Direct Research Journal of Engineering and Information Technology

Vol.5 (5), pp. 32-35, December 2018
ISSN 2354-4155
DOI: https://doi.org/10.26765/DRJEIT.2018.2608
Article Number: DRJA1057332608

Direct Research Journal of Engineering and Information Technology
http://directresearchpublisher.org/journal/drjeit/
Research Paper

Effect of Vine Section on the Tensile Properties of Fluted Pumpkin Vine

*[1]Uguru, H. and [2]Uyeri, C.

[1]Department of Agricultural and Bio-Environmental Engineering Technology, Delta State Polytechnic, Ozoro, Delta State, Nigeria.
[2]Department of Mechanical Engineering Technology, Delta State Polytechnic, Ozoro, Delta State, Nigeria.
*Corresponding Author E-mail: erobo2011@gmail.com

Received 29 October 2018; Accepted 26 November, 2018

The tensile properties of fluted pumpkin vine were studied in this research by using universal testing machine (Testometric model). The tensile test was conducted at three different pumpkin vine sections (root, middle and tail). Results obtained showed that vine section had significant ($p \leq 0.05$) effect on all the tensile properties (Tensile strength, Young modulus, tensile energy, tensile strain, yield strength, yield energy and yield strain) investigated. In addition, the results indicated that the ability of the fluted pumpkin vine to resist deformation decreased significantly ($p \leq 0.05$) from the root to the tail section. The average tensile strength of root, middle and tail of the pumpkin vine were 28.6, 20.48 and 11.13 MPa respectively. The tensile strain was 5.46, 8.01 and 9.92 % at the root, middle and tail section of the vine respectively. The results of this study would be useful in composite boards' production and textile industries.

Keywords: Fluted pumpkin vine, mechanical properties, modulus of elasticity, tensile strength, yield strength

INTRODUCTION

Fluted pumpkin (*Telfariaoccidentalis* Hook) is a member of the *cucurbitaceae* plant family, with about 90 genera and more than 700 species. It is a native of West Africa and a perennial vine but cultivated as annual crops under the traditional farming system of West Africa (Okoli and Mgbeogwu, 1983; Gill,1988). The plant has the widest diversity in terms of variation in pod and seed colour, seed and plant vigour, anthocyanin content of leaves and petioles or shoots and leaf size (IPGRI, 1999). Pumpkin leaf has high nutritional, medicinal and industrial values (Tindal, 1986). In the recent time, fluted pumpkin had gained medicinal recognition, as it a good blood purifier (Aletor *et al*., 2002) and useful in maintenance of good health. Asiegbu, (1987) reported that the seed contain about 30.1 and 47% of protein and oil, respectively, while its essential amino acid content compare favourably with those of other legumes such as groundnut. Apart from the nutritional and medicinal values of fluted pumpkin, the pumpkin vines have high potential of being a natural fibre, due to its similarity to cucumber vine and okra stem.

Natural fibres are green substitute of synthetic fibres in composite applications, and are classified on the basis of origin into; plant, animal and mineral. Natural fibres are gaining progressive account as renewable, environmentally acceptable, and biodegradable starting material for industrial applications, technical textiles, composites, pulp, and paper, as well as for civil engineering and building activities. Natural fibres reinforced composites combine acceptable mechanical properties with a low density (Yang *et al*., 2004).Plant based fibres are used extensively because of their renewability and availability (Cristaldi *et al*., 2010).The mechanical properties of natural fibres determine its usefulness and the service life of composite that can be expected from its reinforcement. The advantages of using natural fibres include high specific stiffness and mechanical strength, availability, reduced energy consumption, low hardness which minimizes the wear of processing equipment, renewability, recyclability, non-hazard, and biodegradability (Hossain *et al*., 2013).

Many studies have been conducted to determine the tensile properties of plants stalk, stem and vine. Sakharov *et al*. (1984) reported that the force required to cut stretched mulberry stalks was 50% less than the force required for the unbent mulberry stalks. Tensile properties of greenhouse cucumber cane were investigated by Xu *et al.* (2016). In their report, they recorded that the average tensile strength of root, middle and head of fresh cucumber cane were 7.35 MPa, 6.30 MPa and 4.68 MPa, respectively. The compression, stretching, bending, shearing destruction stress and elastic modulus of mature reed stalk were tested by Cao *et al*. (2011). They observed that the maximum destruction stress and elastic modulus were essential in analyzing the stress-strain distribution during the process of cutting the reed stem. However, there is no reported literature on the tensile properties of fluted pumpkin vine, in relation to the vine's sections (root, middle and tail). Therefore, this study was carried out to determine tensile parameters (Tensile strength, Young modulus, tensile energy, tensile strain, yield strength, yield energy and yield strain) in fluted pumpkin vine at different sections (root, middle and tail), to evaluate how its tensile properties varied across the vine length.

MATERIALS AND METHODS

Sample collection and preparation

The fluted pumpkins were grown at the research farm of Delta State Polytechnic, Ozoro, Nigeria, planted February, 2018 and harvested on October, 2018. The fluted pumpkin vines used for this experiment were selected randomly based on size and length uniformity, no mechanical damage, no freedom from pests and diseases attacked. Each fluted pumpkin vine was divided into three different vine sections (root, middle and tail). The length of each sample was 120 mm, with 10 mm of both ends used for clamping, according to the provisions of GB/T228.1-2010 (Xu *et al*., 2016). The width and thickness of each sample was measured by a digital vernier caliper, with accurate to 0.1 mm. The general cross-sectional areas of the samples were found to be irregular polygon, which can be approximated to a rectangle.

Tensile test

The tensile properties test was carried out at the Material Testing Laboratory of the National Center for Agricultural Mechanization (NCAM), Ilorin, Kwara State, Nigeria. The tensile test was done with a Universal Testing Machine (Testometric model), equipped with a microcomputer. For each test, individual sample was carefully placed in between the jaws of the load cell of 50N, with crosshead speed of 5.00 mm/min. At the end of each test, the tensile properties (Tensile strength, Young modulus, elongation at break, tensile energy, tensile strain, and yield strength) of the sample were generated automatically by the microprocessor of the Universal Testing Machine. The experiment was conducted at room temperature. Yield strength of the pumpkin vine was the amount of stress applied to the pumpkin vine, that will deformed it permanently. Tensile strength was the maximum amount of stress the pumpkin vine was able to withstand while being stretched without breaking. Tensile strength was calculated as force per unit area as shown in equation 1 (Xu *et al*., 2016).

$$\sigma_{max} = \frac{F_{max}}{A} \qquad (1)$$

Where, $\sigma_{max}$is the tensile strength, MPa;
F_{max} is the maximum load in the test, N;
A is the cross section for the fracture area, mm^2.

Statistical analysis

The data obtained from this research were subjected to Analysis of variance using SPSS statistical software (version 20.0, SPSS Inc, Chicago, IL). The difference between mean values of parameters was investigated using Duncan's multiple range tests at 95% confidence level. All the experiments were conducted in ten replications and the average value recorded

RESULTS AND DISCUSSION

The Analysis of Variance (ANOVA) of the influence of fluted pumpkin vine section on its tensile properties is presented in (Table 1). Table 1 shows that the vine section had significant ($P \leq 0.05$) effect on all the investigated parameters. The separated mean values of the tensile parameters, calculated using Duncan's multiple range tests at 95% confidence level, are presented in (Table 2). From the experimental results, the vine root section had the highest tensile strength (28.6MPa), while the middle and tail sections tensile strength was 20.48 and 11.13MPa respectively. Furthermore, the Young modulus of the pumpkin vine was 755.66 MPa at the root section, 555.07 at the middle section, and 243.21 MPa at the tail section. These results were similar to pervious researches of (Xu *et al*., 2016 and O'Dogherty *et al*., 1995) for cucumber vine and wheat straw. Xu *et al.* (2016) reported the average elastic modulus of 280.58, 198.81 and 137.22 MPa, for the root, middle and tail part of cucumber cane; while O'Dogherty *et al. (*1995) reported that the young' modulus of wheat

Table 1. ANOVA of effect of vine section on the tensile properties of fluted pumpkin vine.

Source of variation	Parameter	df	F	Sig
	Tensile strength	2	92.2077	3.13E-05*
	Young modulus	2	106.284	2.07E-05*
Pumpkin section	Tensile energy	2	26.89	1.01E-03*
	Tensile strain	2	37.86	3.96E-04*
	Yield strength	2	14.604	4.95E-03*
	Yield energy	2	36.580	4.35E-04*
	Yield strain	2	92.149	3.13E-05*

* =Significant at P≤ 0.05

Table 2. The tensile parameters of fluted pumpkin vine sections.

Parameter	Root	Middle	Tail
Tensile strength (MPa)	$28.6^{c}\pm2.17$	$20.48^{b}\pm2.36$	$11.13^{a}\pm1.01$
Young modulus (MPa)	$755.66^{c}\pm88.48$	$555.07^{b}\pm94.2$	$243.21^{a}\pm17.8$
Tensile energy (Nm)	$0.889^{c}\pm0.086$	$0.553^{b}\pm0.120$	$0.324^{a}\pm0.073$
Tensile strain (%)	$5.46^{a}\pm0.46$	$8.01^{b}\pm0.80$	$9.92^{c}\pm0.59$
Yield strength (MPa)	$26.43^{c}\pm5.81$	$18.62^{b}\pm1.87$	$10.81^{a}\pm0.58$
Yield energy (Nm)	$0.503^{c}\pm0.085$	$0.317^{b}\pm0.052$	$0.068^{a}\pm0.042$
Yield strain (%)	$4.94^{a}\pm0.10$	$6.60^{b}\pm0.49$	$9.70^{c}\pm0.57$

Values are mean ± Standard Deviation; Means with similar superscript in the same row did not differ significantly (p ≤ 0.05); MPa = Megapascal; mm = millimeter.

straw ranged between 4.76 and 6.58 GPa.

As shown in (Tables 1 and 2), the average tensile energy of the vine root section was significantly (p ≤0.05) highest than those of middle and tail sections. The lowest tensile energy value was recorded at the tail section of the vine. The variations in the tensile energy with the vine length may be attributed to the cellular and fibrous structures differences across the vine length. The results also showed that the ability of the fluted pumpkin vine to resist deformation decreased significantly (p ≤0.05) from the root to the tail section. Tensile and yield strain decreased towards the root section of the vine. The tensile strain increased from 5.13% at the root to 12.82% at the tail section. Similar result was reported by Mir *et al*. (2012), who recorded tensile strain of 5.1% for raw coir fibres.

Conclusion

In this study, the tensile properties of fluted pumpkin vine were determined with the Universal Testing Machine. The results obtained from this research showed that pumpkin vine section had significant effect on the tensile properties investigated. Form the results obtained, the average tensile strength of fluted pumpkin vine inroot, middle and tail sections was28.6, 20.48 and 11.13 MPa respectively. The Young modulus was 755.66, 555.07 and 243.21 MPa at the root, middle and tail section of the vine respectively. In addition, the results showed that the ability of the fluted pumpkin vine to resist deformation decreased from the root to the tail section. The results of this study would be useful in composite boards' production and textile industries.

REFERENCES

Aletor O, Oshodi, AA, Ipinmoroti K (2002). Chemical composition of common leafy vegetables and functional properties of their leaf protein concentrates. *Food Chemistry*, 78: 63-68.

Asiegbu JE (1987). Some biochemical evaluation of fluted pumpkin seed. *J. Sci. Food Agric*. 40:151-155.

Cao Z, Jin X, Liao Q (2011). Experimental research on physical and mechanical parameters of matured bottom stalks of the reed for harvester design.*Int J Agric&BiolEng*, 4(2): 36–42.

Cristaldi G, Latteri A, Recca G, Cicala G (2010). Composites based on natural fibre fabrics.Woven Fabric Engineering. Croatia: Sciyo,

Hossain SI, Hasan M, Hasan MN, Hassan A (2013). Effect of chemical treatment on physical, mechanical and thermal properties of ladies finger natural fiber.*Advances in Materials Science and Engineering*. Pp.1 -6.

Gill LS (1988).*Taxonomy of Flowering Plants*. African FEP Publisher Ltd. Ibadan, Nigeria.

IPGRI (1999).*The biodiversity of traditional leafy vegetables*. Published by IPGRI, Rome (1999) Eds. Pp.1-18

Mir SS, Hasan SMN, Hossain J, Hasan M (2012).Chemical modification effect on the mechanical properties of coir fiber. *Eng. J.* 16(2): 73–84.

O'Dogherty M J, HubertJA, Dyson J, Marshall CJ (1995). A study of the physical and mechanical properties of wheat straw. *J. Agric. Eng. Res*. 62: 133–142.

Okoli BE, Mgbeogu CM (1983). Fluted Pumpkin Telfairiaoccidentalis.West Africa Vegetable crop.*Econ. Bot.* 37(2): 145-147.

Sakharov VV, Rakmanberdiev GG, Guagev GG (1984). An investigation into the severing of pre-tensed mulberry stems by a screw-type cutter. *Mekhanizatsiya i Elekfikikatsiya Sel'Skaogo Khozyaistva* 3: 61-62.

Tindal HD (1986). *Vegetables in the Tropics*: Macmillan Education Ltd. Houndmills, Hampshire.
Xu YF, Zhang XL, Sun XJ, Wang JZ, Liu JZ, Li Z,Guo Q, Li P (2016). Tensile mechanical properties of greenhouse cucumber cane. *Int. J. Agric. Biol. Eng*. 9(5): 1-8.
Yang HS, Kim HJ, Son J, Park HJ, Lee BJ, Hwang TS (2004). Rice-husk flour filled polypropylene composites; mechanical and morphological study.C*omposite Structures.* 63 (3): 305–312.