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The Effect of Sliver Delivery Speed on the Unevenness of Carded and Combed Cotton Yarns

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ABSTRACT

The purpose of this study is to determine the effect of five different sliver delivery speeds on the yarn unevenness CVm (%). For this purpose, 100% cotton raw material was used, and card sliver samples were produced at five different card sliver delivery speeds (60 m/min, 120 m/min, 180 m/min, 240 m/min and 300 m/min). A total of 600 sample cops were produced in the ring spinning machine, each of which is 10 pieces of knitting and weaving yarn types in the carded and combed machine line, with the yarn counts Ne 20/1, Ne 30/1 and Ne 40/1 from these reed strips produced. The quality characteristics of the raw material used and the produced carded sliver samples were measured using the Uster HVI 1000 and Uster AFIS test equipment. The quality characteristics of the ring yarn cops samples produced on the ring spinning machine were measured with the help of Uster Tester 4 and Uster Tensojet Test devices. The results were analyzed by inferential and descriptive analysis methods. ANOVA analysis method was used for statistical analysis. According to the research findings, in both carded and combed Ne 40/1 yarn samples, an increase in yarn unevenness was observed with the increase in card sliver exit speed, and this increase created a statistically significant difference. The results revealed that the yarn unevenness is directly proportional to the card sliver exit speed and the increase of the card sliver exit speed causes the production of card sliver samples with higher unevenness values (Cvm (%).

Şerit Çıkış Hızının Karde ve Penye Pamuk İpliklerinin Düzensizliklerine Etkisi

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ÖZET

Bu çalışmanın amacı, beş farklı tarak şerit çıkış hızının iplik düzgünsüzlüğü CVm (%) üzerindeki etkisini belirlemektir. Bu amaçla %100 pamuk hammaddesi kullanılmış ve beş farklı tarak şeridi çıkış hızında (60 m/dk, 120 m/dk, 180 m/dk, 240 m/dk ve 300 m/dk) tarak şeridi numuneleri üretilmiştir. Karde ve penye makina hattında Ne 20/1, Ne 30/1 ve Ne 40 /1 iplik numaralarında her biri 10 adet trikove dokuma iplik türünde ring iplik makinasında toplam 600 adet numune kops üretilmiştir. Kullanılan hammaddenin ve üretilen karde şerit numunelerinin kalite özellikleri, Uster HVI 1000 ve Uster AFIS test ekipmanı kullanılarak ölçülmüştür. Ring iplik makinasında üretilen ring iplik kops numunelerinin kalite özellikleri Uster Tester 4 ve Uster Tensojet Test cihazları yardımıyla ölçülmüştür. Sonuçlar çıkarımsal ve betimsel analiz yöntemleriyle analiz edilmiştir. İstatistiksel analiz için ANOVA analiz yöntemi kullanılmımştır. Araştırma bulgularına göre hem karde hem de penye Ne 40/1 iplik numunelerinde tarak şeridi çıkış hızının artmasıyla iplik düzgünsüzlüğünde artış gözlenmiş ve bu artış istatistiksel olarak anlamlı bir fark yaratmıştır. Sonuçlar, iplik düzgünsüzlüğünün tarak şeridi çıkış hızı ile doğru orantılı olduğunu ve tarak şeridi çıkış hızının artmasının, daha yüksek düzgünsüzlük değerlerine (Cvm (%)) sahip tarak şeridi örneklerinin üretilmesine neden olduğunu ortaya koymuştur.

1. Introduction

Today, although the textile industry is in a constant development and change, the expectations of the end consumer, who purchase the textile products produced for a certain amount, from the textile product they buy have increased (Çelik & Kadoğlu, 2009). This situation shows parallelism with the concept of quality that has developed over time. In order for a textile product to provide the desired properties, first of all, the yarn that makes up the fabric from which the product is made must be produced with appropriate properties. In the early 1900s, when modernization efforts were intensified, even producing yarn in the desired number was considered a success in yarn production. From those years until today, excellent quality yarn can be produced with many features, research and development activities continue to increase in order to produce better (Kılıç, 2010).

The short fiber spinning industry, which keeps up with the ongoing developments and changes in the world textile industry, has also taken its share from this process. The production capacities of the machines used for yarn production as a result of technological developments draw attention. These capacity and speed increases have brought along a very important concept. The increasing speed and capacity due to technological development and how the product quality is affected by these increases are of great importance (Rokouzzaman et al., 2017).

The card is one of the most important process steps of a spinning mill and is called the heart of the spinning mill.

The material that has undergone a good combing process is the harbinger of a good quality yarn (Gupta, 2013). In a spinning mill, the situations caused by the malfunction occurring in the processing steps before or after the carding machines or the yarn shipment trying to reach the delivery date can affect the operation at constant card sliver exit speeds. In such cases, it is generally aimed to prevent losses in production by increasing the sliver exit speed, but the quality of the produced card slivers is not considered. For this reason, a detailed examination of the effect of different card sliver exit speeds on yarn quality is important for the spinning mill to maintain yarn production of a certain quality.

Mahmoudi et al. (2009) produced card slivers at three different doffer speeds (31.3 rpm, 44.8 rpm and 60.1 rpm) of the card. By using these comb sliver samples, ring yarn samples were obtained in cop form with a yarn count of Ne 19.6/1. They determined that doffer speed has no effect on yarn evenness. Chaudhari et al. (2017c) examined the effect of card licker-in speed on yarn quality. In this context, they produced card slivers at 3 different licker-in speeds and produced 30/1 combed ring yarn from these card slivers. 1000, 1200 and 1400 rpm speeds were determined as the licker-in speed, and the unevenness values of the strips produced at these speeds were measured along the combing production line. It has been found that increasing the licker-in speed produces an increase in card sliver unevenness. Rashid et al. (2019) within the scope of their study, five different carding machine flat speeds (200, 240, 280, 320 and 360 mm/min) produced card slivers with Ne 0.110 number. They produced Ne 24/1 and Ne 30/1 combed ring yarn samples from the card slivers they produced. It was found that the unevenness of the sliver and the yarn produced decreased proportionally with the increase in the flat speed in the carding machine. Turdialiyevich & Khabibulla (2020) produced card slivers at five different carding machine flat speeds (200 m/min, 240 mm/min, 280 mm/min, 320 mm/min and 360 mm/min) and Ne 0.110/1 number. And they produced Ne 20/1 and Ne 30/1 combed ring yarn samples with card slivers. As a result of the study, it was found that as the carding flat speed increased, the unevenness values of the yarn produced in both yarn counts decreased.

Chaudhari et al. (2017a) They mixed card sliver and comber sliver in certain proportions in the 2nd Passage draw frame and produced ring yarns with combed yarn count Ne 50/1 for each blend. Card sliver ratios in four different mixtures are 67%, 50%, 33% and 0%. As a result, they found that the yarn unevenness value decreased as the card sliver ratio in the 2nd Passage draw frame mixture decreased. Jabbar et al. (2013) produced combed ring yarn samples at 24/1 yarn count at 3 different card production rates (80 kg/h, 100 kg/h and 120 kg/h). They found that increasing the card production rate significantly increased the yarn evenness. Bagwan & Jadhav (2016) produced Ne 24/1 ring yarn from the card slivers they produced in two different settings. While the card sliver exit speed is 130 m/min in the first setting, 120 m/min card sliver exit speed is used in the other setting. As a result, they found that the yarn produced with the second setting had better evenness. Chaudhari et al. (2017b) They produced 4 different card production rates. These production rates were determined as 44 kg/h, 48 kg/h, 52 kg/h and 56 kg/h. In the study investigating the effect of the card production rate on the yarn quality, they concluded that the change in the card production rate did not have a significant effect on the yarn evenness.

In general, these studies on the card sliver exit speed examined the properties of ring yarns produced in a single number according to the card sliver exit speed. These studies, which also limited yarn samples in terms of twist coefficient and machine line, focused on yarns produced on a single machine line with only one kind of twist coefficient. Another common point of these studies is that the sliver speeds selected for the research are limited. Considering all these, there is a lack of a comprehensive study in the literature examining the effect of five different card sliver exit speeds on yarn unevenness, using yarn samples produced in different numbers, including different twist coefficients, and produced on different machine lines. Therefore, with this study, it is aimed to fill this gap in the literature and to shed a detailed light on other studies to be done on this subject.

2. Materials and Method

In this study, 100% cotton blend belonging to Söke region was used. Sample yarn was produced from this cotton blend in two different production lines, carded and combed. The production of carded yarn samples was carried out respectively on blowroom, card, 1st passage draw frame, 2nd passage draw frame, roving and finally ring spinning machines. Combed yarn samples were produced respectively in blowroom, comb, 1st passage draw frame, combed preparation, combed, 2nd passage draw frame, roving and finally ring spinning machines. Uster HVI 1000 (High Volume Instrument) and Uster Afis test devices were used to determine the properties of cotton fibers belonging to Söke region, which are used for the production of carded and combed yarn samples. The HVI test system is a test device developed by the Uster company and used to determine the fiber properties, and it has a great importance in the standardization of the fiber (Foulk & Mcalister, 2002). The average values found as a result of the measurements made for this study are shown in Table 1.

The values of the production parameters of the yarn samples produced for this study on the ring spinning machine (G33) are shown in Table 2.

Table 1. HVI 1000 tester measurement averages of cotton fiber

	Mean	Standard Deviation
Micronaire (µg/inch)	4.57	0.13
UHML (mm)	30.08	0.23
Uniformity index (%)	85.0	0.7
SFI (%)	6.1	0.6
Strength (g/tex)	30.0	0.7
Elongation (%)	5.9	0.4
Degree of whiteness	73.7	0.7
Degree of jaundice	8.2	0.3
Color grade	41-1	-
Number of trash	79	0

In order to prevent machine-related reasons that may cause different results in the measurements of carded and combed ring yarns produced in the ring spinning machine in cop form with the Uster Tester 4 device, the samples were produced using the same spindles of the roving and ring spinning machines. Production was made for each card sliver exit speed on the ring spinning machine. Knitting and Weaving ring yarn samples with Ne 20/1, Ne 30/1 and Ne 40/1 numbers were produced separately for each card sliver exit speed, equivalent to the thin and coarse counts most commonly used in the market.

2.1. Data analysis

The data collected in this study, which aims to examine the effect of card sliver exit speed on yarn strength, were analyzed by inferential and descriptive analysis methods. Before statistical analysis, data were prepared for data analysis in the data preprocessing stage and no missing data were found. ANOVA test was used in the analysis of the data. Scheffe post hoc analysis was used to determine between which groups the statistically significant result was.

Table 2. Parameters Used in Yarn Sample Production

	Ne 20/1	Ne 30/1	Ne 40/1
Card, Draw Frame and RSB Sliver Number (Ne)	0.12	0.12	0.12
Roving number (Ne)	0.9	0.9	0.9
Roving twist (T/inch)	1.2	1.2	1.2
Knitting yarn twist coefficient (α_e)	3.7	3.7	3.7
Weaving yarn twist coefficient (α_e)	4.3	4.3	4.3
Knitting yarn twist (T/m)	652	798	922
Weaving yarn twist (T/m)	758	928	1072
Average ring speed (d/dk)	11500	13000	15000
Traveler type and ISO number	PM Udr Safir - 56	PM Udr Safir - 40	PM Udr Safir – 35.5
Clip number (mm)	3.75	3	2.5

3. Findings

Yarns produced in the number of Ne20/1, Ne30/1 and Ne40/1 and the values of the production processes were presented in the previous sections, were passed through the carding machine with five different output speeds according to their type and types. CVm (%) measurements were made according to each yarn count and card sliver exit speed, and the average values of these measurements are presented in Figure 1 and Figure 2 according to carded and combed yarn types.

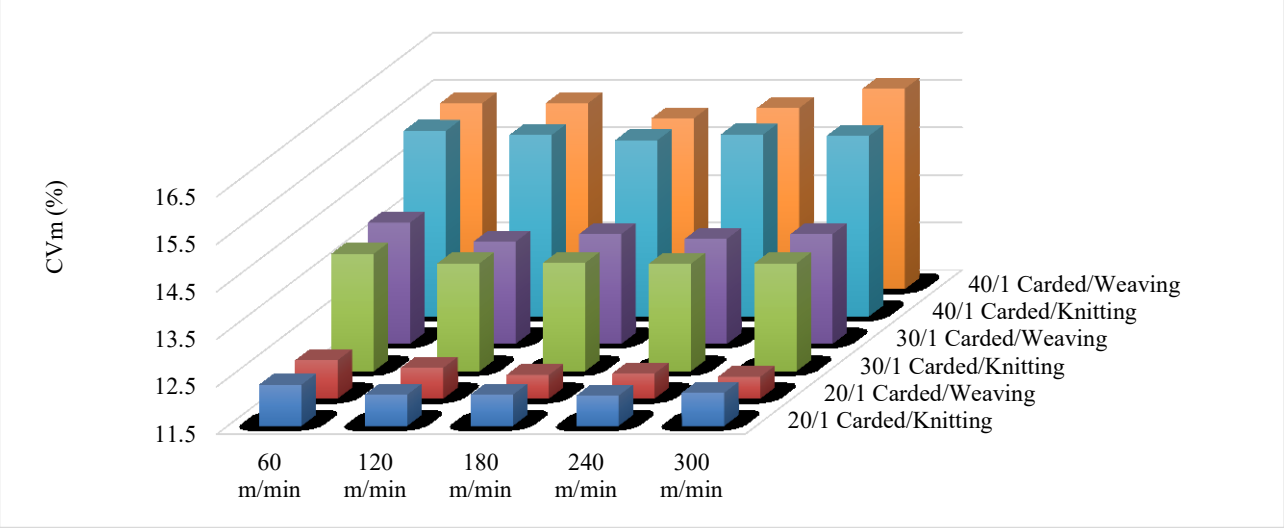

Figure 1. Average of carded yarn CVm (%) values according to card sliver exit speed

When the averages of CVm (%) values of the carded yarn are examined in Figure 1, an increase in CVm (%) values is observed as the yarn count increases, regardless of the yarn type (Knitting-Weaving). However, when the values

obtained according to the card sliver exit speed are taken into account, there is no significant difference between yarns of the same type (Knitting-Weaving) produced in the same number. In general, CVm (%) values of carded Weaving yarns produced in three different numbers were found to be higher with a small difference compared to carded Knitting yarns. When each yarn count and type is evaluated within itself –although the difference is observed to be small- it was found that CVm (%) values at the lowest and highest (60 and 300) card sliver exit speeds were slightly higher than the other sliver exit speeds.

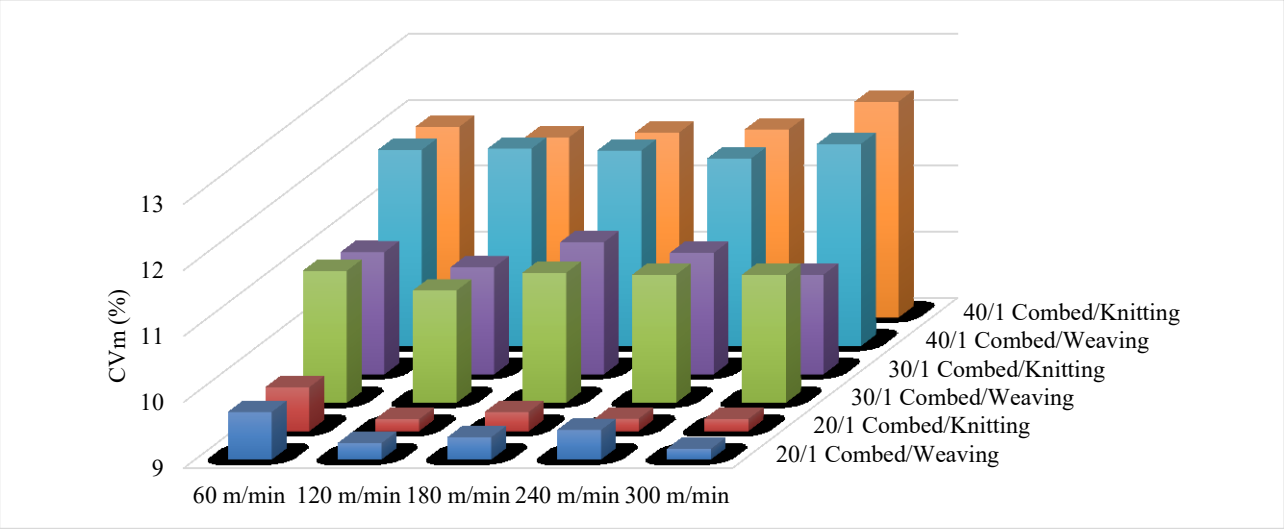

Figure 2. Average of combed yarn CVm (%) values according to card sliver exit speed

When the average values of combed yarn CVm (%) given in Figure 4.6 according to yarn number are examined, it is observed that there are similar rates to the CVm (%) ratio differences in the average values of yarns produced in carded yarn type, regardless of yarn type. In other words, the CVm (%) values of the combed yarns produced increased as the yarn count increased. When the ratios according to the yarn type (Knitting-Weaving) are examined in general, it was found that the CVm (%) values of the Weaving yarns were slightly higher than the Knitting yarns, although it was not observed at all card sliver speeds. When the CVm (%) averages of the combed yarn were evaluated according to the card sliver speed, it was found that the average values of the yarns produced at the lowest card sliver speed in Ne20/1 and Ne30/1 numbers were slightly higher than the yarns produced at the other card sliver exit speed. This difference is especially noticeable for the Ne20/1 number. The average CVm (%) values of combed yarns produced in Ne40/1 count, on the other hand, drew a graph in contrast to Ne20/1 and Ne30/1 yarns. Yarns with Ne40/1 numbers reached the highest CVm (%) values at the highest card sliver speed. Figure 1 also shows that when each count and yarn type (Knitting-Weaving) is evaluated according to the card sliver speed, it is seen that there is a fluctuation in terms of Cvm (%) values.

Although some differences were observed between the mean values indicated in Figures 1 and 2, ANOVA statistical analysis was conducted to examine whether these findings created a statistical difference according to the card sliver exit speed. The results of the Cvm (%) analysis according to the card sliver speed are presented in Table 3.

When Table 3 is examined, ANOVA analyzes show that there is a statistically significant difference between Cvm (%) values of yarns produced as Carded-Weaving, combed-knitted and Combed-Weaving yarns in Ne 20/1 yarn count according to the card sliver exit speed. Statistically significant differences were found between CVm (%) values in yarns produced as Carded-Weaving and Combed-Weaving yarns at Ne 30/1 yarn count, and in yarns produced as carded-Weaving and combed-Weaving yarns with Ne 40/1 yarn count. In order to understand between which card sliver exit speeds these significant differences occur, Scheffe post hoc analyzes were carried out separately for each yarn count. The results of CVm (%) post hoc analysis of yarns produced in Ne20/1 number are given in Table 4.

According to the post hoc results given in Table 4, no significant difference was found between the CVm (%) values of the carded Knitting yarns produced in Ne20/1 number according to the card sliver speed. On the other hand, when the CVm (%) values of the Carded-Weaving yarns are examined according to the card sliver exit speeds, it can be seen that the sliver speeds of 60 m/min - 180 m/min, 60 m/min -240 m/min and 60 m/min -300 m/min. significant difference was found. There was no statistically significant difference between the other card sliver exit speeds. In other words, the highest CVm (%) average value was obtained at the lowest card sliver exit speed (60 m/min). CVm (%) average values of Carded-Weaving yarns produced at 180 m/min, 240 m/min and 300 m/min card sliver exit speeds decreased. This decrease made a statistically significant difference and is important for the generalizability of the data.

Table 3. CVm (%) ANOVA analysis results according to card sliver exit speed

				Sum of Squares	sd	Mean Square	F	p
Ne 20/1	Carded	Knitting	Between Groups	0.378	4	0.094	2.178	0.087
			Within Group	1.952	45	0.043		
			Total	2.330	49			
		Weaving	Between Groups	0.831	4	0.208	6.011	0.001*
			Within Group	1.556	45	0.035		
			Total	2.387	49			
	Combed	Knitting	Between Groups	1.876	4	0.469	9.834	0.000*
			Within Group	2.146	45	0.048		
			Total	4.021	49			
		Weaving	Between Groups	1.737	4	0.434	9.972	0.000*
			Within Group	1.960	45	0.044		
			Total	3.697	49			
Ne 30/1	Carded	Knitting	Between Groups	0.341	4	0.085	1.418	0.243
			Within Group	2.707	45	0.060		
			Total	3.048	49			
		Weaving	Between Groups	0.944	4	0.236	3.895	0.008*
			Within Group	2.727	45	0.061		
			Total	3.671	49			
	Combed	Knitting	Between Groups	0.583	4	0.146	1.567	0.199
			Within Group	4.183	45	0.093		
			Total	4.766	49			
		Weaving	Between Groups	1.515	4	0.379	5.131	0.002*
			Within Group	3.323	45	0.074		
			Total	4.838	49			
Ne 40/1	Carded	Knitting	Between Groups	0.198	4	0.049	0.612	0.656
			Within Group	3.634	45	0.081		
			Total	3.832	49			
		Weaving	Between Groups	2.056	4	0.514	4.748	0.003*
			Within Group	4.872	45	0.108		
			Total	6.928	49			
	Combed	Knitting	Between Groups	0.265	4	0.066	1.154	0.344
			Within Group	2.580	45	0.057		
			Total	2.845	49			
		Weaving	Between Groups	1.820	4	0.455	6.873	0.000*
			Within Group	2.979	45	0.066		
			Total	4.799	49			

*: There is a statistically significant difference at the 0.05 level.

Table 4. CVm (%) Ne 20/1 Scheffe post hoc analysis results

			Carded			Combed		
	Card Sliver Exit Speed (m/min)		**Mean Difference**	**Standard Error**	**p**	**Mean Difference**	**Standard Error**	**p**
Knitting	60	120	0.216	0.09315	0.268	0.472	0.09766	0.001*
		180	0.217	0.09315	0.264	0.384	0.09766	0.009*
		240	0.237	0.09315	0.186	0.275	0.09766	0.113
		300	0.179	0.09315	0.459	0.56	0.09766	0.000*
	120	180	0.001	0.09315	1	-0.088	0.09766	0.935
		240	0.021	0.09315	1	-0.197	0.09766	0.409
		300	-0.037	0.09315	0.997	0.088	0.09766	0.935
	180	240	0.02	0.09315	1	-0.109	0.09766	0.869
		300	-0.038	0.09315	0.997	0.176	0.09766	0.524
	240	300	-0.058	0.09315	0.983	0.285	0.09766	0.093
Weaving	60	120	0.158	0.08316	0.471	0.485	0.09333	0.000*
		180	0.312	0.08316	0.014*	0.375	0.09333	0.007*
		240	0.285	0.08316	0.031*	0.477	0.09333	0.000*
		300	0.355	0.08316	0.004*	0.481	0.09333	0.000*
	120	180	0.154	0.08316	0.497	-0.11	0.09333	0.845
		240	0.127	0.08316	0.676	-0.008	0.09333	1
		300	0.197	0.08316	0.248	-0.004	0.09333	1
	180	240	-0.027	0.08316	0.999	0.102	0.09333	0.877
		300	0.043	0.08316	0.992	0.106	0.09333	0.861
	240	300	0.07	0.08316	0.949	0.004	0.09333	1

*: There is a statistically significant difference at the 0.05 level.

When the values of Ne20/1 numbered combed-knit yarns given in Table 4 are examined, a statistically significant difference was found between the average of CVm (%) obtained from the lowest card sliver speed and the average of CVm (%) obtained at other card sliver exit speeds (60 m/min -120 m/min, 60 m/min -180 m/min and

60 m/min -300 m/min). Accordingly, the average CVm (%) values of combed-knit yarns produced at the lowest card sliver exit speed are higher than the CVm (%) values obtained at the other card sliver exit speed. As the card sliver speed increased, the average CVm (%) values of combed-knit yarns decreased. However, although a slight increase was observed in the average CVm (%) value of combed-knit yarns produced at 240 m/min card sliver speed, this increase did not exceed the average CVm (%) value of yarns produced at 60 m/min card sliver speed. In addition, it did not cause a statistically significant difference between the average CVm (%) values obtained from other card sliver speeds.

When the average CVm (%) values given for the Combed-Weaving yarns produced in the number Ne20/1 given in the same table are examined, it is observed that results similar to the other results are obtained. In other words, the highest average CVm (%) value was measured at the lowest card sliver speed (60 m/min), and the difference between this value and the average CVm (%) values at other card sliver speeds was found to be statistically significant. Average CVm (%) values of Combed-Weaving yarns produced at high card sliver exit speeds (120 m/min, 180 m/min, 240 m/min and 300 m/min) is lower than the average CVm (%) of Weaving yarns. This significant difference between the mean CVm (%) values is also important for the generalizability of the data.

The results of CVm (%) post hoc analysis of yarns produced in Ne30/1 number are presented in Table 5.

Table 5. CVm (%) Ne 30/1 Scheffe post hoc analysis results

			Carded			Combed		
	Card Sliver Exit Speed (m/min)		Mean Difference	Standard Error	p	Mean Difference	Standard Error	p
Knitting	60	120	0.201	0.10968	0.507	0.304	0.13635	0.307
		180	0.197	0.10968	0.528	0.034	0.13635	1
		240	0.218	0.10968	0.424	0.065	0.13635	0.994
		300	0.207	0.10968	0.477	0.064	0.13635	0.994
	120	180	-0.004	0.10968	1	-0.27	0.13635	0.428
		240	0.017	0.10968	1	-0.239	0.13635	0.552
		300	0.006	0.10968	1	-0.24	0.13635	0.548
	180	240	0.021	0.10968	1	0.031	0.13635	1
		300	0.01	0.10968	1	0.03	0.13635	1
	240	300	-0.011	0.10968	1	-0.001	0.13635	1
Weaving	60	120	0.404	0.11009	0.017*	0.223	0.12152	0.506
		180	0.237	0.11009	0.342	-0.154	0.12152	0.807
		240	0.34	0.11009	0.065	0.003	0.12152	1
		300	0.241	0.11009	0.325	0.333	0.12152	0.131
	120	180	-0.167	0.11009	0.682	-0.377	0.12152	0.063
		240	-0.064	0.11009	0.987	-0.22	0.12152	0.52
		300	-0.163	0.11009	0.701	0.11	0.12152	0.934
	180	240	0.103	0.11009	0.927	0.157	0.12152	0.795
		300	0.004	0.11009	1	0.487	0.12152	0.007*
	240	300	-0.099	0.11009	0.936	0.33	0.12152	0.137

*: There is a statistically significant difference at the 0.05 level.

When Table 5. is examined, the post hoc results of the average CVm (%) values of the yarns produced in the number Ne30/1 show that there is no significant difference in carded-Knitting and combed-Knitting yarn types according to the card sliver exit speed. On the other hand, a statistically significant difference was found between the average CVm (%) values of the yarns produced at 60 m/min and 120 m/min speeds in Carded-Weaving yarns. There was no statistical difference between the average CVm (%) values obtained according to the other card sliver exit speeds. In other words, while the average CVm (%) values of the yarns produced at 60 m/min sliver speed are the highest, the average CVm (%) values of the yarns produced at 120 m/min sliver speed are the lowest among the average CVm (%) values of the yarns produced at other sliver speeds. From this point of view, although the average CVm (%) values experienced a significant decrease in 120 m/min sliver exit speed, it started to increase again as the sliver exit speed increased. However, even with this increase, it still could not exceed the average CVm (%) value of the yarns produced at 60 m/min sliver exit speed.

Another statistically significant difference in Table 5 was observed between the average CVm (%) values of Combed-Weaving yarns produced at 180 m/min and 300 m/min card sliver exit speeds. The highest average CVm (%) value of these yarns was obtained at 180 m/min card sliver exit speed, while the lowest average CVm (%) value was found at 300 m/min sliver exit speed.

The results of CVm (%) post hoc analysis of yarns produced in Ne40/1 number are presented in Table 6.

Table 6. CVm (%) Ne 40/1 Scheffe post hoc analysis results

			Carded			Combed		
	Card Sliver Exit Speed (m/min)		Mean Difference	Standard Error	p	Mean Difference	Standard Error	p
Knitting	60	120	0.08900	0.12709	0.974	-0.02400	0.10709	1.000
		180	0.19700	0.12709	0.664	0.00300	0.10709	1.000
		240	0.08500	0.12709	0.978	0.13000	0.10709	0.830
		300	0.10900	0.12709	0.946	-0.09500	0.10709	0.939
	120	180	0.10800	0.12709	0.947	0.02700	0.10709	0.999
		240	-0.00400	0.12709	1.000	0.15400	0.10709	0.724
		300	0.02000	0.12709	1.000	-0.07100	0.10709	0.978
	180	240	-0.11200	0.12709	0.940	0.12700	0.10709	0.842
		300	-0.08800	0.12709	0.975	-0.09800	0.10709	0.932
	240	300	0.02400	0.12709	1.000	-0.22500	0.10709	0.367
Weaving	60	120	0.00600	0.14715	1.000	0.16100	0.11506	0.743
		180	0.32000	0.14715	0.331	0.09300	0.11506	0.956
		240	0.10700	0.14715	0.970	0.04000	0.11506	0.998
		300	-0.30800	0.14715	0.370	-.38400	0.11506	0.038*
	120	180	0.31400	0.14715	0.351	-0.06800	0.11506	0.986
		240	0.10100	0.14715	0.976	-0.12100	0.11506	0.892
		300	-0.31400	0.14715	0.351	-.54500	0.11506	0.001*
	180	240	-0.21300	0.14715	0.719	-0.05300	0.11506	0.995
		300	-.62800	0.14715	0.004*	-.47700	0.11506	0.005*
	240	300	-0.41500	0.14715	0.112	-.42400	0.11506	0.016

*: There is a statistically significant difference at the 0.05 level.

The differences between the average CVm (%) values according to the ipost hoc results of the yarns produced in the number Ne40/1 are presented in Table 6. According to these results, no statistically significant difference was found in the average CVm (%) values of Carded-Knitting and combed-knitted yarns according to the card sliver exit speed. In Carded-Weaving yarns, a statistically significant difference was found between the average values of the yarns produced only at 180 m/min and 300 m/min sliver exit speeds. In Carded-Weaving yarns, the lowest average CVm (%) value was found at 180 m/min sliver exit speed, while the highest average CVm (%) value was found at 300 m/min sliver exit speed. No significant difference was found between CVm (%) values of Carded-Weaving yarns compared to other card sliver speeds.

When the CVm (%) values of Ne40/1 number Combed-Weaving yarns in the same chart are examined, a significant difference was observed between the average CVm (%) values of the yarns produced at 300 m/min sliver speed and the average values of the yarns produced at 60 m/min, 120 m/min and 180 m/min sliver speeds. In other words, the average CVm (%) values increased as the card sliver exit speed increased and the highest average CVm (%) value was obtained at 300 m/min card sliver exit speed.

In summary, when the results of the CVm (%) analysis are examined in general, the CVm (%) values increase as the yarn count increases. Considering the yarn type, it was found that Knitting and Weaving yarns had almost equal levels or Knitting yarns had slightly higher average CVm (%) values. However, while no proportional increase or decrease could be found between the average CVm (%) values according to the card exit speed, generally higher average CVm (%) values at the lowest sliver speed (60 m/min) in Ne20/1 and Ne30/1 yarns has been obtained. The highest average CVm (%) values were reached in Ne40/1 yarns at the highest sliver exit speed (300 m/min). As a result, it was determined that the card sliver exit speed did not have an effect on the CVm (%) values of the yarns produced in the numbers Ne 20/1 and Ne 30/1, while it had an effect on the yarns produced in the number Ne 40/1. In other words, CVm (%) values increased as the card sliver exit speed increased.

4. Discussion and Conclusion

The statistical analysis results presented in the research findings show that even though no effect of the card sliver exit speed on the yarn evenness, it was found in the samples produced at Ne 20/1 and Ne 30/1 numbers that there is a direct proportionality between the increase in the yarn count and the unevenness. In other words, when considered independently of the card sliver exit speed, the yarn evenness increased as the yarn count increased. This situation is expressed in the literature as follows. With the increase of yarn number, a uniform fiber arrangement cannot be obtained and as a result, yarn evenness increases (Erdumlu et al., 2009; Erdumlu, 2011; Leitner et al., 2010; Tyagi et al., 2004a; 2004b; Zou et al., 2014). On the other hand, in both carded and combed Ne 40/1 yarn samples, an increase in yarn unevenness was observed with the increase in card sliver exit speed, and this increase created a statistically significant difference. This result obtained for Ne 40/1 yarns also overlaps with the findings of previous studies on card sliver exit speed and yarn unevenness (Jabbar et al., 2013; Bagwan et al., 2016; Rokomuzzaman et al., 2017). It can be said that the yarn unevenness is directly proportional to the card sliver exit speed and the carding efficiency of the card decreases with the increase in the card sliver exit speed. The reason for the decrease in carding efficiency can be stated as higher material feeding with the increase in card sliver

exit speed (Jabbar et al., 2013). Higher card sliver exit speed causes an increase in the amount of material between the flat and the drum, where the actual carding is made, and therefore the carding process cannot be done well enough. For this reason, it can be said that the increase of the card sliver exit speed causes the production of card sliver samples with higher unevenness values (Cvm (%). Also, the card sliver samples with high unevenness affect the unevenness values in the yarn. However, it is also known that short fibers affect the yarn unevenness (El -Sayed et al., 2012) Therefore, it can be concluded that short fiber ratios increased with the increase in card sliver exit speed, and as a result, higher unevenness values were obtained at high card sliver exit speeds.

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