revealed excellent to fairly well (4-5&3-4), for the perspiration medium, in all the treatment methods on both cotton fabrics. the results from dyed cotton extracted from ethanol medium combination revealed that washing fastness test was excellent to fairly well (4-5&3-4), showing no colour change and negligible colour staining; Light fastness test result was excellent (7, 6 & 5-6); Rubbing fastness test results exhibited excellent to fairly well (4-5&3-4) both on wet and dry, with negligible colour staining; Perspiration results was also excellent tofairly well (4-5 & 3-4) in acidic and alkaline media, both on cotton fabrics respectively.

Strong co-ordination tendency of ferrous sulphates enhances the interaction between the fibre and the dye, resulting in high dye uptake (Jothi, 2008). Ferrous sulphate and copper sulphate have the ability of forming co-ordination complexes (co-ordination numbers are 6 and 4 respectively). Also the functional groups such as amino and hydroxyl groups of the fibres can occupy the unoccupied sites on interaction with the fibre. This form a complex by the metal salt (mordant) on which one site is with the fibre and the other site is with the dye (Jothi, 2008).

Therefore, the few colour losses were from the mordants of alum, copper sulphate results tests, which could mean no strong co-ordination that can interact between the fibre and the dye which make dye uptake very low resulting in loss of colour of (2-3), however, there were negligible colour staining on all the tested fabrics samples of the treatment methods.

It can also be noted that the mordanted fabrics were immediately used for dyeing because some mordants are light sensitive. The chromatophore of the dye makes it resistant to photochemical attack, but the auxochrome may alter the fastness (Pathade, 2011).There were good washing, light, rubbing fastness observed on all the tested dyed fabric samples with the dye extract from the plants, this was due to formation of complex with the metal salts which protects the chromatophore from photolytic degradation, the wash fastness was influenced by the rate of diffusion of the dye and state of the dye inside the fibre (Mahala, 2001).

It can be concluded that, all the colours extracted from the plants' fruit be acceptable as natural dyesand be used by textiles industries, training institutes and other related organisations in our dear nations (Nigeria)

V. CONCLUSION

One of the most interesting and intricate issue in the construction of any fabric (cloth) is the addition of beauty to the appearance and serviceability .Therefore, dyes is the answer to improving the appearance of fabric surface, as it provides everlasting beauty and delight to the beholder by adding colour to it. Synthetic dyes are most appreciated for numerous reasons; but have some threatening effect on the environment and human life. Therefore, it is advisable and good to go back to the natural dyes from plants as they still hold relevance in the dye and textile industries.

All tests conducted revealed that the extracted colour can be applied on fabrics especially natural fabrics, specifically on cotton because excellent to good, fairly good results were recorded on the colour fastness test, with brightly soft and light colours obtained.

In conclusion, fruit extracts can be used in the discovery of other natural dyes and be used for future research, especially to bring out the chemical structure for good understanding of interaction between mordant to be applied, fabric to be used and to any interested persons/individuals, organisations and the government to recognize this plant as natural dyes, it is economically available especially in tropical and sub-tropical region, using different methods of extraction and with other mordants apart from those used in this study.

VI. RECOMMENDATIONS

The following are recommendations made based on the outcome of the study:

1. Natural dyes are good source of dye absorption dyers using natural dyes should maintain good mordanting of fabric for better result/ colours.

2. Indian almond fruits are good sources of natural dyes. Dyers, farmers and the general public can utilize it as dyes and source of income to the farmers.

3. Since Indian almond fruits produce natural colours that can be used for dyeing, scientist can help to bring out a solving solution of using natural dyes and encourage farmers to venture into the raising almond trees.

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