جمعية أمسيا مصر (التربية عن طريق الفن)
المشهرة برقم (٥٣٢٠) سنة ٢٠١٤
مديرية الشئون الإجتماعية بالجيزة

Categorical Study on the Properties of Woven Fabrics Containing weft of Vortex or Banana Yarn.

أعداد

احمد رمضان عبد الحميد

كلية الفنون التطبيقية جامعة دمياط

(AmeSea Database – ae – Oct - 2024- 657)

Abstract:

This paper discusses the characteristics of fabrics made from vortex and banana yarns at filling direction as regards studying the woven fabric performance produced from these yarns in different weaving conditions. The concept of balanced weaving is put forward, to maintain uniformity

Based on the analysis of the woven specimens produced, the performance of the fabric produced is defined as an indicator of the weaving conditions. Determining the most proper weave types for customer satisfaction is intended, also In order to deduce whether the type of spinning method also which pattern in the woven fabric These discussions led to the control of fabric parameters using three different weave structures (plain 1/1, twill 2/2 and satin 4).The awareness of and demand for apparel fabrics using new textile materials as vortex and natural fibers as banana for sustainability usage as a major quality criterion need more trials and comparisons to discover the outcome of multiple parameter interactions, including physiological, psychological, and physical.
Key words:
Vortex, Filling direction, Apparel fabrics.

1. Introduction:

Due to the often repeated maxim that there is sufficient for everybody's needs but not for their greed ,this appears to be literally true for the natural resources available in abundance across the world. The textile industry is constantly striving for innovative production techniques to improve product quality, and it is important that these products be developed in an environmentally friendly way Paul, R. (2014). The textile and apparel industry is a broad international system of production, merchandising, marketing, and distribution. Gizem, G. K. and C. Özgün (2017). Today, this industry is experiencing significant growth in production by manufacturers and in the sales of apparel retailers worldwide with different yarns and finishing techniques for woven fabric.

Advanced and engineered materials, whether natural or synthetic materials are also included in textiles along with conventional textile materials to obtain particular properties in required applications, their application depends upon their performance properties. Yarn type, spinning methods and yarn structures have a strong influence on the performance properties of the fabric produced. Patnaik, A. and S. Patnaik (2019).

The sole motivation for searching for alternative spinning methods is to increase productivity, since ring spinning reached its upper limit long ago. Behera, B. K. and P. Hari (2010).

New spinning systems differ from conventional ring spinning systems in the yarn twisting mechanism; they produce yarns with different fiber configurations and packing density distributions. Owing to recent developments there are many innovations by textile manufacturers to meet new criteria for woven fabrics. One of these criteria is based on the innovation of machinery to produce new yarn as vortex yarn, while others go to nature to extract fibers from plants to produce new yarns like banana. The increasing awareness for comparison of different woven fabrics made from different spun yarns is required particularly in different subjects, to improve this production or stop producing it. Özdemir, H. and R. T. Oğulata (2011).

This paper indicates the performance of woven fabric produced from banana and vortex yarn in the weft direction .A lot of different subscriptions in yarn properties can be attributed to the differences in their structure, which is the consequence of different production processes.

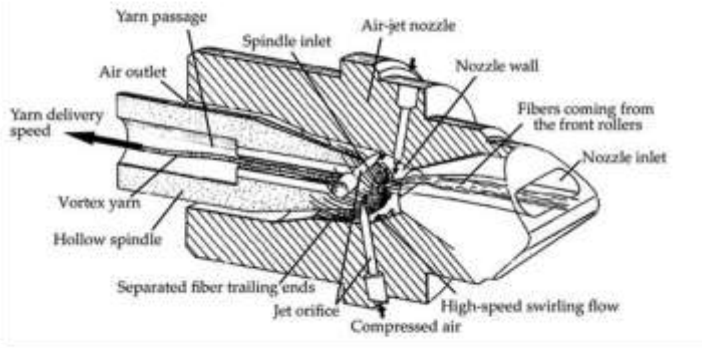


Fig (1) shown schematic diagram of the nozzle block of vortex spinning machine.

In term of VORTEX spinning technology, to twist the yarn as Fig (1) shown unique air technology, which uses a modified single air nozzle, is developed and manufactured by Murata Machinery, LTD. Erdumlu, N., et al. (2012). This system is claimed to be capable of producing 100% carded cotton yarns, which have a ring spun-like appearance and higher tenacity due to the high number of wrapping fibers when compared with the previous air-jet spinning systems. Gizem, G. K. and C. Özgün (2017).

Previous studies proved that the structure and performance of vortex spun yarns were influenced by the effects of nozzle angle, nozzle pressure, spindle diameter, yarn delivery speed, yarn linear density, fiber composition, and the distance between the front roller and the spindle. Basal, G, and W. Oxenham (2006), Hossain, M. A., et al. (2024), Ortlek, H. G. and S. Ulku (2005).

Besides high production speed, vortex yarns boast many outstanding characteristics, as Kostajnšek, K. and K. Dimitrovski (2016) indicate in their paper. Most studies in terms of vortex dealt with the properties of the thread only, either singly or blended with other fibers.

In terms of using natural fibers such as banana fibers, etc. to decrease the usage of petroleum-based fuels and products in the textile industry ., this reason led manufacturers to increase their search for more efficient materials, which had a significant impact on the development of new products.

Banana fiber is the best fiber, which is obtained from the pseudo-stem of the plant. The fibers obtained are lustrous and fine, with relatively good mechanical properties. After the fruits are harvested two to four times a year, the stem of the banana plant is a major waste material, which creates disposal problems. P., U. [1] (2009), S Hawas, H., and Y. Abo El Amaim (2021). A low percentage of these stems have been dedicated to cattle feed. Banana fiber can be extracted from banana stems by many different methods, such as manual, mechanical, chemical, and biological methods. Mumthas, A. C. S. I., et al. (2019).

The study of the properties of fabrics woven from banana fibers was taken into account by several studies and manufacturers, which use them in several applications as light- and heavy-weight woven fabrics from 230 to 540 g/m2, kids wear, lightweight bags for outdoor use, furniture for sitting, baby nests, luxury footwear, Unisex sneakers, and mall bags for holding essentials with adjustable hip and shoulder carry options. S Hawas, H. and Y. Abo El Amaim (2021)

The most research studies found in the term banana are studding the banana yarn, especially in cases with different blending ratios with nature or synthetic fibers. It can be said that there is no study established in the case of using 100%% natural banana fabrics made from 100% banana fibers.

So that the current study carried out this research to study the different woven fabric performance produced from vortex and banana to contribute to more positive changes by creating a knowledge base for the properties of these fabrics using the simplest textile methods known technically in order to provide knowledge readings about their physical and mechanical properties inside woven fabrics to find better standards.

2.1. Research specimens. *Experimental protocol***:**

As shown in Tables (one, two, three, and four), respectively, the specification of weft yarn used, the specification of loom parameter, the specification of fabric parameter, and three weave structures (Plain 1/1, Twill 1/3, and Stain ¼) are used. Subsequently, six woven fabrics were used. To maintain uniformity, the same warp yarn (30-Ne Ring carded) was used.

The experimental protocol is briefly described by the equation below:

^{2} weft yarn type × ^{3} weave structure = ^{6} samples.

^{64} experimental are measured and the samples tests parameters given in Table .5.

Notice:

- Vortex Yarn was manufactured and sent to the researcher via DHL by Murata Machinery, LTD. 136, Taskeda Mukaishiro, Fushimi-ku, Kyoto 612-8686, Japan.
- Banana Yarns were manufactured and sent to researchers via DHL by Bananatex® ANANATEXAG c/o Arnold Legal AG Gotthardstrasse 36300 Zug Switzerland.

Table 1. Weft yarn specification

Object/ Yarn	30/2 Ne VORTEX.	20/1 Ne Banana.
Count average.	16.0	20.0
Twist Method. Mesdan Tester 2531C. Twist (TPI) of single Yarn.	-	16
B-force (g/f).	24	4.5
Strength Method / TensoRabid4 Breaking Length (RKM).	22.1	19.0
Average Elongation %.	4.2	13
CV. %.	10.1	9
Thin places *1000 km (-50%).	5.6	4.1
Thick places *1000 km (+50%).	22.5	16.4
Neps *1000 km (+200%).	26	12

Table 2. shown the specification of loom parameter	
Loom parameter.	
Manufacture	Vamatex silver HS 2010.
Weft insertion system	Rapier.
Shed system	Negative dobby (Stäubli 2670)
Machine speed	450 rbm.
Machine width	190 cm
Let off system	Electronic
Take up system	Electronic
Warp stop motion	Electric
Initial Warp tension	(3) Kn
crossing angle (Shedding close time)	From (40 - 320)^{o}
Shed angle.	(24 ^{o})

Table 3. shown the specification of fabric parameter	
Fabric Parameter.	
Weave structure	Plain (1/1). Twill (1/3). Stain(1/4).
Warp count	30 Ne carded.
Warp density/Inch	60
Warping beam width /cm	167
Warp width in reed /cm	171,45
Drawing -In reed	2
Warp Yarns Total.	3770
Pick / Inch.	47
Reed count / Cm.	13,7
Weft count/ spun method.	30/2 Ne VORTEX
	20/1 Ne Banana
Weft density/Inch	47
Fabric width in loom /cm	160
Selvdages.	16 yarns each side
	Palin (2/2) weave structure.

Table2. Woven fabrics' specifications.

V: Refers to vortex. B: Refers to Banana.

2.2. Laboratory Testing:

In the warp direction, tension is applied by the warp beam at two values of tension at (3) KN, which allow weaving stability for two articles. In the filling direction, tension is applied by the loom temples, and it is this tension that prevents the filling yarn from crimping.

The samples had no finishing process at mile, whereas the only process was washing fabrics with the help of a simple cylinder machine with a cistern at 80 °C, then drying and ironing at 125 °C at the evaporation water point by using *Ramallumin* drying tower cylinders.

All tests were carried out in the weft direction after conditioning specimens in a standard atmosphere (temperature of 20 ± 2 °C, 65 ± 2% relative humidity) at the Uni-Governmental Laboratory.

Tensile strength measurements of the fabric samples were carried out on the Titaan 10-kn James Heal instrument in accordance with ASTM 5035.

The tear behavior of fabrics was carried out in accordance with ASTM D2261 by the tongue (single rip) producer (constant rate of extension Titan 10 instrument).

The standard test method ASTM 1424 (Tearing Strength of Fabrics by Falling-Pendulum Type) was used for the determination of the force required to propagate a single-rip tear starting from a cut in a fabric using the automatic falling-pendulum type. This test was performed on a tear tester (*El Mater) by* James Heal instrument.

Mass per unit area (weight) of fabric according to ASTM 37776 and specimen thickness according to ASTM 1777 are counted using a Hans Schmidt gauge instrument. All fabric samples were cut according to previous standards. Three samples were used for each test, and their average values were taken.

Table3. Indicate all Woven fabrics' measurements specifications.

Sample code	Sample Direction	TENSILE	ELOGNATION	Tear /TENSILE	Tear D1424	Air permeability $FT^3/FT^2/MIN$
V^P	WARP	507.68	27.2	25.78	28.7	510
	WEFT	1015.18	29.44	21.02	18.2	
V^T	WARP	433.66	24.04	44.57	33.1	1300
	WEFT	751.63	24.98	36.91	32.46	
V^S	WARP	471.57	23.02	50.30	32.89	1160
	WEFT	857.55	24.39	42.15	32.19	
B^P	WARP	510.24	20.5	14.65	10.33	2160
	WEFT	389.6	44.76	20.13	9.06	
B^T	WARP	444.37	16.92	31.13	20.21	3960
	WEFT	485.61	36.05	47.13	20.53	
B^S	WARP	288.50	19.82	24.39	18.17	4600
	WEFT	476.25	30.5	35.95	23.625	

2. Results and Discussion.

Since the current assessments of the produced fabrics for physical focus are in the weft direction, all the test results are given in Table 3, and their interpretations are given in the following sections.

To clarify the statistical transactions performed to find relationships between dependent and independent variables, a multiple comparison test was used. The statistical software package EXEL was used to interpret ~~the~~ experimental data.

***Analysis* statically protocol**: to determine the positive and opposite relations and their impact on measured properties. All the test specimens' results are divided into groups as shown in Table.3, and their interpretations are given in the following sections. All test results related to the physical, etc., properties of the woven fabrics were evaluated in this study for *not significant differences* but positive and opposite relationships between parameters.

Due to the researcher's deepening, the research compares. All test results related to physical etc. properties of the woven fabrics were evaluated in this study for *not significant differences* but positive and opposite relationships between parameters between the used material and the weave structure

3.1. Tensile Strength & Elongation Property:

This section studies the effect of the vortex and banana filing yarns on the specimen's tensile strength and elongation in the warp and weft directions while using three weave structures (Plain (1/1), Twill (1/3), and Stain (1/4)), respectively.

The most important output of a tensile test is *a load-elongation curve,* which can be converted into a stress-strain curve. The stress-strain curve relates the application of stress to the resulting strain. Abd El, A. R. El-Tantawi (2020). Each specimen has its own unique stress-strain curve. The researcher encodes this behavior, as shown in Table 3, in numerical values.

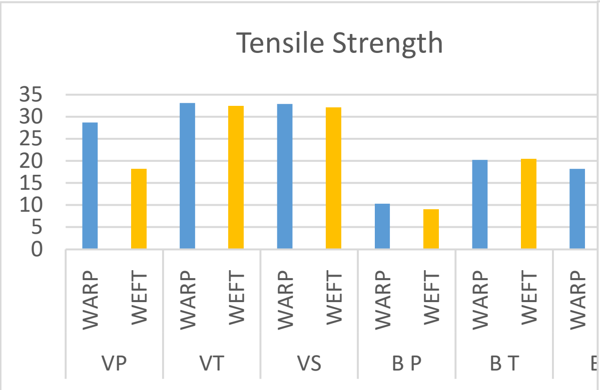


Figure2. Fabric tensile strength at different weave structures, density and different spun yarn.

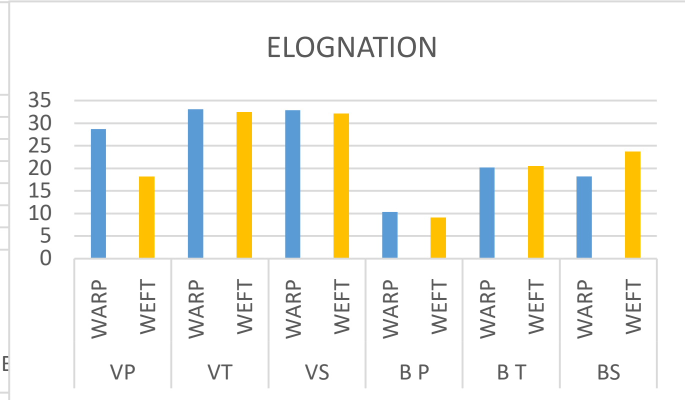


Figure3. Fabric Elongation at different weave structures, density and different spun yarn.

As shown In Fig.2&3:

- We can encode the largest tensile strength value while using the three-weave structure, whether it is in a state warp or weft direction. It was the largest value in the case of using vortex yarn. This sample has the largest breaking strength rates, and it can be said exactly the opposite.
- By analyzing the percentage of elongation of woven fabric: The largest elongation value occurs when using the three-weave structure, whether it is in a state warp or weft direction. It was the largest value in the case of using vortex yarn.

The researcher believes that the result above about tensile and elongation occurred at research samples due to several reasons, firstly the amount of twisting of the Vortex yarns, which gave it inside the fabric a greater amount of resistance to tension and elongation to the point of breaking cut. Secondly ., it is also assumed that the method of spinning the rotor of the Murata LTD Company gives a balanced internal homogeneity to the fibers inside the fabric, much more than the method of hand-spinning used at banana yarns, which improves the properties of yarns inside fabrics in terms of mechanical resistance and stresses imposed on them.

3.2. Tear Property:

This section studies the effect of the vortex and banana filing yarns on the specimen's tear strength in the warp and weft directions while using three weave structures (Plain (1/1), Twill (1/3), and Stain (1/4)), respectively.

As Ahmed Ramadan El-Tantawi. (2020) defined fabric tearing as the consecutive bearing of yarns or collections of yarns laterally done on a fabric, it was also clarified that the tear resistance of woven fabric to failure in a tear test can be measured reliably and reproducibly in a simple transverse load test.

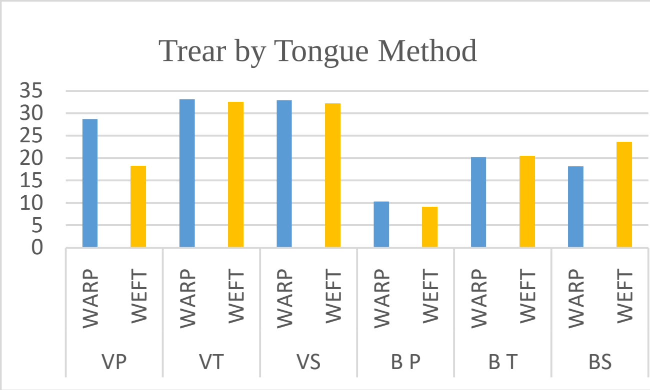
So the researcher prefers to use two types of tear propagation. The first, tear behavior of fabrics, was carried out in accordance with ASTM D2261 by the tongue (single rip) producer (constant rate of extension); the second, tear strength of fabrics by falling-pendulum type

The advantage of using ASTM D2261 is that it shows the tearing force in the form of a peak or peaks depending on the nature of the specimen. This test method is considered satisfactory for acceptance of fabric durability and mechanical qualities during daily usage.

The Falling-Pendulum Type test occurs progressively along a line and can be initiated by a moving fabric being caught on a sharp object. The amount of force necessary to rip the fabric depends on its tearing strength. For garment items, such as outdoor clothing, overalls, and uniforms, tearing strength is a very important quantity. Sinclair, R. (2014).

To prevent slippage at the grips in two types mentioned above, it take into consideration about while clamping the specimens also uniform the pre-tension in the instruments. Because they have an effect on measurement values.

The statistical schematic presented in Figs. (4&5) Shown is clear that the largest **tear** value while using the three-weave structure, whether it is in a state warp or weft direction, was the largest value in the case of using vortex yarn.



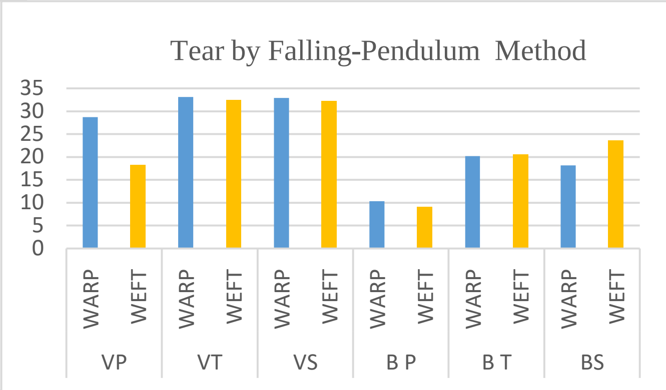


Figure4. Fabric Tear strength at different weave structures, density and different spun yarn by Tongue test.

Figure5. Fabric Tear strength at different weave structures, density and different spun yarn by Tear Falling-Pendulum test.

As shown at Fig.4&5:

The estimated tearing resistance for banana fabrics was the lowest compared with vortex fabric, and as it turns out, there is not much difference in the value of tear resistance between the three weave structures. Thanks to the utilization of vortex spinning technology with the long fibers, the fibers, which have an extremely flat structure, are softer with cooperation in the yarn structure, which leads to an improvement in the yarn's evenness. The yarns inside woven fabrics can participate in the higher effective length in the yarn structure, and more tearing load is required. So that, the woven sample in this case tolerates the load more and requires more tearing force before it ruptures.

Bananas also have a low level of tear resistance; this is due to the spacing between single threads that are torn and the tiny force required to make them slip over the crossing threads. Also, the spinning method with hand twist for banana fiber or using commercial machines to spin this fiber has an effect of tearing mechanism with attention to a hole or slit angle that is a result of specimens cutting trajectory as a result of an accident that may happen while wearing fabrics in daily use, which stresses of normal use are quite capable of causing an extension of such damage.

3.3. Air Permeability Property:

This section studies the effect of the vortex and banana filing yarns on the specimen's air permeability while using three weave structures (Plain (1/1), Twill (1/3), and Satin 4, respectively.

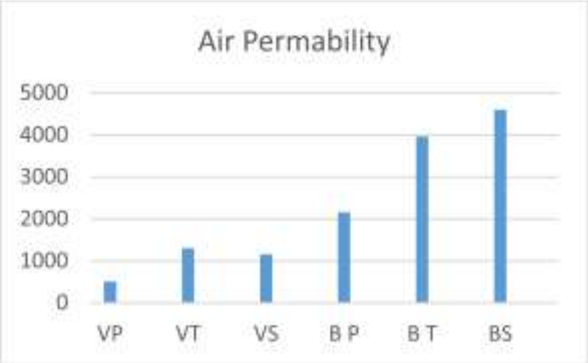


Figure6. Fabric Air Permeability Property

It measures the ability of a fabric to allow air to pass through it, which is an essential factor in determining the comfort and breathability of a woven sample. The advantages of air permeability testing are numerous; it provides a measure of fabric porosity and relates directly to fabric thickness and density and they contribute to the overall quality and performance of the final product.

As shown in Fig. 6, banana samples are given a high result for air permeability compared with vortex yarn. Regardless of the weave structure, this is due to several reasons. This is due to the yarn, which has the lowest value of hairiness. On the contrary, vortex yarn has more migration fibers covering the fabric surface, so as a result, the fabric becomes low porosity and hence the air permeability decreases. Besides that, the cross section of banana fiber and its surface morphology with its high surface area porous structure lead to an increase in passing air through the fabric effectively.

Conclusion:

The interest in new spinning methods is increasing in the textile sciences, as well as their popular applications. Researchers are also showing interest in studying mechanical stresses and fracture behavior in the latest materials. In many such applications, vortex and banana woven materials experience severe mechanical stresses during both handling and actual usage. While most of these wovens are durable under tensile stresses, they are very prone to failure upon tearing. Thus, it is quite important to know the critical energy release rate during the fracture of the films for accurate material design.

Related to the quality parameters of producing woven fabric from the newest fibers, such as banana and vortex yarns. The structure and arrangement of fibers within yams and fabric create a complex mechanism for synchronization. Understanding fabric geometry is crucial for research on new article fabric quality, as it affects interlaced yarns in fabric through two common models: geometrical and mechanistic.

This study concluded that the influence of the parameters affected in vortex woven mechanical parameters occurred related to the component fibers as twisting, breaking force, elongation, and so on, with a high correlation with machinery calibers compared with the semi- or hand spinning method of banana woven fabrics.

A Spotlight on: This study demonstrates that the strength of the spinning method significantly influences the serviceability and performance of daily cotton-woven fabrics.

These results pave the way towards a model for the assessment of the cost-benefit analysis of new fibers with related daily comfort properties; in other words, the rise in new performance fabrics means there is a need for new chemical treatments or so on and improved technology for testing their performance to back up their claims.

Acknowledgements.

The author wish to express his sincere appreciation to Murata Machinery, LTD. 136, Taskeda Mukaishiro, Fushimi-ku, Kyoto 612-8686, Japan for sending raw material for this project and Mahalla EL-Koubra Ltd, Egypt for their collaboration by making available their manufacturing site and stuff for carrying out this project.

Declaration of Competing Interest:

The author determines that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References:

Abd El, A. R. El-Tantawi (2020) "A Review on: The ratio between applied stresses and resultant strain

behavior of textile materials (yarn and woven fabric)." stress 13: 79.

Akgül, E., et al. (2017). "Optimization of the Murata Vortex Spinning machine parameters by the SMAA-

MOORA approach." Industria Textila 68(5): 323-331.

Basal, G. and W. Oxenham (2006). "Effects of some process parameters on the structure and properties of

vortex spun yarn." Textile research journal 76(6): 492-499.

Bhattacharya, S. S. (2020). Value Added Textile Yarns-Manufacturing Techniques and Its Uses, Om SaiTech

Books.

Chand, N. and M. Fahim (2020). Tribology of natural fiber polymer composites, Woodhead publishing.

Chen, X. (2005). "Characteristics of cloth formation in weaving and their influence on fabric

parameters." Textile research journal 75(4): 281-287.
Erdumlu, N., et al. (2012). "Vortex spinning technology." Textile progress 44(3-4): 141-174.
Gizem, G. K. and C. Özgün (2017). "A research on tensile properties of vortex yarns." DE REDACTIE: 170.
Günaydin, G. K. and A. S. Soydan (2017). "Vortex spinning system and vortex yarn structure." Vortex structures in fluid dynamic problems: 247-269.
Guo, H., et al. (2008). "A numerical and experimental study on the effect of the cone angle of the spindle in Murata vortex spinning machine."
Hossain, M. A., et al. (2024). "A novel approach to produce neppy yarn in vortex spinning technology." The Journal of the Textile Institute: 1-11.
Ibrahim, I. (2018). "Effect of fiber length and short fiber percent in cotton on fiber and yarn quality." alexandria Science Exchange Journal 39(OCTOBER-DECEMBER): 663-668.

Kumar, B. and S. Thakur (2017). Textiles for advanced applications, BoD–Books on Demand.

Lawrence, C. A. (2003). Fundamentals of spun yarn technology, Crc Press.

Murthy, H. S. (2016). Introduction to textile fibres, CRC Press.

Ortlek, H. G. and S. Ulku (2005). "Effect of some variables on properties of 100% cotton vortex spun yarn." Textile research journal 75(6): 458-461.

Özdemir, H. and R. T. Oğulata (2011). "Comparison of the properties of a cotton package made of vortex (MVS) and open-end rotor yarns." Fibres & Textiles in Eastern Europe 19(1): 84.

Patnaik, A. and S. Patnaik (2019). Fibres to smart textiles: Advances in manufacturing, technologies, and applications, CRC Press.

Paul, R. (2014). Functional finishes for textiles: improving comfort, performance and protection, Elsevier.

Pei, Z. and C. Yu (2010). "Numerical and experimental research on the influence of parameters on the tensile
properties of Murata vortex yarn." The Journal of the Textile Institute 101(10): 931-940.

Rossol, E. (2019). The Viability of Banana Fiber-based Textiles in the Fashion Industry, Kent State University.

S Hawas, H. and Y. Abo El Amaim (2021). "Influence of Using Different Blend Ratios of Banana Fiber on the
Mechanical Properties of Woven Fabrics."

Schwartz, P. (2019). Structure and mechanics of textile fibre assemblies, Woodhead publishing.

Stalder, H. (2014). The Rieter Manual of Spinning, Volume.

Sun, F., et al. (1997). "A generalized model for predicting load-extension properties of woven fabrics." Textile
research journal 67(12): 866-874.

Suzuki, Y. and S. Sukigara (2013). "Mechanical and tactile properties of plain knitted fabrics produced from
rayon Vortex yarns." Textile research journal 83(7): 740-751.

Tausif, M., et al. (2018). Yarn and thread manufacturing methods for high-performance apparel. High-
Performance Apparel, Elsevier: 33-73.

Uyanık, S. and P. Duru Baykal (2018). "Effects of fiber types and blend ratios on Murata Vortex yarn
properties." The Journal of the Textile Institute 109(8): 1099-1109.

Uyanık, S. and P. Duru Baykal (2020). "Investigation on moisture management properties of knitted fabrics
produced from vortex-spun yarns." The Journal of the Textile Institute 111(4): 565-574.

Zou, Z. (2015). "Influence of the Yarn Formation Process on the Characteristics of Viscose Fabric Made of
Vortex Coloured Spun Yarns." Fibres & Textiles in Eastern Europe(3 (111): 58-63.

Behera, B. K. and P. Hari (2010). Woven textile structure: Theory and applications, Elsevier.

Erdumlu, N., et al. (2012). "Vortex spinning technology." Textile progress 44(3-4): 141-174.

Kostajnšek, K. and K. Dimitrovski (2016). "Comparative study on the properties of vortex and ring spun yarn
and the properties of woven fabrics containing those yarns in weft." Fibres & Textiles in Eastern
Europe(2 (116): 59-65.

Pitimaneeyakul, U. (2009). Banana fiber: Environmental friendly fabric. Proceedings of the environmental
engineering association of Thailand.

Mumthas, A. C. S. I., et al. (2019). "Effect of physical, chemical and biological extraction methods on the
physical behaviour of banana pseudo-stem fibres: Based on fibres extracted from five common Sri
Lankan cultivars." Journal of Engineered Fibers and Fabrics.

Sinclair, R. (2014). Textiles and fashion: materials, design and technology, Elsevier.