COMPARATIVE STUDY OF COTTON QUALITY GINNED ON BOTH RECIPROCATING AND ROTARY KNIFE GIN-STANDS IN SIDS GIN-PLANT

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Abstract

Similar seed cotton samples representing the Giza 80 Egyptian cotton variety were ginned using a conventional reciprocating-knife gin-stand and modern rotary-knife gin-stand sequences in three replications. Samples from ginned lint were tested to evaluate the differences in fiber properties and yarn manufacturing performance resulted from using the two techniques in ginning.

Regarding to waste losses, total blow-room and carding waste values were 9.5% and 4.8% for both lint ginned on reciprocating and rotary knife gin-stand, respectively. The low blow-room and carding waste in the rotary gin-stand can be related to its low ginning out-turn, while high ginning out-turn in reciprocating gin include high blow-room and carding waste due to absence of seed-cotton and lint cleaners. It is worthy to mention that as seed cotton and lint cleaning takes place in rotary-knife ginning plant, the removal of impurities, is usually accompanied by shortening of the length distribution. In practice, the trash content of lint cotton is a major concern for, mainly, spinning mills. Therefore, it is important to conclude that the rotary gin-stand reduce the trash content, impurities and short fibers, high productivity, which resulted in maintenance of the fiber and yarn quality in spite of reducing the ginning out-turn. Hence, it is preferable to redraw the policy of ginning in Egypt to development the ginneries sector with rotary gins equipped with seed-cotton and lint cleaners.

INTRODUCTION

Ginning is the first important mechanical process that cotton undergoes on its way from the cotton field to the textile mills where it is spun into yarn and converted into fabrics.. Ginning in Egypt is 100% roller ginning. The average age of the gins is 100 years. Most gins were installed in 1905. In Egypt there are currently about 52 ginning mills in Egypt. The ginning mill in Egypt, contains an average 65 roller gin stands with leather rollers and reciprocating-knifes.

Mangialardi (1972) showed that lint cleaners improved the composite grade by reducing foreign matter and blending the fibers to improve the color. Some fibers are removed during the cleaning process along with the foreign matter, thus lint turn-out is reduced. Abdel-Salam and Nomeir (1973) compared the two types of gin stand; the

reciprocating and rotary knife, for ginning three varieties representing the two extreme Egyptian cotton categories; Giza 45 and Menoufi (ELS) and Ashmouni (MLS). The rotary gin stand gave somewhat better fiber length properties than the reciprocating-knife gin stand for the three varieties, but with regard to yarn properties the response differed according to variety. Youssef *et al.* (1976) found that, no significant difference was detected between the reciprocating and rotary-knife gin stand in fiber quality and they added that it could be stated that: the rotary-knife gin stand could be used safely in ginning the finest Egyptian cotton. Sallouma (1980) compared the two gin types. The rotary-knife gin stand system (including seed-cotton and lint cleaning) ,increased ginning capacity by 375 %, improved lint grade at the same magnitude as reciprocating-knife gin stand did, decreased non-lint percentage particularly for the low grades of the MLS cotton while no differences were observed for fiber nep potential, fiber properties, and yarn strength.

McCarthy roller gin gained world-wide acceptance during the late 18th century and early 19 th century, and continued to be in extensive use in many countries among them Egypt. Its ginning capacity, however, remained relatively low, about one kantar per hour. The rotary knife gins have virtually eliminated the use of McCarthy gins in the USA. In Egypt, one gin stand was installed in the laboratories of the Cotton Res. Inst. in mid 1970s for research purposes. A ginnery equipped with rotary-knife gin stands is established in Sids to serve the foundation seed production program of the institute, Abdel-Salam (1999).

The fact is that ginning technology has not changed over the last fifty years or more, only the machines run faster and produce more bales per hour and the best of the gins have pneumatic systems to move seed cotton from the opening tables to the blending rooms, and a second system to move it directly to the gin stands. These pneumatic systems reduce human contact with the cotton and actually remove dust and dirt from the seed cotton, but the approach has not changed. When in fact, over the last fifty years ginning technology has evolved into much more than just faster equipment. More recently, there is a growing tendency, in conjunction with privatization of the ginning industry, for further modernization especially installing seed-cotton cleaners and probably using rotary gin stands.

Regarding to Egyptian Cotton Gazette (2007), cotton production in the last 13 years, 1993/1994 has generally remained 415700 Tons with the lowest production occurring in 2007, yielding about 215800 Tons. The number of gins has steadily decreased over that same time period and has declined at a rate of 65 gins per year since 1994 (Table 1). In 2007, 3363 roller gins operated in Egypt, as compared to 4217 in 1994, a 20% reduction. All indications show that these trends in gin numbers

and volume will continue to move in the same direction. This trend will require the remaining gins to adopt new technology to increase capacity and deliver a timely and quality product, Textile industries Holding Company (2007).

Table 1. Distribution of the available capacity of roller gin-stand in Egypt

Ginning Company	No. of gin-stands		Status
	1994	2007	
Arabia Ginning	804	804	Private
Misr Ginning	995	622	Public
Delta Ginning	1008	708	Public
Nile Ginning	722	590	Private
Al-Wadi Ginning	688	639	Public
Total	4217	3363	

Source: Cotton and Textile Industries Holding Company.

Due to the importance of cotton ginning in Egypt, the Cotton Research Institute, in its effort to continuously improve the Egyptian cotton competitiveness in world markets, installed a new rotary gin plant in Sids, Beni-Souef, governorate, as a start point to development of ginning sector in Egypt.

Further work is necessary to better define the quality effect of ginning type "conventional reciprocating and rotary-knife gin-stand" on lint out-turn, fiber properties, spinning waste and yarn quality.

MATERIALS AND METHODS

Two experiments were conducted at the Sids gin-plant, Cotton Research Institute, Bani-souef governorate, to evaluate the effect of conventional reciprocating and rotary-knife gin-stand on lint out-turn, fiber and yarn quality, spinning waste and spinning performance of Giza 80.

315 Kg "two Kantars" homogenous bulk of seed cotton from Giza 80 cotton variety of 2006/2007 crop was used in this study. The seed-cotton grade was classified as Good + ¼. The ginning machinery sequence was typical of that found in Sids and in conventional ginneries and was maintained constant throughout the experiment. One Kantar was ginned in the process sequence in the rotary gin i.e., rock trap, incline cleaner, extractor-feeder, roller gin stand, roller lint cleaner, and the other kantar was ginned in the ordinary reciprocating-knife roller gin-stand. The time required for ginning each Kantar, and the weight in Kg of ginned lint was recorded. The lint out-turn was estimated as the percentage of ginned lint in relation to the seed cotton weight.

The principal raw cotton fiber properties of the ginned lint were measured on the High Volume Instrument (HVI) according to ASTM (D-1684-96). Lint cotton was processed through the pilot spinning mill, into carded yarn of ring spinning into 30Ne and 40Ne counts at 4.0 twist multiplier. Blow-room and carding waste were also, determined. Fiber and yarn properties were evaluated at Cotton Technology Research Division, Cotton Research Institute. Data from each experiment were statistically analyzed by analysis of variance of complete randomized design, and significant differences between treatment means determined Least significant difference "LSD" at 5% level of significance.

The lint grades were determined by qualified lint classers. All fiber properties were carried out under standard atmospheric conditions of (65 % ± 2) relative humidity and (70° F ±2, 21.1°C ±1) temperature degree.

The characteristics of ginning efficiency i.e. ginstand capacity and ginning outturn were determined and calculated according to the following equations as proposed by Chapman and Stedronsky (1959).

$$1 - \text{Ginstand capacity (kg/h)} = \frac{\text{lint mass (kg)}}{\text{ginning time (min)}} \times 60$$

$$2 - \text{Ginning outturn} = \frac{\text{lint mass (kg)}}{\text{seed-cotton mass (kg)}} \times 100 \quad (\%)$$

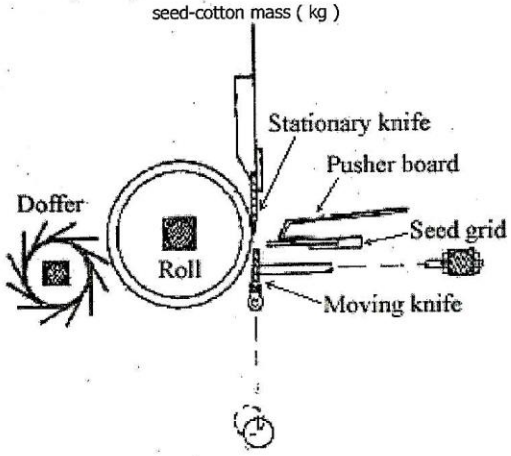

Figure 1. Conventional reciprocating-knife roller gin stand of McCarthy

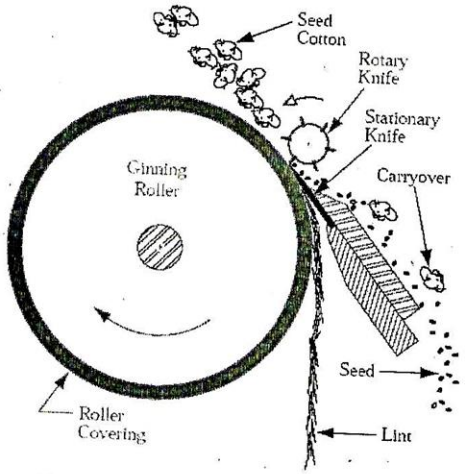

Figure 2. principle of rotary-knife roller gin-stand

RESULTS AND DISCUSSION

Lint out-turn and gin-stand capacity

The two methods of ginning were exerted significant difference at 0.05 probability levels on the lint out-turn. The reciprocating ginned lint of Giza 80 showed significant increases in lint out-turn of 2.22% than rotary ginned lint (39.36% and 37.14% respectively). The relative higher value of lint out-turn for reciprocating ginned cotton compared with these for the rotary ginned could be explained by the fact that roller ginning places in the lint extra materials composed primarily of foreign matter, non-lint content, aborted seed motes, and short fibers. The decrease in lint out-turn due to cleaning machinery in the rotary gin plant system, could be probably, ascribed to the removal of unopened immature seed cotton locks during seed-cotton cleaning, in additional to the removal of a proportion of immature fibers during lint cleaning.

Regarding to gin-stand capacity, both ginning methods exhibited significant effect on the gin-stand capacity at 0.05 probability level. This is clearly due to the very wide range between the capacities of the rotary and reciprocating knife gins. Since the former exceeded the latter one by about 7-8 times.

Table 2. HVI fiber data for Giza 80.

Ginning system	Ginning out-turn (%)	Fiber length parameters			Fiber tenacity		Mic. reading	Color	
		UHM (mm)	UI %	SFI	T. (g/tex)	Elong. (%)		Rd %	+b
Reciprocating	39.36	30.8	85.5	9.75	38.0	7.3	4.3	63.2	13.1
Rotary	37.14	31.3	86.8	6.5	38.0	7.3	4.2	63.5	12.3
L.S.D. at 0.05% level	1.34	N.S.	0.05	1.01	N.S.	N.S.	N.S.	N.S	0.07

N.S. insignificant

Raw fiber properties and lint grade

The HVI results were summarized in Table 2. Quality attributes measured by the HVI were superior in fiber length parameters for the rotary ginning than for the roller ginning treatment. Generally, the effects of ginning treatment on fiber length, uniformity index, short fiber index measurements were statistically significant.

Upper half mean length averaged 30.8 and 31.3 mm, uniformity index averaged 85.5% and 86.8%, short fiber Index averaged 9.75 and 6.5%, micronaire reading averaged 4.3 and 4.2 on the reciprocating and rotary gin, respectively. Fiber tenacity and elongation were insignificantly affected regarding to ginning treatment. The presence of trash and its subsequent removal during the ginning process affects color characters due to getting rid of a considerable proportion of foreign matter mixed with fibers that led to decreased non-lint content and improving the grade and the fiber brightness. While foreign matter remaining mixed with the seed cotton, as in case of reciprocating ginned lint, resulted in decreasing the fiber brightness.

The composite seed-cotton, regardless of ginning treatment, had very similar grade was "Good + 1/4", but in the case of the lint cotton ginned on reciprocating knife gin-stand the grade Good +3/8. While, in case of lint ginned on rotary gin-stand, the lint cotton was Good/Fully Good, meaning that the seed-cotton and lint cleaners improve the lint grade due to the extraction a lot of trashes and impurities.

Regarding to machine sequence of rotary gin-stand, the seed-cotton and lint cleaners were the most important machine in the gin in relationship to maintaining and improving fiber quality and accordingly, lint grade. This finding is agreed with Ahmed et.al. (1986) who reported that the processing lint through lint cleaner decreases the amount of trash grade and improved the color and grade index.

Yarn manufacturing characteristics

The yarn manufacturing phase of the experiment consisted of spinning 30s and 40s carded yarns on ring spinning system and conducting spinning potential tests at the Pilot spinning mill. The amount of waste extracted in blow-room and carding processing is mostly determined by the trash in cotton. Regarding to waste losses in this comparative study, as shown in Table 3, blow-room and carding waste values were 9.5% and 4.8 for both lint ginned on reciprocating and rotary knife gin-stand respectively. The difference was found statistically significant. The low blow-room and carding waste in the rotary gin-stand can be related to low ginning out-turn, while high ginning out-turn in reciprocating gin-stand include high blow-room and carding waste due to absence of seed-cotton and lint cleaners. Spinning performance and end breakage for 30s and 40s yarns was defined as being in the interval 0-12 ends down for each group of 96 spindles/hour. For the 30s yarn, the end breakage was 4 and 1, while the values of 40s were 8 and 3 for both lint ginned on reciprocating and rotary gin-stand respectively.

Spinning potential tests were also run on the lint ginned from each treatment. The spinning potential yarn number indicates the finest yarn number that can be spun from a cotton sample without any end breakage when using specific processing procedures. The spinning potential values were identified at yarn count of 55s and 47s for the lint ginned on reciprocating and rotary gin-stand respectively.

The presence of trash in ginned lint impacts the spinning performance and spinning potential. High short fiber index in the lint ginned on reciprocating showed a detrimental effect upon both spinning performance and yarn quality, especially in finer yarn counts. As such, trash extraction for lint ginned on rotary gin-stand is a vitally important aspect in the high spinning performance and yarn quality.

Yarn properties

As shown from Table 3 the yarn has a higher strength at coarse count (30s), and as the yarn gets finer (40s), the strength significantly decreases. In general, good yarn strength was obtained from Giza 80 lint ginned on rotary gin-stand, while the same material which ginned on reciprocating gin recorded lower single yarn strength.

The single yarn strength of 30s and 40s yarn was affected by ginning systems, but yarns spun from lint ginned on rotary gin-stand were significantly stronger than those from lint ginned on reciprocating gin-stand

Table 3. Spinning performance and yarn property measurements of lint ginned on reciprocating and rotary gin stand.

Spinning performance and yarn property measurements	Reciprocating ginning	rotary ginning	L.S.D. at 5% level
Blow-room and card waste	9.5%	4.8%	1.33
Spinning end breakage no.			
30s yarn	4	1	0.87
40s yarn	8	3	0.82
Spinning potential yarn No.	53	48	0.21
Single yarn strength			
30s yarn	18.16	19.34	0.36
40s yarn	17.31	17.73	0.40
Unevenness			
30s yarn	15.23	14.55	0.33
40s yarn	16.78	16.21	0.42
No. of neps			
30s yarn	70	52	5.64
40s yarn	85	64	5.82
Hairiness			
30s yarn	5.4	5.4	N.s.
40s yarn	5.1	5.1	N.s.

N.s. : insignificant .

The yarn evenness data indicates that 30S C.V. % was 15.23 for reciprocating gin and 14.55 for rotary gin with significant differences due to the high percentage of short fibers in lint ginned on reciprocating gin which results in yarn unevenness. The same trend was recorded in the 40s yarns. Yarn evenness depends on two sets of factors, the first one is fiber properties, and the second is processing conditions. Regarding to fiber properties, the main differences between the lint ginned on reciprocating gin and rotary gin are found to be in short fiber index and uniformity ratio. Short fibers are mostly not under full control during drafting, usually called floating fibers, and their presence in the cotton causes the so-called drafting waves

which are alternating to unevenness and imperfections along yarn length. Also, lower length uniformity results in lower yarn evenness.

Yarn neps also showed significant differences due to lint ginned on different ginning systems. Yarns spun from lint ginned on reciprocating gin were more neppy than those spun from lint ginned on rotary gin due to increase in trash content and trash area which is increasing neps. Therefore, it was evident that the number of neps was increased with increasing yarn count because it will be more visible in fine yarns than in coarse count.

According to least significant difference, the yarn hairiness showed in significant differences between the lint ginned on reciprocating and rotary gin, but the yarn hairiness increase as yarn becomes coarser.

It could be fairly stated that in seed-cotton and lint cleaning in rotary knife ginning plant in Sids, that removal of impurities, is usually accompanied by shortening of the length distribution. In practice, the trash content of lint cotton is a major concern for, mainly, spinning mills.

Therefore, it is important to conclude that the rotary gin-stand reduce the trash content, impurities and short fibers, high productivity, which maintaining the fiber and yarn quality in spite of reducing the ginning out-turn, meaning that it is important to redraw the policy of ginning in Egypt to development the ginneries and also in commercial transactions, the price differences between the successive grades should be maximum.

REFERENCES

1. Abdel-Salam , M. E. 1999. The Egyptian cotton; production, quality and marketing. El-Kalema Press
2. Abdel-Salam , M. E. and A. A. Nomeir. 1973. Agric. Res. Rev., 51 , 1.
3. Ahmed, M.S., Nafessa T. Ahmed and M.A. Mahgoub (1986). Response of cotton fiber properties to moisture and lint cleaning as measured by 'HVI. Agric. Res. Rev., 64 (6): 849-856.
4. A.S.T.M., standards 1982. Designations: 1684-96. American Society for Testing and Materials, philadelphia, Pa., U.S.A.
5. Chapman, W.E., and V.L. stedronsky. 1959. Ginning Acala Cotton in the Southwest. U.S.D.A., Agric. Res. Serv., Prod. Res. Rept. No. 27
6. Cotton and Textile Industries Holding Company. 2007. Cotton ginning improvement report. Cotton and raw materials sectors.
7. Mangialardi, G.J., Jr .1977. lint retriever for cotton gins-a progress report. The cotton gin and oil mill press, 78 (21):12-13.

8. Salloumа , B.M. 1980. CRI report.
9. The Egyptian Cotton Gazette. 2007. Alcotexa. Statistical Section No. April 2007.
10. Youssef M. M., M. R. Abdel Mohsen and A. Awad. 1976. Egyptian cotton qualities as affected by the American rotary knife gin stand. Agric. Res. Rev., Egypt, 54 (8).

دراسة مقارنة لجودة القطن ناتج الحلج على حلاجات السكينة الترددية و السكينة الدورانية بمحلج سدس

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يهدف هذا البحث إلى دراسة تأثير نظام الحلج المطور (حلاجات ذات سكينة دوارة) على خواص شعيرات القطن المصرى وجودة الغزل، ولهذا تم حلج عينات متماثلة فى ثلاث مكررات من صنف جيزة ٨٠ على نظام الحلج ذو السكينة الدوارة و نظام الحلج ذو السكينة الترددية (مقارنة) كما تم أخذ عينات ممثلة من القطن الشعر لأختبار خواص شعيرات القطن وجودة الغزل.

أدى أستخدام نظام الحليج المطور ذو السكينة الدورانية إلى الحصول على صافى حلج وعوادم تفتيح وتسريح أقل بالمقارنة بالنظام التقليدى ذو السكينة الترددية وذلك لغياب منظفات الزهر والشعر فى النظام التقليدى، حيث كانت نسبة العوادم الناتجة من خط التفتيح والتنظيف والتسريح ٩,٥% و ٤,٨% لكلا من نظام الحليج العادى والحليج المطور على التوالى.

كما أدى استخدام نظام الحليج المطور إلى انخفاض نسبة المواد الغريبة، والشعيرات القصيرة، و ارتفاع كفاءة الحلج و الحفاظ على الخواص الطبيعية لشعيرات القطن ويحقق أفضل أداء للغزل فى مقابل انخفاض صافى الحليج نتيجة إزالة نسبة كبيرة من الشوائب والمواد الغريبة والفصوص الميتة. لذا يمكن القول أنه من المهم إعادة رسم سياسة تطوير نظام الحليج القطن فى مصر بما يتيح استخدام الحلاجات ذات السكينة الدورانية و منظفات الزهر والشعر.