Flattening the ALS to Increase the Workable Flat Surface Area for Production of Disposable Dining Wares

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Abstract-*Areca leaf sheath can be a typical farming waste created in Southeast Asia worldwide areas that is extensively used throughout the decades to shape biodegradable expendable eating products. The reasonable surface of Areca leaf sheath for warmth earnest is controlled path to the concavity in the center and collapsing along the edges of Areca leaf sheath. This examine suggests that the Areca leaf sheath is straightened the use of a cushioning mutilate sooner than the shaping methodology. The goal is to examine the impact of Areca leaf sheath thickness and thumping down strain on the end word lastingness and percent resist crush of Areca leaf sheath. The data got is exposed to a nova factual assessment. The morphology of Areca leaf sheath is examined beneath a fluorescent magnifying instrument and its concoction creation is moreover distinguished. It's resolved that Areca leaf sheath thickness and smoothing strain affect the impacts in an alternate manner. The greatest outstanding lastingness is obtained from grain course tests straightened at five bar, regardless of their thicknesses; while the absolute top of the line pressure is mean of forty one.58% from opposite grain course tests smoothed at five bar, with thickness.*

Keywords: *Areca Leaf Sheath, Tensile Properties, Flattening, Morphology, Disposable & Dining Ware.*

I INTRODUCTION

There was growing public consciousness for environmentally pleasant and sustainable merchandise in current years to hold our mother earth. However, in latest Malaysia's context, the usage of plastic disposable eating wares stays considerable in diverse eating places. Steady with a take a look at performed through jam becket al. (2015), Malaysia is inside the eighth function among the international locations that have created the worst plastic wastes amongst 192 nations. This hassle urges effective alternatives to trade plastics because the uncooked cloth to deliver disposable eating wares since using disposable products are understandably unavoidable within the daily lives of city citizens. There are limitless tries achieved by using researchers and companies to supply paper and bio-primarily based polymers merchandise. An easy yet sustainable uncooked cloth has been used historically for many years in India to shape disposable dining wares like plates, cups and bowls, which is that the areca leaf sheath. The areca palm is typically relating the most cultivated species betel palm Linn. The plantation of Areca palm trees is inspired by using the leisure chewing addiction of its nut in

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south Asia and consequently the pacific oceanic regions. Areca leaf sheath is that the extension of the rachis of the areca leaf, which absolutely encircles the tree stem of Areca palm. The Areca leaf sheath sheds 5-6 times a yr in keeping with tree.

A grownup Areca leaf sheath is concaved within the middle, it additionally features a greenish or brown, waxy and difficult outer floor, with a glossy creamy-colored internal surface 1982. Areca leaf sheath is an agricultural waste at the areca palm plantation fields. Normally, the fallen Areca leaf sheath is are amassed then burnt off thanks to its sluggish decomposition price. Open burning contributes to heating and carbon deposit. Accordingly, the locals impart industrial values to the prevailing biodegradable useful resource with the aid of using it to be the staple for producing disposable plates and containers. The Areca leaf sheath is disposable plates have a smooth and electricity efficient manufacturing process. The raw Areca leaf sheath is are amassed from the areca palm plantation as soon as the sheaths fall from the timber. Then, the sheaths got to be solar dried and stored. Generally, the drying and storage time is round six months. To shorten the time of drying Areca leaf sheath is, there was an attempt to expand a cost-effective solar dryer. Then, the sheaths are being washed manually in water by means of employing a

Brush. Areca leaf sheath is absorbed water all through this procedure, consequently gaining some moisture, making it extra flexible for urgent afterwards. Then, the dried sheaths had been located into the urgent gadget, with the urgent dies heated to certain temperatures with the aid of external power source. The Areca leaf sheath is were pressed for a brief time to adapt its shape to the shape of the mound. It ought to be cited that the moisture content of the sheaths ought to be maintained at above five% to prevent cracks at the fabric. If the moisture content material of the pressed plates is simply too excessive, then the plates got to be used at once to forestall fungi from developing; rather it desires to be dried. The dried Areca leaf sheath is product are often saved for as much as one year. Subsequently, the manufactured products are packaged in bundles in plastic baggage to live them dry and hygienic earlier than used.

There is no study determined concerning the microstructure examine of Areca leaf sheath is except its bodily houses. Lignocellulosic substances like Areca leaf sheath is are made from herbal polymers like cellulose, hemicellulose, lignin and A few different minor components. Multiple researches stated these chemical compositions of Areca leaf sheath is restrained examine has been finished about processing Areca leaf sheath is to be disposable eating wares, kind of a research administered by means of kalian et al.(2006), which the factors of moisture content material of Areca leaf sheath is and temperature at some point of manufacturing are studied. On pinnacle of the very reality that Areca leaf sheath is Dining ware production is sustainable and power-green, there is difficulty on the practicable floor of the mature Areca leaf sheath is resulting from its concavity inside the center and the folds at the sheaths.

Those traits of Areca leaf sheath is lead to fabric waste because the producers get obviate the folded parts of Areca leaf sheath is after pressing handiest the flat floor. As some distance due to the fact the authors are conscious, there's No literature discovered to cater this difficulty. This observe started out the aim to get to the bottom of this trouble through offering the Areca leaf sheath is to Be flattened earlier than it is pressed into the shapes of containers. The tensile residences of the Areca leaf sheath is earlier than and after the knocking down technique are investigated. Factors that have been taken into consideration to have an effect on the tensile residences are the thickness of Areca leaf sheath is the knocking down strain of the padding mangle used. The effect of those factors are analyzed the usage of analysis of variance strategies inside the current examine.

II METHODS

1.1 Materials

In this look at, samples of Areca leaf sheath originated from Indonesia were used. The samples had been stored in an air conditioned Laboratory after collected. Before the test, the surface of the samples became wiped clean thoroughly with a wet fabric to take away the particles accumulated. The Areca leaf sheath has non-uniform thicknesses over the floor. The utmost and minimum thicknesses measured from the Areca leaf sheath employing a Vernier micrometer are 8.2 mm and 0.9 mm respectively. The maximum thickness utilized on this study is 4.5 mm for the ease of manual slicing, despite the big distinction among thicknesses.

2.1.1 Morphology study on Areca leaf sheath fiber

The morphology of Areca leaf sheath fiber is studied with the aid of finishing the maceration manner consistent with technical affiliation of pulp and paper enterprise trendy t233-su-sixty four and a take a look at by means of nor Marlana. The fibers have been dig matchstick of 25 to 30 mm long and multiple mm in breadth. Then, 25 ml water was introduced with 1.5g Sodium chlorite into test tubes that incorporate the fibers. After the test tubes were being water bathed for 24 hours, the fibers were shaken in distilled water to get the individual fibers.

To offer shade pigment to the fibers, a drop of safranin-o was dropped into the fibers for shade pigmentation and therefore the fibers had been left for 1 hour. Then, a few man or woman fibers from extraordinary take a look at tubes have been transferred into a slide. From the slide, 50 fibers have been measured underneath a Quantimeter photograph analyzer ready with Leica fluorescence microscope to get the everyday fiber period, fiber diameter, and lumen diameter and fiber cell-wall thickness.

2.1.2 Chemical analysis

The Areca leaf sheath were wiped clean then dig small pieces to be floor into first-class fibers employing a Thomas Wiley mill. The lowest fibers have been then sieved via BS 40-mesh (425 µm) and BS 60-mesh (250 µm) to get Finer fibers, according to technical affiliation of the pulp and paper enterprise requirements t 257 cm-02 - Sampling and making ready timber for evaluation. Holocellulose content of Areca leaf sheath determined steady with sensible et al. (1946). α- cellulose content, become analyzed steady with the process defined in the TAPPI T 203 os-74. Next, pentosane Content material changed into identified the usage of the tactic of Savard et al. (1954). Whereas, the chemical contents of α-cellulose, lignin, alkali

Solubility, water solubility, ash and silica content had been investigated steady with TAPPI preferred strategies t 203 os-74, T 222 om-02, t 212 om-02, t 207 cm-99, and t 211 om-02, respectively. 3 replications have been completed each analysis. The content of hemicellulose are regularly received via the difference between the values of holocellulose and α- cellulose content material of the fibers.

2.1.3 Knocking down procedure

Due to the concavity of Areca leaf sheath inside the middle, this examine proposes that the sheaths be flattened using a vertical laboratory padding mangle. The padding device features a number of knocking down stress alternatives from 1 bar to 5 bar. Three parameters of the knocking down pressure had been selected, i.e. 0 bar (as control), 1 bar, and 5 bar. The 1 bar and 5 bar of strain have been selected to analyze the minimal and most effect of the stress on Areca leaf sheath. Areca leaf sheath become fed into the rollers within the instructions that are parallel and perpendicular to the grains for parallel and perpendicular oriented tensile take a look at samples respectively. The pulling down procedure become repeated for three (3) times every pattern.

2.1.4 Experimental design

A completely randomized 2 to 3 factorial experimental layout become hired to analyze the impact of Areca leaf sheath thickness and Pulling down strain on the tensile houses of Areca leaf sheath, i.e. final lastingness and strain percent. Areca leaf sheath thickness has 2 ranges of class (2.five mm), while the knocking down stress has 3 tiers. The samples with zero bar knocking down are basically the controls. The interaction among those two Elements is moreover studied. As 5 (5) replications were wished for every stage, one test set calls for a whole of thirty (30) experimental runs. Since Areca leaf sheath is an anisotropic material, sets of experiments were administered for both parallel and ordinary directions to the grain of Areca leaf sheath.

Table1: Randomized Run Generated by Minitab 18.1

Standard Order	Run Order	Thickness, mm	Pressure, bar
14	1	<2.5	1
8	2	<2.5	1
20	3	<2.5	1
15	4	<2.5	5
13	5	<2.5	0
6	6	>2.5	5
1	7	<2.5	0
21	8	<2.5	5
2	9	<2.5	1
25	10	<2.5	0
16	11	>2.5	0
23	12	>2.5	1
28	13	>2.5	0
3	14	<2.5	5
12	15	>2.5	5
10	16	>2.5	0
4	17	>2.5	0
9	18	<2.5	5
29	19	>2.5	1
27	20	<2.5	5
17	21	>2.5	1
26	22	<2.5	1
11	23	>2.5	1
22	24	>2.5	0
5	25	>2.5	1
18	26	>2.5	5
19	27	<2.5	0
7	28	<2.5	0
30	29	>2.5	5
24	30	>2.5	5

2.1.5 Tensile Test

Tensile test was conducted in accordance with ASTM D638-14, Standard Test Method for Tensile Properties of Plastics. The tests were conducted on Universal Testing Machine (Lloyd LR30K Plus, Canada).

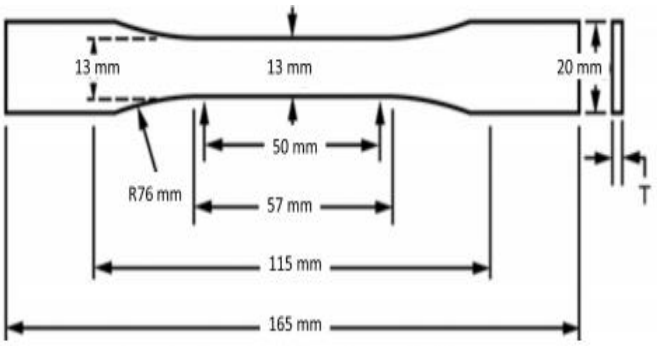

Figure 2: Dimensions of Tensile Test ALS Samples

The ALS were cut manually into dumbbell shape, where in ASTM D638 is classified into the Type I specimen. The sample dimensions are as illustrated in figure 1.The samples that break outside of the narrow gage length section were discarded and new samples were taken for retests. The speed of testing was set at 5 mm/min as specified in the standard, for a rupture time within 5 min. The width and thickness of the ALS tensile test samples were measured with a Vernier caliper to the precision of 0.05 mm. the precision level is sufficient since the application of ALS does not require tight tolerance of its dimensions.

2.1.6 Statistical Analysis

The main effects and interaction of ALS thickness and pressure on response variable analyzed by two-way ANOVA followed by Tukey Pairwise Comparison Test strength and strain percentage. The factors the responses of tensile test in this study.

III RESULTS

1.2 Morphology Study on ALS Fiber

As shown in figure 2, the lumen and cell wall of pig pigmented ALS fiber can be clearly observed and measured under the fluorescence microscope. Table 2below compares a few stiff fiber types that have similar fiber dimension values to ALS fiber. The tensile strength and strain diameter, cell wall thickness and lumen diameter respectively.

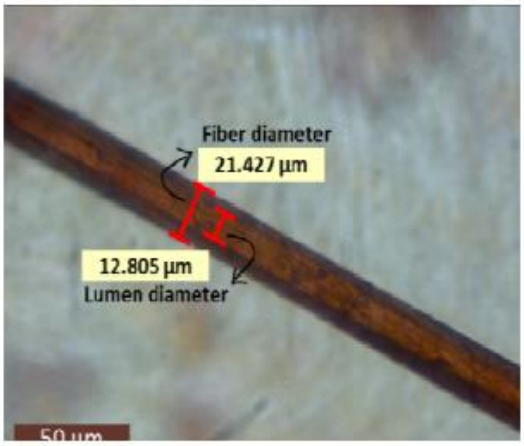

Figure 2: Measurement of Fiber Diameter and Lumen Diameter on One of the ALS Fibers

Table 2: Comparison of ALS Fiber Dimensions with Some Other Plant Fibers

Fiber type	Length (mm)	Diameter (μm)	Cell-wall thickness (μm)	Lumen diameter (μm)	Tensile strength, MPa	Strain, %	Reference
ALS	*1.77 ± 0.63*	*22.00 ± 4.60*	*4.20 ± 0.70*	*13.60*	-	-	*Current study*
Coir	0.84 ± 0.17	20.09 ± 3.84	4.41 ± 1.14	13.59 ±3.26	106.00 – 175.00	15.00 – 40.00	(Mwaikambo, 2006), (Komuraiah et al., 2014), (Nor Mazlana et al., 2014)
	0.90 – 1.20	16.20 – 19.50					
	1.25	17.5					
Sisal	1.80 – 3.10	18.30 – 23.70	-	-	80.00 – 840.00	2.00 – 14.00	(Ansell et al., 2009), (Komuraiah et al., 2014)
	2.50	21.00				8.00	
Kenaf (bark)	2.32 ± 0.21	21.9 ± 4.60	4.2 ± 0.8	11.90 ± 3.40	295.00 – 1191.00	-	(Ververis et al., 2004), (Komuraiah et al., 2014)
	2.35	19.80			743		
Bagasse	1.70	20.00	-	-	290.00	-	(Tewari et al., 2012), (Komuraiah et al., 2014),
	0.61	13.00					

According to Komuraiah et al. (2014 small diameter, small lumen diameter and thick cell 2, it can be deduced that ALS fiber should and sisal fibers. Figure ALS) Subjected to Flattening application: Flattening Pressure SCOPUS Dimensions of Tensile Test ALS Samples. ALS thickness and pressure on response variables were analyzed by followed by Tukey Pairwise Comparison Test using Minitab 18.1 software. The response variables are ultimate tensile strength and strain percentage. The factors with low probability value (P≤0.05) were identified to have significant effect on in this study. The lumen and cell wall of a pigmented ALS fiber can be clearly observed and measured under the below compares a few stiff fiber types that have similar values.

The tensile strength and strain of the fibers are also shown. In brief, the means for diameter, cell wall thickness and lumen diameter of ALS fibers are 1.77 mm, 22.00 Komuraiah et al. (2014) and Zhang et al.(2015), plant fibers need to have long small diameter, small lumen diameter and thick cell-wall to have higher tensile strength. From should have higher tensile strength than coir and bagasse Figure 2: Measurement of Fiber Diameter and Lumen Diameter on One of the ALS Fibers 25 editor@tjprc.org were analyzed by two-way ANOVA The response variables are ultimate tensile 0.05) were identified to have significant effect on can be clearly observed and measured under the types that have similar values of fiber dimensions to the means for the fiber.

IV CHEMICAL ANALYSIS

Table 2 below shows the comparison of ALS chemical composition results obtained by current study to a few other studies. The results obtained are generally in agreement with values reported by Ban agar et al. (2018) and Padma raj et al. (2013). The difference of results may be caused by the difference in analysis methods used and different geographical and climate conditions of the plant origin (Komuraiah et al., 2014).

Table 3: Chemical Composition of ALS Fiber

Chemical composition	Content (%)				
	Current study	(Banagar et al., 2018)	(Padmaraj et al., 2013)	(Nagaraja et al., 2014)	(Poddar et al., 2016)
α – cellulose	30.30	34.82	-	26.40	66.08
Hemicellulose	40.20	25.68	35.00 – 64.80	16.00 – 17.00	7.40
Lignin	14.40	16.58	13.00 – 24.00	38.68	19.59
Ash	5.40	10.86	4.40	-	-
Alkali solubility	37.60	-	-	-	-
Pentosan	13.90	-	-	-	-
Ethanol-toluene	4.40	-	-	-	-
Moisture	16.32	12.06	8.00 – 25.00	-	-

It is to be noted that ALS fiber generally has lower cellulose content than other commercialized non-wood plant fibers such as hemp, flax, cotton, jute, sisal and ramie fibers. A generally lower cellulose content of ALS indicates that it is expected to have lower tensile strength compared to these fibers. From table 3, the chemical composition of ALS is similar to that of bagasse, bamboo, piassava and kenaf fibers (Komuraiah et al., 2014). A higher value of hemicellulose and lignin of ALS increases the rigidity and hydrophobicity of the material. This aids in its ultimate function to contain wet foods without losing its dimension stability (Liu et al., 2018).

V EFFECT ON ULTIMATE TENSILE STRENGTH AND STRAIN OF ALS

Table 3 presents the ultimate tensile strength and strain obtained at different combinations of ALS thicknesses and flattening pressures for both parallel and perpendicular directions to the grain lines. It can be clearly seen from Table 3 the tensile strength of the ASL samples at parallel direction is higher than those at the perpendicular direction. The even fracture surface of perpendicular oriented samples shows that it while the parallel samples that shows irregular splitting along the longitudinal direction indicates that it has high toughness. The irregular splitting of parallel oriented tensile test sample also is observed on the bamboo block tensile test sample. It is also observed that the stress otherwise is observed for perpendicular sample longitudinal bundled fibers elongated and broke abruptly at the breaking point together.

Table 4: Ultimate Tensile Strength and Strain Percentage for Parallel and Perpendicular Oriented Sample

Pressure, bar	Thickness, mm	Parallel Oriented		Perpendicular Oriented	
		Ultimate Tensile Strength, MPa	Strain, %	Ultimate Tensile Strength, MPa	Strain, %
5	>2.5	31.596	7.209	0.952	32.712
5	<2.5	31.858	8.271	1.057	41.576
1	>2.5	29.184	5.747	0.985	21.223
1	<2.5	25.732	7.882	0.976	18.145
0	>2.5	25.360	7.459	1.247	8.109
0	<2.5	22.196	7.304	1.134	20.622

Perpendicular stress-strain graph is caused Figure ALS Subjected to Flattening application and Flattening Pressure SCOPUS Indexed Journal Ultimate Tensile Strength and Strain Percentage for Parallel and Perpendicular Oriented Samples. Thickness, mm Parallel Oriented Perpendicular Ultimate Tensile Strength, MPa Strain, % Ultimate Tensile Strength. Table 4, the tensile strength of the ASL samples at parallel direction is higher than those at the perpendicular direction.

The even fracture surface of perpendicular oriented samples shows that it while the parallel samples that shows irregular splitting along the longitudinal direction indicates that it has high The irregular splitting of parallel oriented tensile test sample also is observed on the bamboo block It is also observed that the stress-strain curve is smooth for parallel sample while otherwise is observed for perpendicular sample in figure 6. As the tensile force was applied on the parallel sample, the s elongated and broke abruptly at the breaking point together. While t strain graph is caused by the gradual side-by-side detachment of fibers during tensile testing.

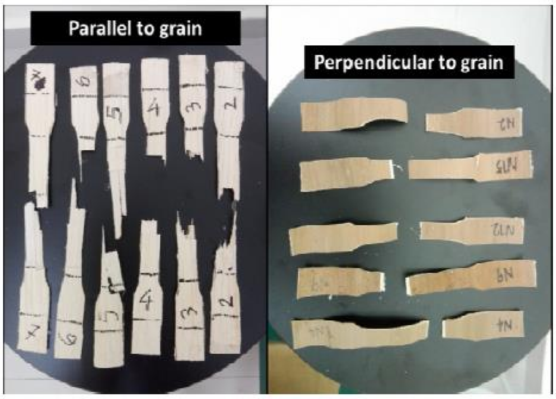

Figure 3: Breaking Pattern of Tensile Test Samples

From table 5, the ultimate tensile strength of the parallel oriented samples were significantly influenced by the flattening pressure (P=0.01). As the pressure increases, the tensile strength also increases for both categories of thicknesses (refer to Table 4). This is due to larger pressure compacted the ALS without breaking them to create a smaller cross sectional area a compact material with smaller cross -sectional area exhibits higher tensile strength than loose material below shows the grouping information by Tukey comparison test for effect of pressure on ultimate tensile strength in parallel oriented category. It is found that the samples that went through 5 bar pressure is significantly different from the control. Whereas, samples that were flattened at 1 bar do not show significant difference from other two.

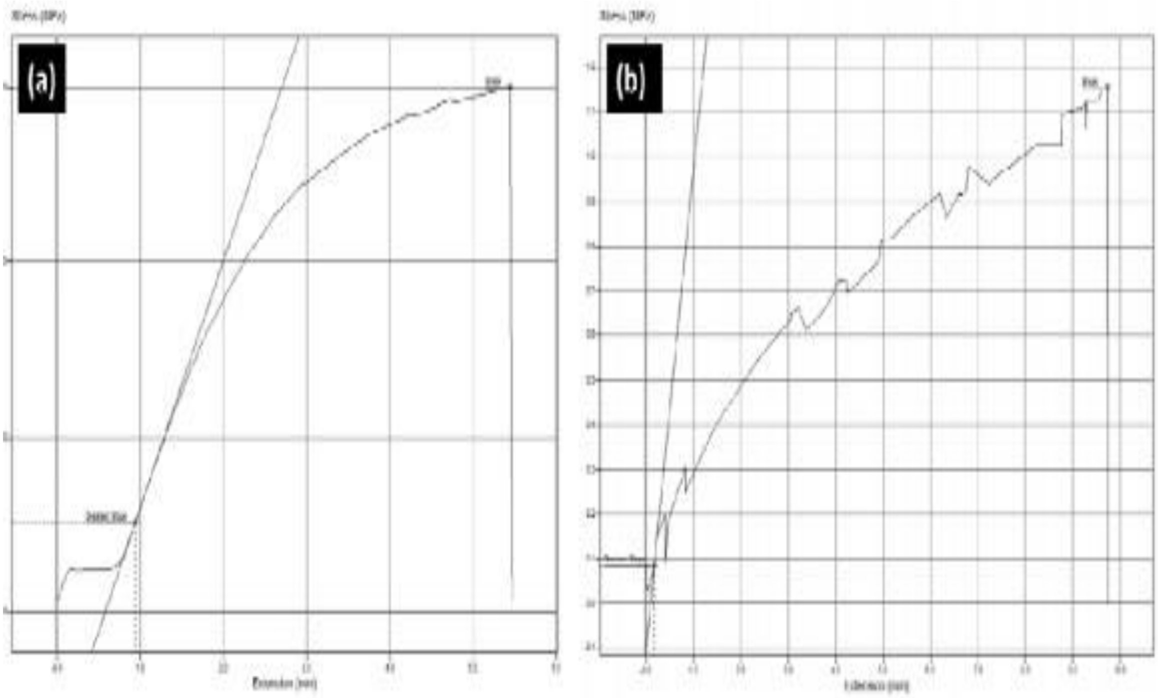

Figure 4: Stress-Strain Graph for (a) Parallel (b) Perpendicular Oriented Samples

Table 5: Two-Way ANOVA Result for the Effect on Ultimate Tensile Strength

Source	Parallel				Perpendicular			
	Adj SS	Adj MS	F-Value	P-Value	Adj SS	Adj MS	F-Value	P-Value
Thickness	33.64	33.64	1.20	0.284	0.00021	0.000209	0	0.965
Pressure	316.51	158.26	5.65	0.010	0.25735	0.128676	1.21	0.318
Thickness*Pressure	21.35	10.67	0.38	0.687	0.05937	0.029684	0.28	0.76
Error	671.85	27.99			2.45492	0.106735		
Total	**1043.35**				**2.77186**			

Table 6: Two-Way ANOVA Results for the Effect on Strain Percentage

Source	Parallel				Perpendicular			
	Adj SS	Adj MS	F-Value	P-Value	Adj SS	Adj MS	F-Value	P-Value
Thickness	7.119	7.119	2.46	0.131	279.1	279.1	1.68	0.207
Pressure	3.881	1.94	0.67	0.521	2840.1	1420.1	8.56	0.002
Thickness*Pressure	6.2	3.1	1.07	0.359	332.5	166.3	1	0.382
Error	63.584	2.89			3979.7	165.8		
Total	**80.894**				**7431.4**			

Table 7: Grouping Information by Tukey Method for Effect of Pressure for Parallel Oriented Samples on Ultimate Tensile Strength

Pressure, bar	Mean	Grouping
5	31.727	A
1	27.458	AB
0	23.778	B

However, the above phenomenon mentioned does not apply to the perpendicular oriented samples there is no significance difference neither by thickness nor pressure on ultimate tensile strength of perpendicular oriented

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ALS. It is also interesting to note that the application of pressure on the perpendicular samples actually lowered their tensile strength especially for the thicker samples illustrated in figure 7. Thus, it is concluded that flattening the ALS along the parallel grain orientation at 5 bar pressure helps to increase the tensile strength of the material. By this, another objective of increasing the workable surface of ALS for hot pressing is also simultaneously achieved.

The ultimate tensile strength obtained for parallel and perpendicular oriented samples before being flattened regardless of their thickness are 23.78 MPa and 1.19 MPa respectively.

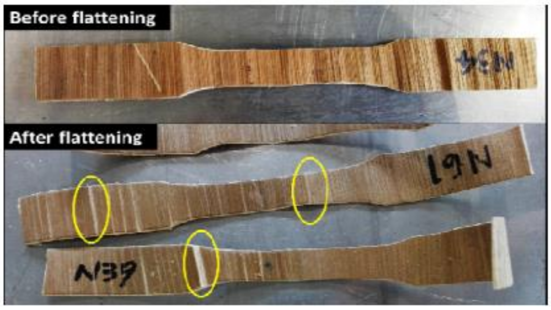

Figure 5: Cracking Happened on the Perpendicular Oriented Samples During Flattening Process, the Circled Parts Indicate the Cracks

The results are compared to other studies in table8. The result of parallel grain samples is consistent with the value reported by Banagar et al 2018. The huge difference of tensile strength value with other two studies may be caused by the different methods used.

Table 8: Comparison of ALS Tensile Strength Between Different Studies.

Sl. No.	Tensile strength, MPa		Method used	Reference
	Parallel	Perpendicular		
1	136.36–163.63	0.18	Not specified	(P. Kalita et al., 2008)
2	140.00–160.00	0.15–0.20	Not specified	(Nikhil et al., 2018)
3	16.45	-	ASTM D3039	(Banagar et al., 2018)
4	23.78	1.19	ASTM D638-14	Current study

Strain or elongation is the ratio of the change in length to the original length of the tensile test samples. When a material has high strain, it does not fracture easily under the application of tension force. When ALS is deformed during pressing which then exceeding its elastic limit, a high strain will prevent it from cracking easily. From the data collected in Table 4, the strain of perpendicular oriented ALS is generally higher than the parallel ones.

Table 9: Grouping Information by Tukey Method for Effect of Pressure for Parallel Oriented Samples on Strain

Pressure, bar Mean G

Pressure, bar	Mean	Grouping
0	37.144	A
1	19.684	B
5	14.365	B

Both ALS thickness and pressure do not affect strain significantly for parallel oriented samples (Table 6). Whereas, the flattening pressure was significantly affecting the strain (P=0.002) for perpendicular direction samples. As the flattening pressure increases, the strain of perpendicular oriented samples also increases. Table 9 displays that non flattened samples produce significantly different strain compared to the samples that were flattened.

VI CONCLUSION

Present work proposes to flatten the ALS to increase the workable flat surface area for production of disposable dining wares. The ALS fiber-dimensions were examined and the average values are 1.77 mm, 22.00 µm, 4.20 µm and 13.60 µm respectively for their fiber length, fiber diameter, cell-wall thickness and lumen diameter. The chemical composition for ALS is also identified. The contents for α-cellulose, hemicellulose, lignin, ash, alkali solubility, pentosane, ethanol-toluene and moisture are 30.30%, 40.20%, 14.40%, 5.40%, 37.60% 13.90% 4.40% and 16.32% respectively.

The effect of ALS thickness and flattening pressure on tensile properties of ALS is investigated. It is found that pressure has significant effect on ultimate tensile strength of parallel oriented ALS. Parallel directions specimens that were pressed at 5 bar irrespective of their thicknesses (2.5 mm) are the strongest ultimate tensile strength quality. This has proven that flattening process helps not only to flatten the ALS surface and also in improving the cracking problem during heat pressing. Strain percentage is significantly affected by pressure only in perpendicular oriented sample category. As the pressure increases, strain of perpendicular samples also increases for both thickness categories from the lowest percentage 8.11% to the highest 41.58%. This information is useful for ALS disposable dining wares manufacturers as it will help to reduce the raw material waste.

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