PROJECT PROPOSAL

EXTRACTION AND DEVELOPMENT OF NILEST-TAN FOR LEATHER INDUSTRIES

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1. EXECUTIVE SUMMARY

NILEST-Tan is a natural product developed through research by the Directorate of Research and Development (DR&D), NILEST; Zaria. It is a vegetable product obtained from an indigenous plant material, *Acacia nilotica* (Bagaruwa) for leather production. The research problem identified from literature to the best of our knowledge was the challenges associated with the extraction and preservation of the tannin extract. Therefore, this research provides a solution to the growth of molds on the tannin extract. We have succeeded in improving the shelve life of the tannin extract. The NILEST-Tan has a tannin content of 35.50% tans with tannin purity of 0.80, this outweighed the 30.10% tannin content reported by Agbaji and Ekanem (1998). In addition, the physical and mechanical properties of the leather tanned with NILEST-Tan was found to be better in comparison to the crude bagaruwa tannage. The tensile strength of the leather tanned with the crude bagaruwa powder was found to be 16.24 MPa at 30% offer. This was found to be low compared to that of the leather tanned with NILEST-Tan. The tensile strength of the leather tanned with NILEST-Tan are: 18.04, 23.14 and 23.33 MPa at 5, 7.5 and 10% offer. The shrinkage temperature of the leather was also found to be 77ºC. This product has proved to be environmentally friendly, improved exhaustion time, clean product and unique colour shade impact on the leather. This project is geared toward green and clean leather production, harnessing of local resources and reduction of over dependence on importation and consequently, contributing to Nigerian Economy. Due to the important of this

product, the DR&D, has estimated the cost of establishing a Pilot Plant for the production of NILEST-Tan to be N68,335,476.50.

2.0 INTRODUCTION

Tannins are water-soluble phenolic compounds having molecular weights between 500 and 3000 capable of precipitating alkaloids as well as gelatin and other proteins from aqueous solution (Bate-smith, 1962). Traditionally, tannins are widely used as agents of converting animal hides/skins to leather ("tanning") by precipitating proteins found in the animal skins (Hagerman, 2002). *Acacia nilotica* (Bagaruwa) is one of the most important tannin-bearing trees. Leather processing technology has evolved naturally from traditional practice to an industrial activity.

1.1 STATEMENT OF THE PROBLEM

According to research survey, Kano State, Nigeria has about fifteen functional leather industries, which produces different leather products with total production capacity of about 310,000 hides and 25.5 million skins per year. It was further reported that the commercial tanneries in Nigeria use up to 6,000 metric tons of bagaruwa annually in the production of vegetable crust leathers, while the rural tanning sub-sector consumed up to 12,000 metric tons (Theresa *et al*., 1982). These industries are facing a lot of solid waste treatment and disposal problems and many tanning industries could not meet the required level of chromium, bio-chemical oxygen demand and total dissolved solid in their effluents. These industries also generate huge amounts of chromium contaminated solid and liquid waste which are non-biodegradable and also emit unpleasant smell to the environment. Vegetable tannins have been identified as an alternative to chrome tanning, but to have the tannins extracts in a refined environmental friendly products has been the issues. The cottage tanners are using the vegetable crude powder direct on the hides/skins leading to low penetration, growth of

microorganism such as moulds, oxidation and high exhaustion time. Furthermore, most of the chemicals used for tannery production are imported and this in turn affect the GDP of Nigeria.

1.2 OBJECTIVE

The objective of the project is to develop an environmental friendly NILEST-Tan from crude plant materials for leather production.

1.3 JUSTIFICATION

To reduce or eliminate the dependence on imported tanning agents with a view to conserving foreign exchange.

2.0 LITERATURE REVIEW

2.1 VEGETABLE TANNINS

Vegetable tannins or natural organic tannins are astringent bitter plant polyphenolic compounds that are known to precipitate proteins, amino acids and alkaloids (Aerts *et al*., 1999). The term tannin is used to mean any large polyphenolic compound containing enough hydroxyl groups and other suitable groups capable of forming complexes with several macromolecules. There are two main classes of tannins, condensed tannins (catechols) and hydrolysable tannins (pyrogallols) (Covington, 2011). Tannins can be used for tanning hides and skins into leather, making them non putrescible while giving them a soft and flexible feel especially after being subjected to wet and dry cycles thus making them suitable for various uses (Thorstensen, 1993). Vegetable tanning is used in the manufacture of all types of leathers especially those used for sole, belting and harness. In addition, retanning of chrome tanned leather with vegetable tanning or vice versa is common in producing most upper leather and garment leather (Tuck, 1981). This technology has been used in Sudanese rural garad tanned crust leathers for production of semi-chrome shoe upper leathers (Musa and Gasmelseed, 2014). Tannins are

also used in the manufacture of ink, iron-tannic pigments, alkaloid antidotes, clarification of beer and wine and in the manufacture of wood adhesives (Jingge *et al*., 1998). In the extraction and quantification of the tannins present in bagaruwa pod, Agbaji and Ekanem (1998) reported that bagaruwa pod tannins collected from several locations in the Northern Nigeria contains 17.10 – 30.10% pure tans. The tannin content as reported above, is below the 35.30% tannin content obtained in this research.

2.2 STRUCTURE AND CLASSES OF TANNINS

Tannins are large polyphenolic compounds with sufficient hydroxyls and other suitable groups such as carboxyls which contribute to their high molecular weight that allows them to form strong complexes with proteins and other macromolecules (Ashok and Upadhyaya, 2012). Tannin molecules must have at least 12 hydroxyl groups and a minimum of five phenyl groups in order for them to precipitate proteins (Haslam *et al*., 1992).

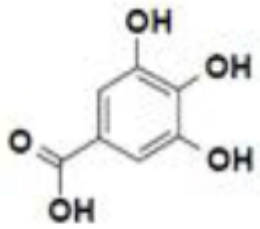
Oligostibenoids (oligo- or polystilbenes) are oligomeric forms of stilbenoids and constitute a class of tannins (Boralle *et al*., 1993) however, there are three major classes of tannins considering the basic units or monomers in each category (Covington 2009). The three classes are as follows:

2.2.1 HYDROLYSABLE TANNINS (PYROGALLOLS)

Hydrolysable tannins will tend to disperse when boiled in an acid solution and are less likely to develop red colours upon addition of alkali. They are easily purified to relatively simple light coloured tannic acids. In addition they develop blue colours on addition of ferric chloride (Yisa, 2009). The tannins of myobalans, chestnut, sumac and divi-divi are of hydrolysable type (Afsar and Sekeroglu, 2008). Hydrolysable tannins are further divided into two groups i.e. gallotannins and ellagitannins (Covington, 2009).

Gallotannins

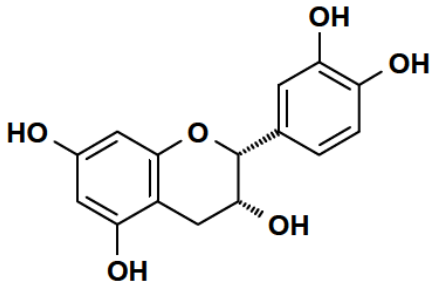
The glucose core in gallotannins is esterified only by gallic acid and bound gallate groups can undergo deep side esterification through their phenolic hydroxyls. Variation in structures arises from the degree of esterification of glucose centre and the magnitude of deep side esterification. The astringency polyphenols depends on the concentration of hydroxyl groups (Covington, 2009).



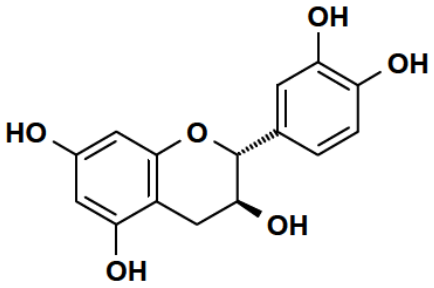
gallic acid

2.2.2 CONDENSED TANNINS (CATECHOLS)

Catechols have a flavanoid ring structure and will show an increase in weight (polymerize) when boiled in an acid solution (Thorstensen, 1993). Condensed tannins will disperse upon addition of an alkali and are oxidized to yield red colours (Thorstensen, 1993). They will develop green colours on addition of ferric chloride (Yisa, 2009). Tannins of black wattle, quebracho, hemlock, cutch, gambier, mangrove, spruce, harch and tea are catechols (Afsar and Sekeroglu, 2008).



epicatechin



catechin

3.0 MATERIALS AND METHODS

3.1 MATERIAL

The Bagaruwa pod powder was obtained from Kano State, Nigeria.

3.1.1 Chemicals, Reagents and Solvents

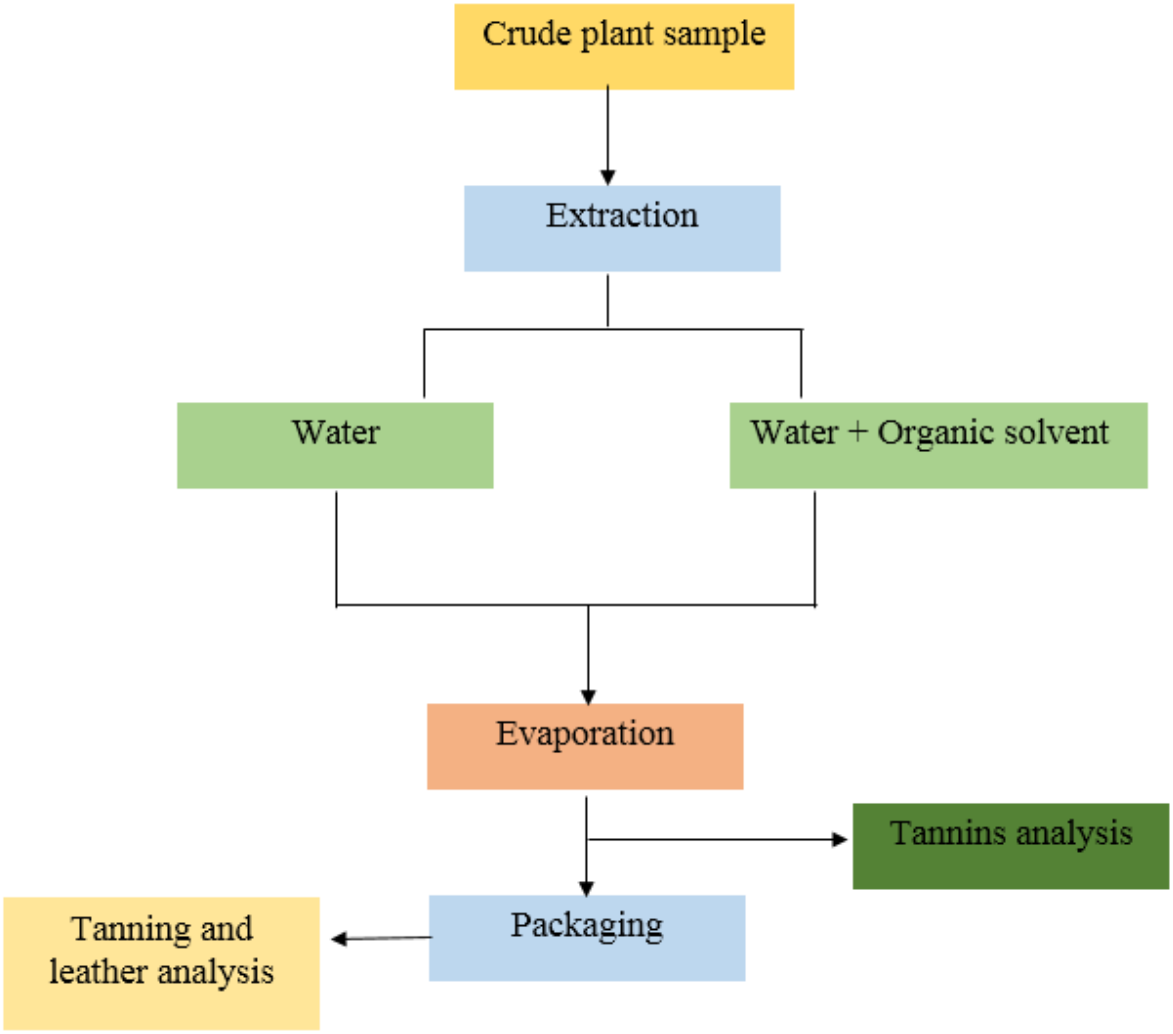
Sulphuric acid, Hydrochloric acid, Sodium hydroxide, Potassium iodide, Sodium thiosulphate, Potassium dichromate, Sodium chloride, ethanol, methanol.

3.1.2 Machines, Apparatus and Equipments

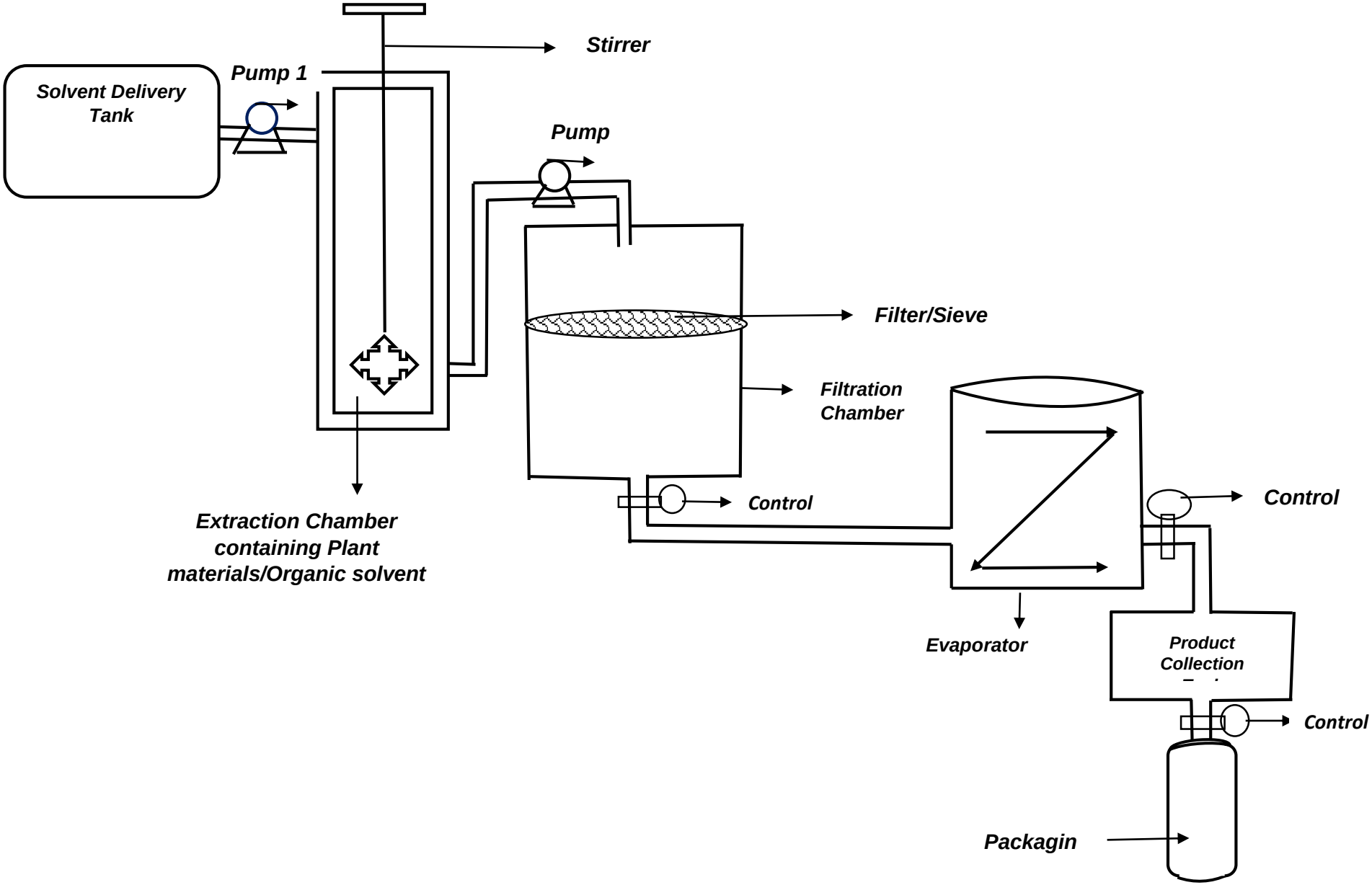
Simple Constructed Reactor, Agilent FTIR Cary 630, UV-Spectrophotometer, pH Meter, Thermometer, Volumetric flask, Soxhlet Apparatus, Beakers, Conical flask, Burette, Pipette, Measuring cylinder.

3.2 METHODS

LABORATORY SCALE FLOWCHART FOR EXTRACTION



Pilot Scale Flowchart



4.0 RESULTS AND DISCUSSION

Table 1: Analysis of the Bagaruwa crude

Parameters	Values
Moisture content	11.00%
Total soluble	43.00%
Non-tans	6.00%
Total insoluble	51.00%
Tannin strength	5.10
Tannin purity	0.80
pH	6.00

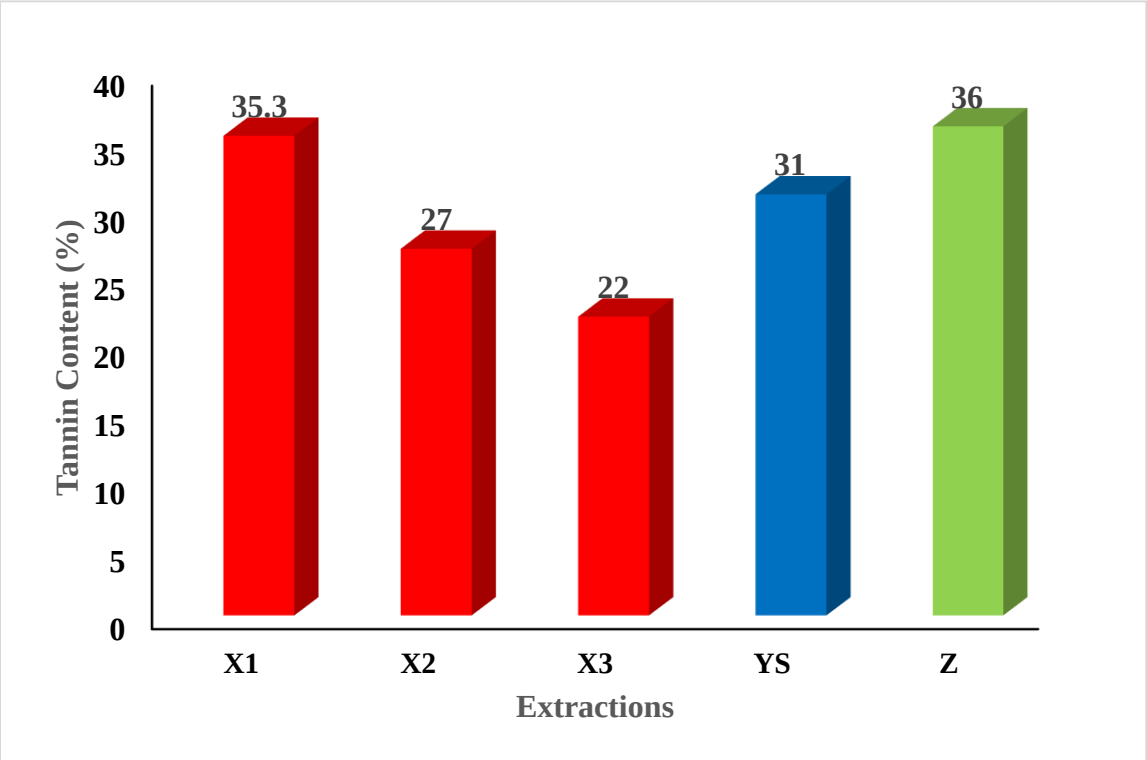


Fig 1: Tannin content in percentage at different

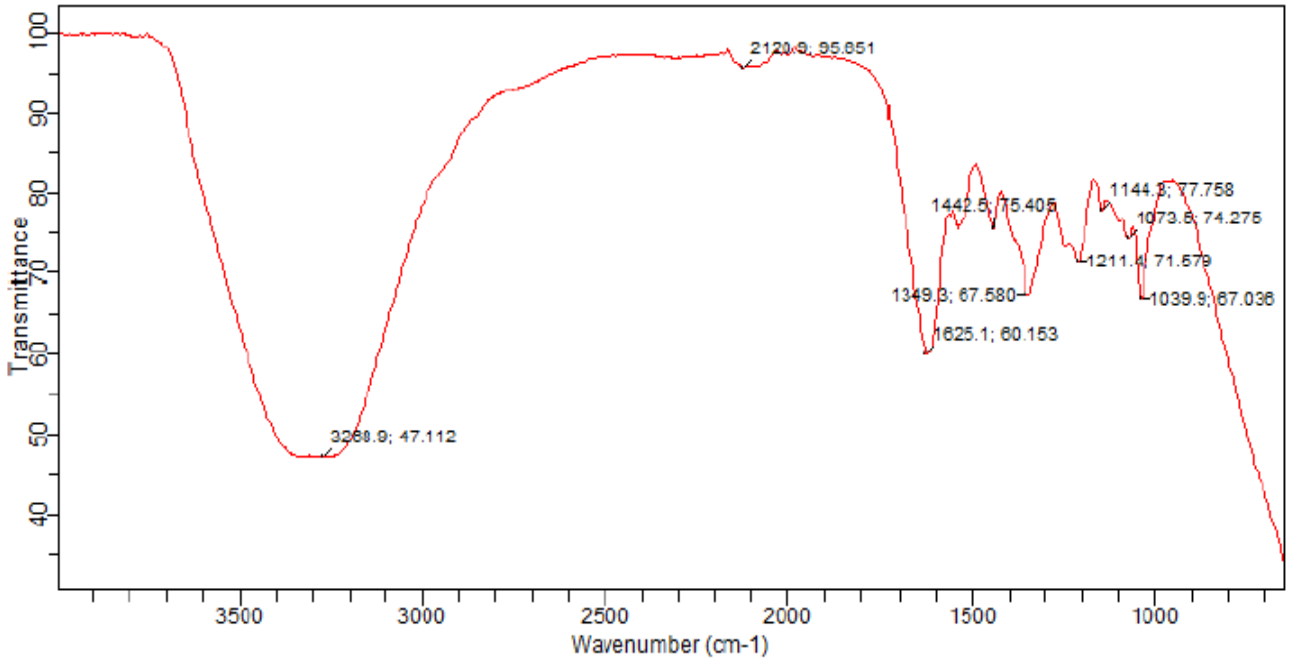


Figure 2: FTIR Spectrum of NILEST-TAN

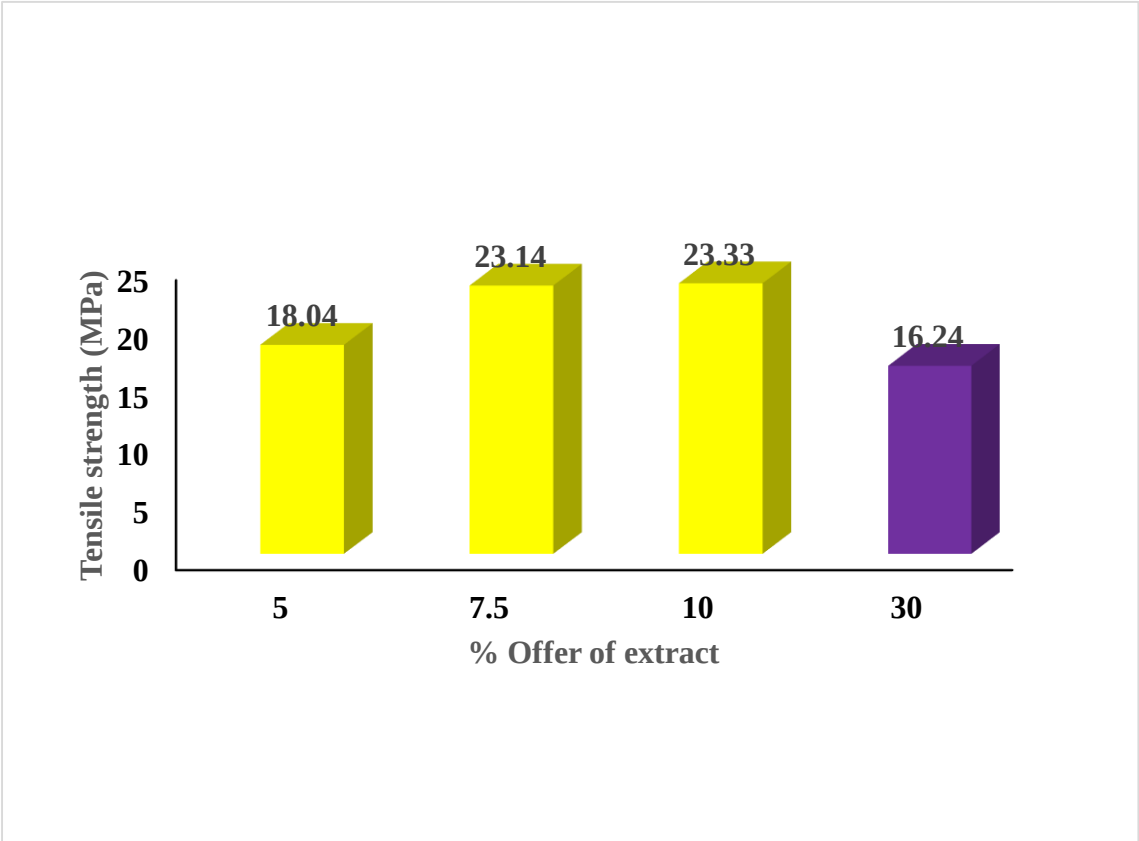


Figure 3: Effect of tannin extract on tensile strength of the leather

5.0 CONCLUSION

- The characterisation of the NILEST-Tan using the FTIR revealed that the –OH functional group broadly appeared at a frequency of 3300cm^{-1}.

- The tannin content of the NILEST-Tan obtained was 35.30%. This indicated that, it can adequately replace the crude bagaruwa.

- The optimum tensile strength of the leather tanned with NILEST-Tan was 23.33 MPa at 10% offer. This outweighed the leather tanned with 30% of crude bagaruwa having about 16.24 MPa. It also has a good shrinkage temperature at about 77ºC.

- Its exhaustion time is less, permitting fast penetration of the tannins during tanning processes.

6.0 WORK PLAN/TIMELINE ACTIVITIES FOR THE DEVELOPMENT OF NILEST-TAN FOR UTILIZATION BY THE TANNING INDUSTRIES IN NIGERIA

1.0	Activities	Months						
		0	2	4	6	8	10	12
1.1	Phase I							
1.1.1	Building Construction of NILEST-Tan Production Unit							
1.1.2	Procurement of machines, raw-materials, chemicals etc.							
1.1.3	Fabrication of the Pilot Plant							
1.2	Phase II							
1.2.1	Development of the NILEST-Tan Product							
1.2.2	Quality Assessment and Standardization							
1.2.3	Final report							
1.3	Phase III							
1.3.1	Packaging and commercialization							

7.0 PROJECT DURATION

This project is expected to last for 12 months and would be carried out in the following phases as shown in the timeline activities:

i. Phase I: 1 - 6 months is for building construction of production unit, procurement of machines, raw-materials, chemicals and fabrication of the pilot plant.

ii. Phase II: 6 – 10 months, development of the NILEST-Tan product, quality assessment and standardization and final report.

iii. Phase III: 8 – 12 months, packaging and commercialization of the product.

8. PROJECT COSTING OF THE PILOT PLANT, RAW-MATERIALS, CHEMICALS AND EQUIPMENT FOR THE PRODUCTION OF THE NILEST-TAN

CONSTRUCTION OF NILEST-TAN PRODUCTION BUILDING					
S/n	**Materials**	**Quantity**	**Unit Price (#)**	**Amount (#)**	**Remark**
1	3-Stores, 1-Millingroom and Production Yard	-	43,000,000.00	43,000,000.00	
ESTIMATE FOR THE RAW-MATERIALS AND OTHERS					
1	Bagaruwa	10 tons	15,000/50kg	3,000,000	
2	Solvent	100L	1,200,000	1,200,000	
3	Distilling Machine	2	389,138.25	778,276.50	
4	Camry Digital Weighing Scale	1	60,000	60,000	
5	Milling Machine	1	95,000	95,000	
6	Industrial Beaker	4	10,000	40,000	
7	Industrial Conical flask	4	10,000	40,000	
8	Industrial Measuring Cylinder	4	4,800	19,200	
9	Safety Gadgets	20&2F	230,000	230,000	
10	Miscellaneous	-	300,000	300,000	
DESIGN AND CONSTRUCTION OF MACHINES FOR NILEST-TAN PILOT PLANT					
1	3000L Water Storage Tank (1 &2)	2	70,000	140,000	
2	400L Stainless Solvent Tank	1	550,000	550,000	
3	200L Reactor	1	800,000	800,000	
4	Filtration Chamber	1	450,000	450,000	
5	Product Storage Tank	1	300,000	300,000	
6	Evaporation Chamber	1	300,000	300,000	
7	Solvent Tank 3(50L)	1	150,000	150,000	
8	5HP Gear Electric Motor	2	750,000	1,500,000	
9	1.5HP Water Pump	2	50,000	100,000	
10	2”x2”x5mm Stainless Angle Iron	10	30,000	300,000	

11	3”x3”x5mm Stainless Angle Iron	10	40,000	400,000	
12	1” Stainless Pipe	6	17,000	102,000	
13	3” Stainless Pipe	2	23,000	46,000	
14	Accessories and Fittings	-	35,000	35,000	
15	Mikano (30KVA Generator)	1	7,000,000	7,000,000	
16	Water Source (Borehole and Accessories)	1	2,000,000	2,000,000	
17	Consumables	-	400,000	400,000	
18	Marketing and Advertisement		5,000,000.00	5,000,000.00	
			TOTAL	**N68,335,476.50**	

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Appendices

Plate I: NILEST-TAN in Liquid Form

Plate II: NILEST-TAN in Pellet Form

Plate III: TANNED LEATHER