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Effect of Chemical Treatment on Kankan Bile Fiber for Composite Production

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Abstract: **Natural fiber from plant was chemically treated to expose the cellulose contents that gave stronger bonding during reinforcement for composite production. Chemical treatment of Kankan bile fiber was done using three different alkaline solutions; Potassium Hydroxide, Nitric acid, and Acetic anhydride. Optimization of process variables was done to get the optimum condition of the process and model equation was developed. The result showed that nitric acid gave the lowest value of 23.81% lignin removal at 10% concentration, 70minutes and 40^{O}Cand highest value of 44.19% removal at 14% concentration, 50minutes and 70^{O}C while Acetic anhydride gave the lowest value of 33.21% lignin removal at 10% concentration, 70minutes and 40^{O}Cand highest value of 46.3995% removal at 14% concentration, 50minutes and 70^{O}C. Also, Potassium hydroxide gave the lowest value of 29.89% lignin removal at 6% concentration, 90minutes and 50^{O}Cand highest value of 41.24% removal at 14% concentration, 50minutes and 70^{O}C. Hence, acetic anhydride was the best chemical to removal lignin from Kankan bile fiber.**

Keywords: **Acetic Anhydride, Composite, Kankan bile, Natural Fiber, Nitric acid, Potassium hydroxide.**

I. INTRODUCTION

Fibers are types of hair-like material that are continual filaments or are in discrete lengthen pieces, close to pieces of thread. They can be revolving into filaments, thread, or rope [1]. Fibers are in the collection of polymer cast composites which comprises of a polymer thermoplastic or thermosetting fortified by fiber [2]. Natural fibers are broadly categorized into three types, namely plant, animal and mineral fiber. The first is essentially made up of cellulose, while the latter is protein-based. However, in the composites industry, natural fibers are frequently referred to as vegetable fibers [3]. The desirable attributes and interest of natural fibers over synthetic fibers are low cost, lightweight, serene availability, recyclability, low density, and moderate energy content but high moisture absorption, deficient interaction with polymeric materials, and poor fiber-matrix bonding are a few unacceptable characteristics that restrict them for certain use [4]. Natural fibers have poor strength properties compare to synthetic fibers but certain modulus and elongation at break in a point are governing the potential of natural fibers as substitution or partial substitution for synthetic fibers in fiber composites. Normally, fibers with high crystallinity, high cellulose content, higher length-to-diameter (aspect) ratio and lower microfibrillar angle have been found to possess higher mechanical properties [5,6]. Natural plant fiber capacity to withstand instantly applied load is defined as impact strength and is expressed in terms of energy. The impact properties of composite materials are exactly related to their gross toughness [7]. The main constituents of natural fibre are cellulose, hemicelluloses and lignin. Cellulose is the innate homopolymer (polysaccharides), where D-glucopyranose rings are attached to each other with β-(1→4) -glycosidic linkages. Cellulose is frequently found as a relatively high modulus, fibril component, of numerous innately occurring composites [8] Hemicellulose is made up of very branched polysaccharides, including glucose, mannose, galactose, xylose, and others [9]. Nevertheless, lignin (pectin) is thermally firm, but responsible for the UV degradation of the fibers. Lignin is made up of aliphatic and aromatic hydrocarbon compounds positioned around the fibers. The firmness and hardness of the fibers are provided by cellulose components via hydrogen bonds and other linkages. Lignin together with hemicellulose is nature's bond in the adventure of the power of cellulose while conferring flexibility. Lignins are very important in the formation of cell walls, especially in wood and bark, since they lend rigidity and do not rot easily. Cellulose, hemi cellulose and lignin percentage is varied for different materials [2]. The main advantages of using natural reinforcements in composite materials, if compared with conventional synthetic fibers were biodegradability, lower specific weight which results in a higher specific strength and stiffness than glass, renewable resource, production with low investment at a low cost which makes the material an interesting product for low wage countries, friendly processing with reduced wearing on tools, better working conditions and no skin irritation. good thermal and acoustic insulating properties.

The chemical treatment of fiber is aimed at upgrading the adhesion between the fiber surface and the polymer matrix. Alkaline treatment removes a certain amount of lignin, wax and oil wrapping the external surface of the fiber cell wall and exposes the short length crystallites. It increases surface roughness resulting in greater mechanical interlocking and the number of cellulose exposed on the fiber surface. Some industries such as automotive, construction, energy, and aerospace, among others make products which are more environmentally sound and lower their dependence on fossil fuels [10,11,12,13]. Fiber-reinforced composites have been employed in furniture, packaging, assembly boards, paneling, sporting goods, fencing, electrical, kitchen to civil constructions, automobile and marine industries, military purposes, space and aircraft manufacturing [14]. Numerous synthetic fibers such as glass, carbon, aluminum oxide, boron fibers, have been used across the counter in reinforcing various polymeric materials.

However, researches in recent years have been focused on the use of natural fibers as a viable and biodegradable alternative in reinforcing plastics [15]. Alam and others [16] studied the effect of process variables on chemical treatment of jute fiber. It was found that variables have direct impact on the quality, strength, and other parameters of the fiber and with the increase of concentration of penetrating agent, the strength, extension at break and fineness were almost same, but with the increase of caustic soda concentration, the strength, extension at break and the fineness were decreased. Chemical Treatments of Jute Fiber for Application in Natural Fiber Reinforced Composites was studied [17]. The effect of chemical treatment method on the properties of Posidonia fibers were also studied [18]. The chemical treatment which is carried out is a combined hydrogen peroxide and sodium hydroxide treatment.

The aim of this study is to optimize the use of chemical treated kankan bile fiber using three alkaline solution.

II. METHODOLOGY

Extraction of Kankan bile (luffa cylindrical) was obtained Agbani, Nkanu West Local Government Area in Enugu State, Nigeria. The natural fiber was extracted and oven-dried. It was stored for 2 weeks after which it was brought out and thoroughly washed with clean water. The bundles were further placed inside the water and further left for a week at room temperature. After which it was washed with excess water and was sundried.

2.1 Chemical Composition of Natural Fiber

2.1.1 Moisture Content Determination

Porcelain crucibles were washed and dried in an oven at100^{o}C for 30 minutes and allowed to cool in a desiccator. 0.5gram of fiber (A) was placed into weighed crucibles and then put inside the hot air oven at 105oC for 4 hours [19]. The samples were removed from the oven weighed. The drying was continued and all the samples with the crucibles weighed until a constant weight (B) was obtained after this period and then cooled and weighed.

Where, A = Original weight of sample. B = Weight of dried sample.

$$\%moisture = \frac{A-8}{A} x \frac{100}{1} \qquad (1)$$

2.1.2 Ash Content

The ash content determination was according to the work of Thomsen et al (2012) with modifications. The ash content was determined by burning 0.5g of the fiber placed in a platinum crucible in a muffle furnace at a temperature of 600°C for a period of 30 minutes.

$$\frac{Weight\ of\ Ash}{Weight\ of\ Sample}\ x\ \frac{100}{1} \qquad (2)$$

2.1.3 Wax content:

0.5g of fiber was put into a thimble and then into a Soxhlet reflux flask and mounted in air oil extraction flask containing some quantity of petroleum ether.

The upper part of the reflux flask was connected to a condenser and airtight.

$$\%Wax = \frac{W_4 - W_3}{W_1} x \frac{100}{1} \qquad (3)$$

Where W_4 is the weight of the thimble and fiber before defatting, W_5 is the weight of the thimble and fiber after defatting, W_1 is the initial weight of the fiber.

2.2 CHARACTERIZATION OF BIOMASS

2.2.1 Extractive Content: Samples was dried until there was no variance in weight and thimble was then placed in the Soxhlet extractor. 360ml of ethanol was then measured using a volumetric cylinder and dispensed into a 500ml round bottom flask which was then placed on the heating mantle. Soxhlet extraction mechanism was then coupled to the flask. After the extraction was conducted for a period pf 4hours using ethanol as solvent, the supernatant was collected. It was evaporated until it reached a volume of about 15.5ml. It was then dried at 105.5°C until a constant weight was reached. The fuel residue represents the ethanol soluble extractive of the biomass.

2.2.2 Lignin Determination

1g of the extractive sample was measured into a beaker and 14ml of cold 72% sulphuric acid was added and stirred. The mixture was left to stand for 2hours. After, the 2hours of mixture was then washed in a 1litre conical flask and diluted to 3% sulfuric acid. The mixture was the boiled for 4hours under reflux. The insoluble material was allowed to settle and filtered. The residue was washed and dried in an oven at 105°C after 2hours, then cooled and weighed as the lignin content.

2.2.3 Cellulose

2g of the extractive free sample was measured and put in a 250ml beaker, then 100ml of 17.5% KOH solution was added and stirred at 25°C for 30minutes. The content of the beaker was then filtered, washed with 25ml of 9.5% KOH solution and 20ml portions of distilled water. The residue was again washed with distilled water and 40ml of 10% acetic acid and further with 1litre distilled water. The residue was then dried at 105°C for 24hours to constant weight.

2.2.4 Hemicellulose

1g of extracted dried biomass was transferred into a 250ml Erlenneyer flask. 150ml of 500mol/m^3 KOH was added. The mixture was boiled for 3.5hours with distilled water. It was filtered after cooling through vacuum filtration and washed with neutral pH. The was dried at 105°C in a convention oven. The different between the samples before and after treatment is the presence of the hemicellulose content.

$$\%Hemicellulose\ content = \frac{W_3 - W_2}{W_3} \times \frac{100}{1} \qquad (4)$$

Where W_3 initial weight of the fiber before extraction, W_2 final weight of the fiber after extraction

2.3 Alkali Treatment of the Sample (Natural fiber)

Fibers was kept at different concentration 3M, 6M, 9M and 12M of KOH, acetic anhydride and nitric acid aqueous solution for different time durations of 20, 40, 60 and 80 minutes at different temperatures of 30, 60. 80 and 100 ^{0}C under vigorous mechanical stirring to remove a certain number of impurities like lignin, wax, and oil from the fiber's external surface, which will reduce the level of adhesion with the polymer matrix. After the alkali treatment, the fiber was washed with tap water for 15min to remove excess chemicals and then after which was treated with distilled water containing 1% acetic acid to neutralize the remaining hydroxide. It was air-dried at room for 24 hours.

2.4 Determination of the Effect of Process Conditions on the alkaline treatment of natural fiber.

2.4.1 Effect of time

The fiber was kept in a concentration of 2M of KOH, acetic anhydride and Nitric acid aqueous solution for different time duration of 20, 40, 60 and 80 minutes at a temperature of 80 ^{0}C under vigorous mechanical stirring to remove a certain number of impurities like lignin, wax, and oil from the fiber's external surface, which will reduce the level of adhesion with the polymer matrix.

2.4.2 Effect of Concentration

The fibers were kept at different concentration of 3M, 6M, 9M and 12M of KOH, acetic anhydride and Nitric acid aqueous solution for time durations of 60 minutes at a temperature of 80 ^{0}C under vigorous mechanical stirring to remove a certain number of impurities like lignin, wax, and oil from the fiber's external surface, which will reduce the level of adhesion with the polymer matrix.

2.4.3 Effect of Temperature

The fibers were be kept at a concentration of 6M of KOH, acetic anhydride and Nitric acid aqueous solution for time durations of 60 minutes at different of temperatures of 30, 60. 80 and 100 ^{0}C under vigorous mechanical stirring to remove a certain number of impurities like lignin, wax, and oil from the fiber's external surface, which will reduce the level of adhesion with the polymer matrix.

Design Matrix for Chemical Treatment of Kankan Bile

RSM is the combination of statistics and mathematical procedures that utilize system modeling and problem analysis to create a response of interest. This response is affected by several variables and the target value [21]. The process factors for chemical treated Kankan bile was optimized using Central Composite Design (CCD). The chemical concentration range of 2, 6, 10, 14, 18% was adopted while temperature range of 40, 50, 60, 70, 80°C and time range of 30, 50, 70, 90, 110minutes were used for the chemical treatment. Table I showed the design matrix for composite production with 60runs.

Table 1: Design Matrix for Chemical treated Kankan bile

Std Order	Run Order	Chem Conc (%)	Time (Mins)	Temp (^{0}C)	Type of Chemical
32	1	10	110	60	Nitric acid
48	2	14	90	70	Acetic Anhydride
36	3	10	70	60	Nitric acid
58	4	10	70	60	Acetic Anhydride
21	5	6	50	50	Nitric acid
38	6	10	70	60	Nitric acid
41	7	6	50	50	Acetic Anhydride
53	8	10	70	40	Acetic Anhydride
17	9	10	70	60	KOH
37	10	10	70	60	Nitric acid
23	11	6	90	50	Nitric acid
6	12	14	50	70	KOH
29	13	2	70	60	Nitric acid
16	14	10	70	60	KOH
4	15	14	90	50	KOH

3	16	6	90	50	KOH
15	17	10	70	60	KOH
56	18	10	70	60	Acetic Anhydride
40	19	10	70	60	Nitric
20	20	10	70	60	KOH
1	21	6	50	50	KOH
52	22	10	110	60	Acetic Anhydride
30	23	18	70	60	Nitric acid
2	24	14	50	50	KOH
45	25	6	50	70	Acetic Anhydride
14	26	10	70	80	KOH
51	27	10	30	60	Acetic Anhydride
28	28	14	90	70	Nitric acid
13	29	10	70	40	KOH
59	30	10	70	60	Acetic Anhydride
39	31	10	70	60	Nitric acid
43	32	6	90	50	Acetic Anhydride
49	33	2	70	60	Acetic Anhydride
50	34	18	70	60	Acetic Anhydride
5	35	6	50	70	KOH
9	36	2	70	60	KOH
44	37	14	90	50	Acetic Anhydride
35	38	10	70	60	Nitric acid
47	39	6	90	70	Acetic Anhydride
33	40	10	70	40	Nitric acid
10	41	18	70	60	KOH
55	42	10	70	60	Acetic Anhydride
31	43	10	30	60	Nitric acid
7	44	6	90	70	KOH
19	45	10	70	60	KOH
57	46	10	70	60	Acetic Anhydride
24	47	14	90	50	Nitric acid
26	48	14	50	70	Nitric acid
18	49	10	70	60	KOH
11	50	10	30	60	KOH
34	51	10	70	80	Nitric acid
46	52	14	50	70	Acetic Anhydride
22	53	14	50	50	Nitric avcid
54	54	10	70	80	Acetic Anhydride
60	55	10	70	60	Acetic Anhydride
25	56	6	50	70	Nitric acid
8	57	14	90	70	KOH
27	58	6	90	70	Nitric acid
42	59	14	50	50	Acetic Anhydride
12	60	10	110	60	KOH

III. RESULTS AND DISCUSSION

3.1 Characterization of Kankan Bile Fiber

Table 3.1 showed proximate analysis of untreated and treated Kankan bile fiber with potassium hydroxide, nitric acid and acetic anhydride.

Table 1: Proximate Analysis of kankan bile fiber

Parameters	Untreated	Treated		
		KOH	Nitric	Acetic
Lignin (%)	16.4	10.87	6.8	12.72
Cellulose	22.26	60.15	68.97	56.15
Hemicellulose	32.49	12.82	10.06	19.66
Wax and Oil	2.9	1.4	1.6	1.9
Moisture	5.6	4.0	3.4	4.6
Ash	0.08	0.06	0.08	0.04

The moisture content of Kankan bile fiber ranged from 4.0%, 3.4% and 4.6% for treated fiber then 5.6% for untreated, showing decrease in moisture content. The ash content ranged from 0.04 to 0.06% for treated fiber and 0.08% for untreated fiber, wax content from 1.4 to 1.9% for treated and 2.9% for untreated, lignin content from 6.8 to 12.72% for treated and 16.4% for untreated fiber, cellulose content from 56.15 to 68.87% for treated fiber and 22.26% for untreated fiber, hemicelluloses content from 10.06 to 19.66% for treated fiber and 32.49% for treated fiber. The high cellulose, hemicelluloses and lignin content of Kankan bile fiber, showed the need for the lignin removal. [20]

3.2 Effect of Chemical Treatment on Fiber

3.2.1 Effect of Time on Chemical Treatment of Fiber

The effect of time on the fiber treatment between 20 and 80 minutes was studied as shown in Fig. 3.1. It shows that as time increases there is effective removal of waste from the fiber until it got to its optimum peak at time 60 minutes after which it begins to deteriorate. Also, the analysis shows that Acetic Anhydride has the most efficient with regards to time.

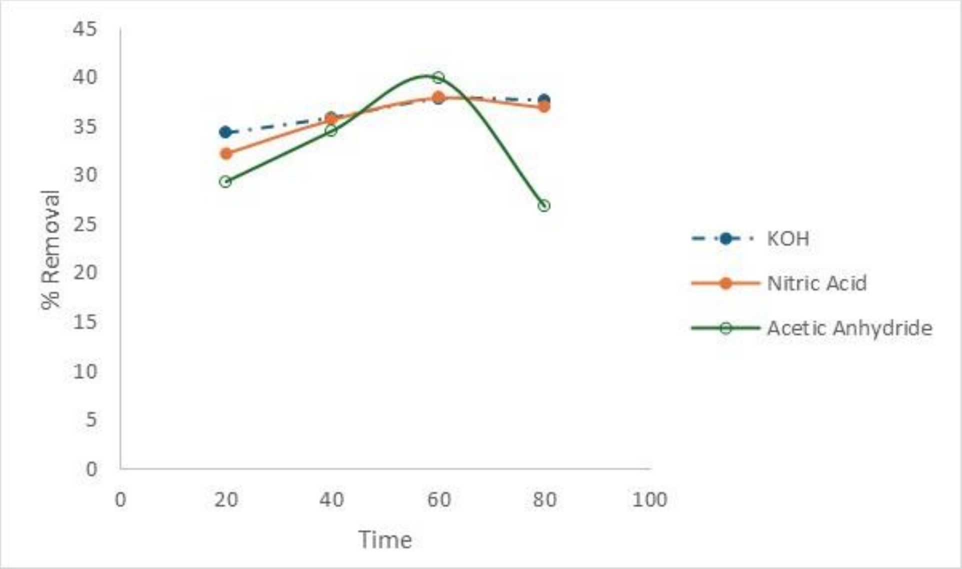

Fig.3.1: Effect of time on fiber treatment

3.2.2 Effect of Concentration on Chemical Treatment of Fiber

The effects of concentration on fiber treatment between 3Mto 12M was studied as shown in Fig. 3.2. As the concentration of the chemicals increases there is removal of dirt from the fiber until it got to its optimum of 9M.

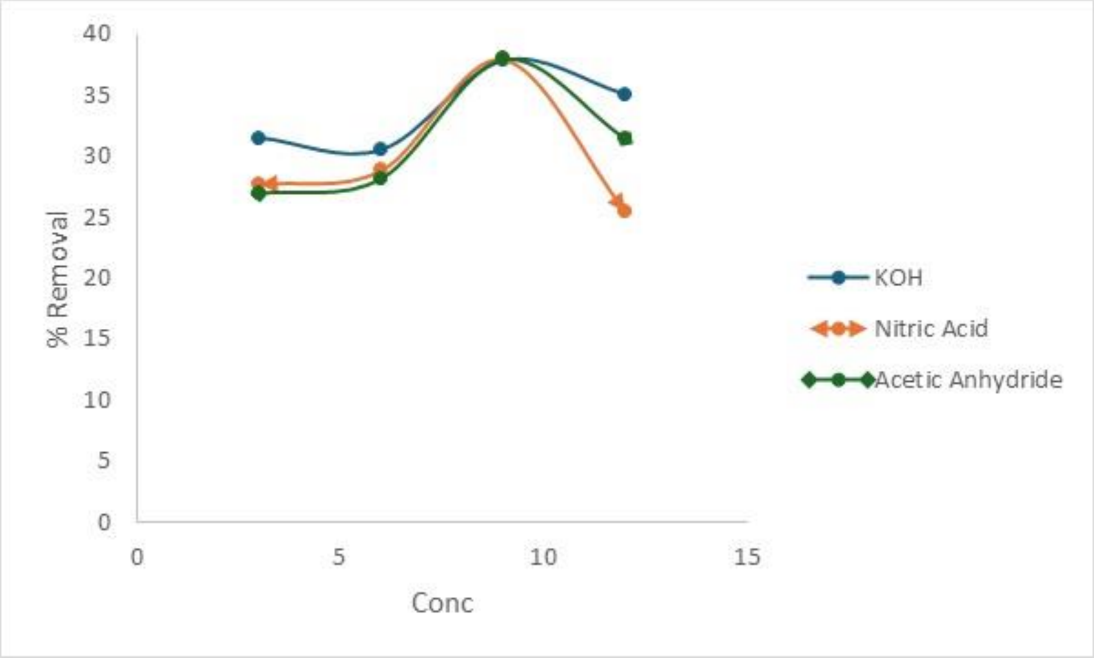

Fig. 3.2: Effect of Concentration on fiber treatment

3.2.3 Effect of Temperature on Chemical Treatment on Fiber

The effects of temperature on fiber treatment between 20 to 80^{o}C was studied as shown in Fig. 3.3

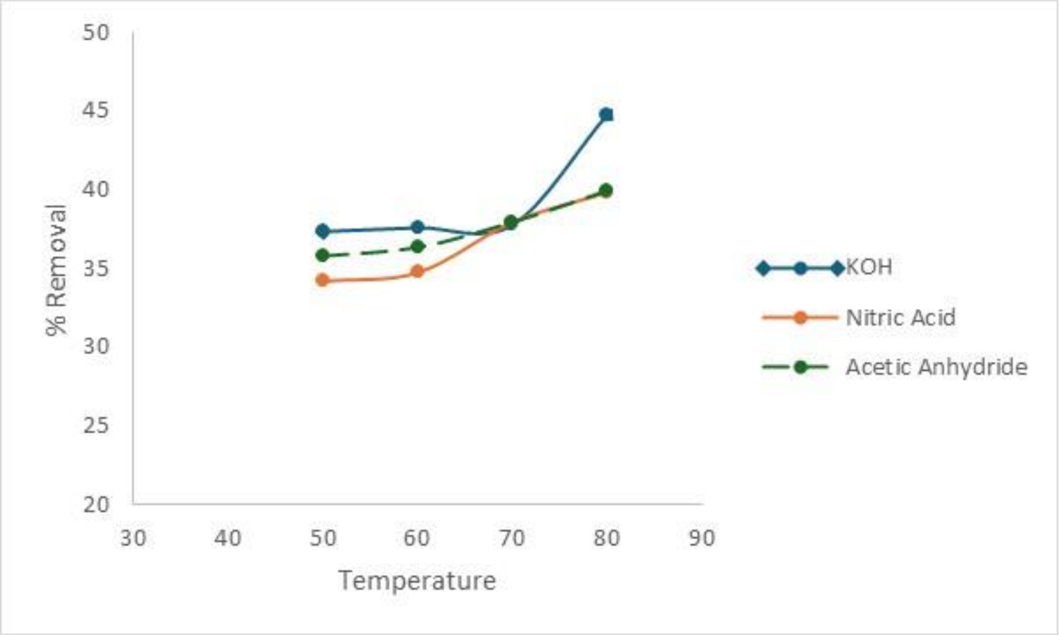

Fig. 3.3: Effect of temperature on fiber treatment

3.3 Results of Design Matrix

The results of design matrix for chemical treated Kankan bile were shown in Table II. It showed the percentage removal of lignin. It consists the results for 60 runs in different concentrations of acid(2,6,10, 14, 18%), times (30,50, 70,90, 110minutes) and temperatures of 40,50,60,70,80^{O}C.

TABLE II: RESULTS OF DESIGN MATRIX

Std Order	Run Order	Chem Conc (%)	Time (Mins)	Temp (^{0}C)	Type of Chemical	Percent. of lignin removed (%)
32	1	10	110	60	Nitric acid	41.5575
48	2	14	90	70	Acetic Anhydride	45.927
36	3	10	70	60	Nitric acid	42.6285
58	4	10	70	60	Acetic Anhydride	44.26854
21	5	6	50	50	Nitric acid	33.2415
38	6	10	70	60	Nitric acid	42.1605
41	7	6	50	50	Acetic Anhydride	34.90356
53	8	10	70	40	Acetic Anhydride	33.20886
17	9	10	70	60	KOH	39.3498
37	10	10	70	60	Nitric acid	40.8195
23	11	6	90	50	Nitric acid	34.0527
6	12	14	50	70	KOH	41.244
29	13	2	70	60	Nitric acid	33.444
16	14	10	70	60	KOH	39.7614
4	15	14	90	50	KOH	37.5606
3	16	6	90	50	KOH	29.8907
15	17	10	70	60	KOH	38.0982
56	18	10	70	60	Acetic Anhydride	44.75984
40	19	10	70	60	Nitric	42.5835
20	20	10	70	60	KOH	39.3078
1	21	6	50	50	KOH	31.0254
52	22	10	110	60	Acetic Anhydride	43.63536
30	23	18	70	60	Nitric acid	41.787
2	24	14	50	50	KOH	35.4018
45	25	6	50	70	Acetic Anhydride	41.96274
14	26	10	70	80	KOH	38.241
51	27	10	30	60	Acetic Anhydride	42.39744
28	28	14	90	70	Nitric acid	43.74
13	29	10	70	40	KOH	30.639
59	30	10	70	60	Acetic Anhydride	44.73156
39	31	10	70	60	Nitric acid	42.6015
43	32	6	90	50	Acetic Anhydride	35.75532
49	33	2	70	60	Acetic Anhydride	35.1162
50	34	18	70	60	Acetic Anhydride	43.8763
5	35	6	50	70	KOH	37.3002
9	36	2	70	60	KOH	31.2144
44	37	14	90	50	Acetic Anhydride	42.25566

35	38	10	70	60	Nitric acid	42.1155
47	39	6	90	70	Acetic Anhydride	42.8841
33	40	10	70	40	Nitric acid	23.8138
10	41	18	70	60	KOH	39.0012
55	42	10	70	60	Acetic Anhydride	44.26854
31	43	10	30	60	Nitric acid	40.3785
7	44	6	90	70	KOH	38.11962
19	45	10	70	60	KOH	39.7866
57	46	10	70	60	Acetic Anhydride	42.86046
24	47	14	90	50	Nitric acid	40.2435
26	48	14	50	70	Nitric acid	44.19
18	49	10	70	60	KOH	39.7446
11	50	10	30	60	KOH	37.6866
34	51	10	70	80	Nitric acid	39.7725
46	52	14	50	70	Acetic Anhydride	46.3995
22	53	14	50	50	Nitric avcid	37.9305
54	54	10	70	80	Acetic Anhydride	43.02114
60	55	10	70	60	Acetic Anhydride	44.71266
25	56	6	50	70	Nitric acid	39.9645
8	57	14	90	70	KOH	40.824
27	58	6	90	70	Nitric acid	40.842
42	59	14	50	50	Acetic Anhydride	39.82704
12	60	10	110	60	KOH	38.787

The percentage removal for lignin varied at different chemical concentration, temperature and time. The result showed that nitric acid gave the lowest value of 23.81% lignin removal at 10% concentration, 70minutes and 40^{O}Cand highest value of 44.19% removal at 14% concentration, 50minutes and 70^{O}Cwhile acetic anhydride gave the lowest value of 33.21% lignin removal at 10% concentration, 70minutes and 40^{O}Cand highest value of 46.3995% removal at 14% concentration, 50minutes and 70^{O}C. Also, potassium hydroxide gave the lowest value of 29.89% lignin removal at 6% concentration, 90minutes and 50^{O}Cand highest value of 41.24% removal at 14% concentration, 50minutes and 70^{O}C. . It was observed that acetic anhydride gave the highest lignin removal of 46.40%.[22,13]

3.4 Analysis of Variance

Table III: ANOVA

Source	**Sum of Squares**	**Df**	**Mean Square**	**F-value**	**p-value**	
Model	1167.97	12	97.33	117.94	< 0.0001	Significant
A-Chem Conc	231.36	1	231.36	280.35	< 0.0001	
B-Time	5.16	1	5.16	6.25	0.0159	
C-Temp	397.07	1	397.07	481.14	< 0.0001	
D-Chemical Type	220.04	2	110.02	133.32	< 0.0001	
AC	7.15	1	7.15	8.66	0.0050	
CD	8.74	2	4.37	5.29	0.0084	
A^2	86.52	1	86.52	104.85	< 0.0001	

C^2	229.05	1	229.05	277.54	< 0.0001	
C^2D	24.03	2	12.01	14.56	< 0.0001	
Residual	38.79	47	0.8253			
Lack of Fit	31.68	32	0.9899	2.09	0.0657	not significant
Pure Error	7.11	15	0.4741			
Cor Total	1206.76	59				

Std. Dev.	0.9084	**R^2**	0.9679
Mean	39.46	**Adjusted R^2**	0.9597
C.V. %	2.30	**Predicted R^2**	0.9121
		Adeq Precision	48.6974

The Model F-value of 117.94 implies the model is significant. There is only a 0.01% chance that an F-value this large could occur due to noise. P-values less than 0.0500 indicate model terms are significant. In this case A, B, C, D, AC, CD, A^2, C^2, C^2D are significant model terms. Values greater than 0.1000 indicate the model terms are not significant. The Lack of Fit F-value of 2.09 implies there is a 6.57% chance that a Lack of Fit F-value this large could occur due to noise. The Predicted R^2 of 0.9121 is in reasonable agreement with the Adjusted R^2 of 0.9597; i.e. the difference is less than 0.2.Adeq Precision measures the signal to noise ratio. A ratio greater than 4 is desirable. The ratio of 48.697 indicates an adequate signal. This model can be used to navigate the design space [23,24,25,26]

3.4.1 Model Equations

KOH $-40.0179+2.675A+0.016B+1.814C-0.0136AC-0.065A^2-0.012C^2$

Nitric acid $-88.223+2.675A+0.016B+3.429C-0.0136AC-0.065A^2-0.025C^2$

Acetic anhydride $-46.45+2.675A+0.016B+2.159C-0.0136AC-0.065A^2$

The equation in terms of actual factors can be used to make predictions about the response for given levels of each factor. Here, the levels should be specified in the original units for each factor. This equation should not be used to determine the relative impact of each factor because the coefficients are scaled to accommodate the units of each factor and the intercept is not at the center of the design space.

3.4.2 Graphical Representation of the Results

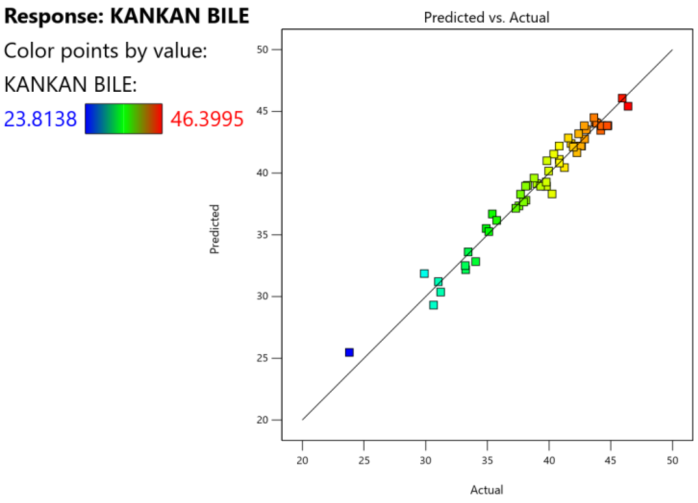

Fig.3.4: Predicted versus actual for Kankan bile lignin removal

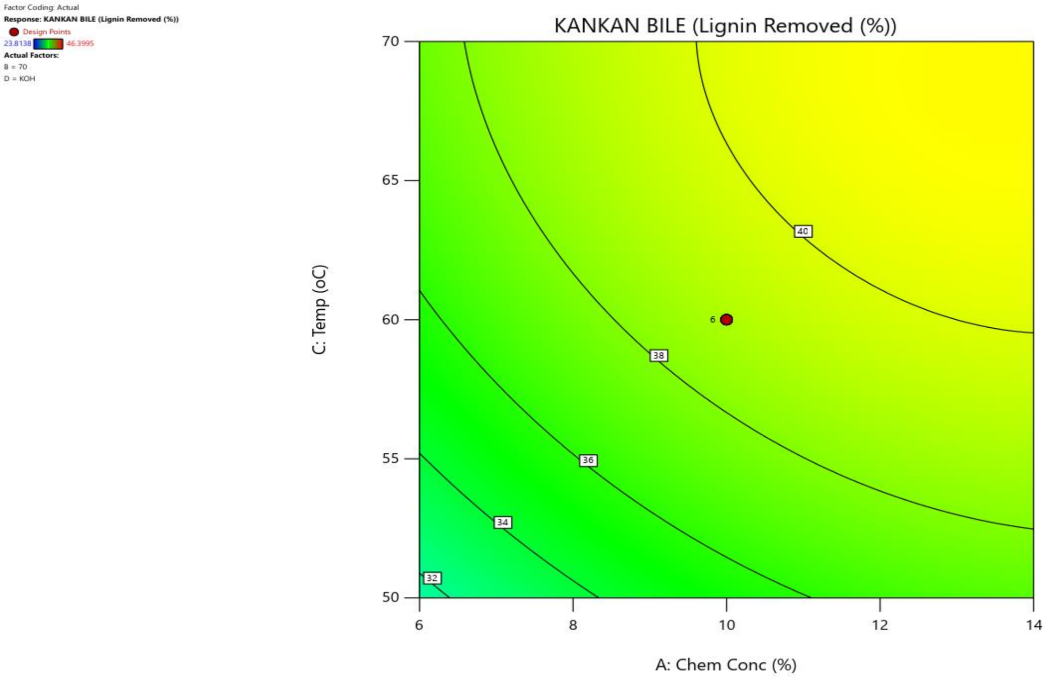

Fig. 3.5: Temperature and chemical concentration % for kankan bile lignin removal

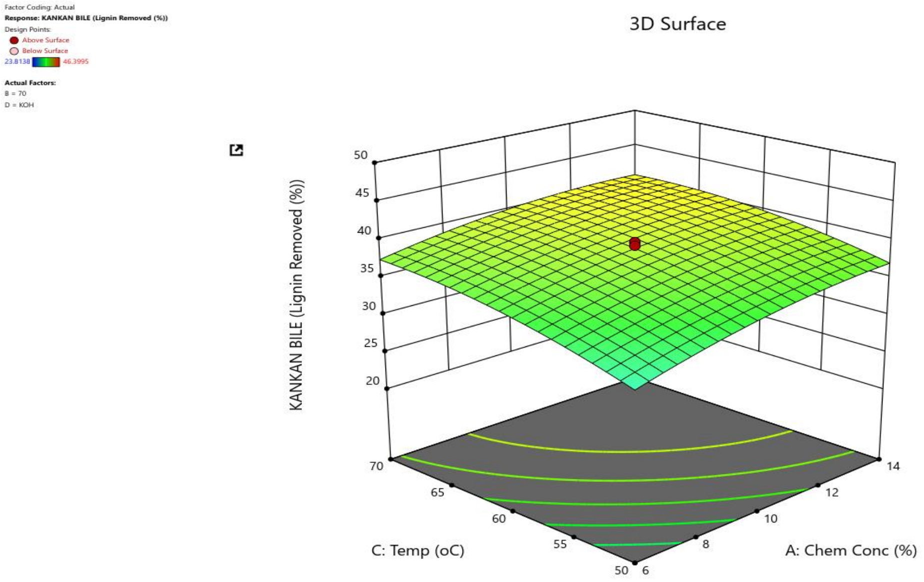

Fig 3.6: RSM Plot for Kankan bile lignin removal

Figure 1-3 showed interaction effect of temperature, time and percentage chemical concentration on lignin removal for Kankan bile. The result gave the optimum value at 46.3995% using acetic anhydride at 14% concentration, 50minutes and 70^{O}C. [4. 27, 28, 21]

IV. CONCLUSION

The chemical treatment of Kankan bile fiber was used to remove lignin resulting to increased interface adhesion between the fiber–matrix. It increases surface roughness resulting in greater mechanical interlocking and the number of cellulose exposed on the fiber surface. The main constituents of natural fiber are cellulose, hemicelluloses and lignin. Lignin is made up of aliphatic and aromatic hydrocarbon compounds positioned around the fibers. The firmness and hardness of the fibers are provided by cellulose components via hydrogen bonds and other linkages. Lignin together with hemicellulose is nature's bond in the adventure of the power of cellulose while conferring flexibility. Lignins are very important in the formation of cell walls, especially in wood and bark, since they lend rigidity and do not rot easily. Cellulose, hemi cellulose and lignin percentage is varied for different material. Experimental analysis of the results showed the outcome of the chemical treatment of Kankan bile fiber using three different alkaline solutions, Potassium hydroxide, Nitric acid, acetic anhydride. The result showed that nitric acid gave the lowest value of 23.81% lignin removal at 10% concentration, 70minutes and 40^{O}Cand highest value of 44.19% removal at 14% concentration, 50minutes and 70^{O}C while acetic anhydride gave the lowest value of 33.21% lignin removal at 10% concentration, 70minutes and 40^{O}Cand highest value of 46.3995% removal at 14% concentration, 50minutes and 70^{O}C. Also, potassium hydroxide gave the lowest value of 29.89% lignin removal at 6% concentration, 90minutes and 50^{O}C and highest value of 41.24% removal at 14% concentration, 50minutes and 70^{O}C. Hence, treated Kankan bile fiber gave the optimum value of lignin removal. Biodegradability, lower specific weight, renewable resource, production with low investment, friendly processing with reduced wearing on tools, better working conditions and no skin irritation. good thermal and acoustic insulating properties are advantages of natural fiber over synthetic fiber.

REFERENCES

[1] D. Chandramohan and .K. Marimuthu. A Review on Natural Fibers. International Journal of Recent Research and Applied Studies. 8(2) pp194-206. 2011

[2] K. Srinivas, A.L. Naidu, and M.V.A Raju Bahubalendruni. A Review of Chemical and Mechanical Properties of Natural Fiber Reinforced Composites. International Journal of Performability Engineering. 13(2)pp189-200. 2017

[3] P. Paulo, Hugo C, Hafiz S. and Marco L. Natural Fibre Composites and Their Applications: A Review. Journal of Composite. Science, 2(4) pp 66. doi:10.3390/jcs2040066. 2018

[4] R. S. Kumara, N. Muralidharana , and R. Sathyamurthy. Optimization of Alkali Treatment Process Parameters for Kenaf Fiber: Experiments Design. Journal of Natural Fibers. Pp 1-11. https://doi.org/10.1080/15440478.2020.1856276. 2020.

[5] Y.M, Leonard, and M.P Ansell. The effect of chemical treatment on the properties of hemp, sisal, jute and kapok fibres for composite reinforcement. Die Angewandte Macromolecular Chemistry, 272(1), 109-110.1999

[6] Y. Wang, B. Tong, S. Hou,M. Li,and C. Shen. Transcrystallization behavior at the poly(lactic acid)/sisal fibre biocomposite interface. Compos Part A Appl S 42:66–74.2011

[7] D ,Ndiyae, .M. Gueye, C.Thiandoume,, A.M. Badji, A.M., and Tidjani, A. Reinforcing fillers and coupling agents' effects for performing wood polymer composites. Chapter 12. In: Thakur, V.J.2015

[8] H. M, Akil,., M. F. Omar, A. A. M. Mazuki, S. Safiee, Z. A. M. Ishak and A. Abu Bakar. Kenaf Fiber Reinforced Composites: A Review. Materials & Design. 32(8-9): 4107- 4121.2011

[9] O. E. Babatunde , J. M. Yatim, M. Y. Ishak, R. Masoud,and R. Meisam. Potentials of kenaf fibre in bio-composite production: a review . Jurnal Teknologi (Sciences & Engineering) 77:12 (2015) 23–30.2015

[10] F.M. AL-Oqla,.and S.M. Sapuan,. Natural fiber reinforced polymer composites in industrial applications: Feasibility of date palm fibers for sustainable automotive industry. Journal of Cleaner. Production., 66, 347–354.2014

[11] V.L.P.; Salazar, A.L.; Leão, D.S.; Rosa, J.G.C.; Gomez, and R.C.P. Alli. Biodegradation of Coir and Sisal Applied in the Automotive Industry. Springer Nature. Vol. 19, pp 677-688. 2011

[12] O. Faruk, A.K. Bledzki, H. Fink, and P.M.Sain. Biocomposites Reinforced with Natural Fibers: 2000–2010. Progress in Polymer Science.37.pp 1552-1596. 2012

[13] Kabir, M. M., H. Wang, K. T. Lau, and F. Cardona. Chemical treatments on plant-based natural fibre Reinforced polymer Composites. An Overview. Composites Part B: Engineering 43 (7):2883–92. doi:10.1016/j. compositesb. 2012.04.053.2012

[14] H. U., Zaman, M.A. Khan and R.A, Khan. “Physico-mechanical and degradation properties of banana fiber/ldpe composites: effect of acrylic monomer and starch”, Composite Interfaces, v. 18, pp. 685 – 700.2011

[15] B. O. Ogunsile, and T. G. Oladeji. Utilization of banana stalk fiber as reinforcement in low density polyethylene composite. Revista Materia. 21(4)pp 953-963.2016

[16] M. Alam , H. M. Z.Hossain , Z. Ahmed and M. Khatun Effect of Process Variables on Chemical Treatment of Jute Fibers. Environmental Science Archives. I (2) pp74-80.2022

[17] M.C. Ojukwu. C.E. Chukwunyelu, F.I. Ilo, Ekwueme S. O. and E. F. Orizu Chemical Treatments of Jute Fiber for Application in Natural Fiber Reinforced Composites. International Journal of Advanced Engineering Research and Science. 4(2)PP21-26.2017

[18] S. Zannen, L. Ghali, M. T. Halimi,and M. B. Hassen. Effect of Combined Chemical Treatment on Physical, Mechanical and Chemical Properties of Posidonia Fiber. Advances in Materials Physics and Chemistry, 7 pp 275-290.2016

[19] N.J, Edeani, K.A, Eze, and M.M. Chukwu.(2023). Thermodynamic properties and Drying kinetics of potato slices using hot air drying. International Journal of Advanced Science and Engineering. 10(1) pp 3224-3236.

[20] G.O.Mbah,and N.J. Edeani, (2014) Optimization of cassava root Sieviate medium to an enriched animal feed by Aspergillus niger. American Journal of engineering research (AJER).Volume 3 issue 2, pp124-131.

[21] C. Campana, R. Leger, R. Sonnier, L. Ferry, and P. Ienny. 2018. Effect of post curing temperature on mechanical properties of a flax fiber reinforced epoxy composite. Composites Part A, Applied Science and Manufacturing 107:171–79. doi:10.1016/j.compositesa.2017.12.029

[22] Haniel, B. Bawono, and P.W. Anggoro. Optimization of Characteristics Polymer Composite Reinforced Kenaf and Jute Fiber Using Taguchi-Response Surface Methodology Approach. Journal of Natural Fibers, 20(2).pp 1-19.2023.

[23] F. A. Agu, N. J. Edeani, & C. M. Nwaeze. Optimization of Process Parameters for Yellow Dextrin Production. International Journal of Novel Research in Engineering and Science.12(1)pp20-29.2025

[24] N. J., Edeani, G.O. Mbah and H.I. Chime. Optimization, drying kinetics and thermodynamic properties of carrot slices in a hot air drying. International Journal of Advances in Engineering and Management. 4(1) pp941-958. 2022.

[25] N.A.G Aneke, G.O. Mbah. and N.J. Edeani. Response surface methodology for optimization of hot air drying of water yam slices. International Journal of Scientific and Research Publication. 8(8) pp 248-239. 2018.

[26] N.J. Edeani, and H.I. Anyaene. ‘’Optimization of Hot Air Drying of Sweet Potato using Response Surface method.’’ International Journal Advance Science and Engineering. 10(2) pp3362-3371.2023.

[27] I.C.,Ekeke, M.M.,Chukwu, C. Ononogbo, J.C., Obijiaku, R.M., Obodo, J.C. Aniezi, N.J., Edeani, P.O.,Ohwofadjeke, P., Agim, O.U., Nwosu, and J.C. Offurum. Experimental Study on the Thin-layer Drying Behavior of Goat Bone for Plant Meals International Journal of Advanced Science and Engineering.10:3 pp3593-3602.2024

[28] G.O. Mbah, N.J. Edeani,, and M.I. Onyiah (2013) Improving the nutritive value of cassava peels and cassava root sieviate through biodegradation with Aspergillus niger. International Journal of Current Research Vol. 5, 10, pp xxx-xxx,xxxxx.