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AN APPROACH TO THE IMPACT OF YARN TENSION AND COIL ANGLE ON THE DYE ABSORPTION OF CHEESES IN WINDING

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ABSTRACT

This study dealt with the winding in the Open-End machine to produce perforated cheeses for dyeing of100 % cotton yarn with count 20/1 Ne and 1447 twist/ meter and the direction of the twists is Z , the aim of this work is to investigate the effect of the factors that affect the cheese dyeing where 6 cheeses were produced using two parameters winding tension and coil angle during the winding process , the first three cheeses(1-2-3) were produced with different tension values by changing the speed of the drum that rotate the cheese , these tension are 30, 28 , 23 cN respectively , the other three cheeses (4-5-6) were produced with different coil angle values by changing the speed of the traverse *which are 30°, 35°, 39 °respectively ,the cheeses were subjected to purification followed by dyeing processes, The yarn density of each cheese was then calculated, The result showed that the density of each cheese are varied under the effect of yarn tension , the dyed knitted fabric samples were subjected to color strength % and ΔE tests and washing fastness (every fabric sample represent its corresponding yarn on the cheese) , the results Cleary demonstrated that the varying of yarns tension during winding has an impact on the yarn density of the cheese on the other hand the difference of coil angles of yarns is influential on both density and color strength% and need to be optimized, the result also confirmed that the color difference ΔE and washing fastness ,light have been affected by these parameters*

Keywords : Cheese Package , Coil Angle , Color Strength %, Density, ΔE , Tension Winding, Washing Fastness

I. INTRODUTION:

Aim of winding is preparation of warps, wefts and knitting yarns .Winding helps in the removal of yarn defects to improve evenness and imperfection with maintaining the physical and mechanical properties of yarn such as the constancy of yarn count , the yarn twist , the resistance of yarn tension and elongation % . winding making the suitable form package for the needed purpose of this package like yarns treatment i.e steaming (bulking) , Sizing , Waxing Winding produces perforated package (cheese and cone) for yarn dyeing ,A lot of studies are focused on winding by using different parameters and measuring the effect of these parameters on the properties

of yarn and the package density [1- 4 Besides , the rewinding (repeated winding) shared in the improvement of some yarn properties as elongation % , strength , yarn quality (thin / thick places and Neps) and CV % [5] By increasing the number of winding times the quality and hairiness %are increased at a certain limit of winding times[5-6] when the balance is achieved between the gained or lost quality and the cost [5] the packing types have been studied according to the way in which the yarn is coiled on the package , the first type is the cross-wound package (cone or cheese) where the flanges aren't used , the second type is the parallel wound package where the yarn coils are parallel to each other and all of them are perpendicular to the package axis , the flanges are used to achieve the stability of yarn , finally the third type is the near-parallel wound package in which the traverse is slow that made the yarns very nearly parallel , the flanges are necessary in this type [3,7] . In cross wound packages the angle types are formed as a result of the direction of yarn laid on the package , the first angle is known as coil angle (angle of winding) that laid between the yarn direction and any perpendicular line on the package axis[2,3] , the second angle is known as the crossing angle that is formed from the crossing of yarns [2 – 3 , 7]The measure of the coil angle is half the measure of the crossing angle [2] , the third angle is known as the reversal angle [3] Some of the factors that affect the density of yarn on the package are , friction force between drum and package, yarn tension in the winding ,[8] coil angle , parameters of winding machine and shape of winding package(conical- cylindrical) [7-8] The conical package is difficult to be built because it has different diameters along its axis and it is supposed that the length of the winded yarn be suitable for the cone package diameter[10] . when package unwinding is used in fabrics production or rewinding it for any propose as cheese dyeing ,improvement of yarn quality, there are problems that arise in the yarn movement as yarn sliding on conical package before forming the balloon , yarn position on package surface and its curvatures [11] and package winding must be suitable for unwinding it [10] Those problems were solved by using math equations [10-11] . The necessity of the winding tension regularity and unchanging during operating and it mustn't exceed the elastic limit of yarn (which nearly equal 1/10 of the breaking tenacity) , tension regularity helps in avoiding problems in the preparations and weaving processes , avoiding the appearance of thin places and the faults of cheeses and cones , keeping the package density constant to avoid the wastes on the package for not being rewinding and not increasing cost or having poor quality [3-4] winding tension affect the package density (parent – textured), physical bulk in the air-jet textured yarn machine [12] and the wool comfortmeter value of the yarn in winding device during testing yarns [13]

As far as I know, there are a few studies about the winding in the Open-End machine although the rapid developments while the most studies are about the winding machine with its types and the majority studied parameters of the machine, So this study is concerned with variation of tension and coil angles changes and their impact on the cheese package density and the amount of the absorbed dye by the package and investigation of the determined role affect the color strength

II. EXPERIMENTAL :

2-1 Preparation Cross wound cheese

100 % cotton fibers were used to produce 6 perforated cheeses packages in the winding of the Open- End , the first three cheese packages (1, 2 , 3) were produced using three different values of winding tension by changing the surface speed of the drum that rotate the cheese at constant coil angle 35° , The tension values are 30, 28, 23 cN. respectively, the other three cheese packages (4, 5 , 6) were produced using three different values of the coil angle which are 30° - 35° - 39° respectively at constant tension 28cN ,all the yarn cheeses of the 6 cheeses have the same count , twist/m and twist direction , table 1 shows the specifications of yarn and table 2 shows the specifications of the Open-End machine

Table (1) The specifications of yarn

properties	Specifications
Material	Cotton 100 %
Count yarn / Ne	20/1
Twist yarn /m	1447
Twist direction	z

(2) The specifications of Open- End machine

properties	specifications
Machine kind	Schlafhorst – German
Rotor speed	42000 rpm
Opening roller	8000 rpm
Rotor Diameter	4.5 mm
Package form	perforated cheeses
Traverse length	152 mm

2-3 Purification of cheeses

Prior to yarn dyeing application, the yarns were further purified by washing with a bath containing, 2 litters of non-ionic detergent, Egyptol BLM (1g/L) ,4 kg of NaOH (38Be) and boil heating for 30 min., rinsing with cold water ,followed by washing thoroughly with hot water at 60 °C for 10 min, and finally rinsing with cold water 2 times.

2-4 Dyeing Process of cheeses

The dyeing of yarns has been carried out through the line production of (Azgl Tex) with total volume of dyeing bath 2000 L .The cheeses were dyed with Reactive Blue 2 RL(9 Kg). Dyeing was started by adding 80 Kg of NaCl dropwise to the dyeing bath at RT for 15 min. Then the amount of sodium carbonate (21Kg) was added to the bath within 10 min at the same RT. The temperature of the dyeing was then raised to 60°C and the dyeing was continued for 90 min. The dyed yarns were rinsed three times with cold water followed by fixing the dye in the bath of acetic acid (4L, 2%) at 80 °C, rinsing with cold water. Finally, the dyed yarns were soaped with 2

litters of non-ionic detergent, Egyptol BLM (1g/L) at 80 °C for 30 min, rinsed with water and finally after treated with softening agent (Fatty acid and micro silicone)

2-5 produced knitting fabric.

6 Samples of knitted fabric were produced to measure the color strength % and ΔE, from each cheese package a sample was taken.

2-3-Tests and analysis.

2-3-1- properties of fiber cotton.

Laboratory tests on the produced yarn samples were carried out at the standard conditions for textiles with an air temperature (20 ± 2°C) and relative humidity of air (65± 5%) according to the American society of testing materials (ASTM) , table 3 shows the properties of cotton fiber .

Table (3) The properties of cotton fiber

properties	Specifications
Length	27.6 mm
Evenness	48%
Tenacity	27.8 g/ tex
Elongation	5.2 %
Micronaire	4.6 g / inch
Maturity	82 %

2-3-2 calculation of cheese density .

Using the law : density = mass / volume (cm^3)

2-3-3 color strength %.

Color strength % were measured using color data 600 TM device using American specifications CMC

2- 3-4 color difference (ΔE) .

ΔE(means color difference) of dyed knitted fabrics from each package were measured using color data 600 TM device

2-3-5 Measuring the Fastness properties (Washing fastness- Light fastness)

Table (4) The specifications tension and coil angle on package perforated cheeses

No of cheese	Tension cN	coil angle
1	30	-
2	28	-
3	23	-
4	-	30°

5	-	35°
6	-	39°

III. RESULTING AND DISCUSSION :

On using cotton 100% at constant twists/meter and count number with changing the values of tension and coil angle during winding in the Open-End spinning , the yarns density of cheese was affected and this density affect the color strength % and ΔE , Table 5 shows the results of changing tension and coil angle .

Table (5) the Results of varying Tension and coil angle on cheese density g / cm³ , color strength% and ΔE of the yarns

No of cheese	Tension cN	coil angle	Density g/ cm³	Color Strength %	ΔE
1	30	-	0.445	94.40	0.37
2	28	-	0.400	94.90	0.36
3	23	-	0.383	97.90	0.19
4	-	30°	0.401	101.57	0.31
5	-	35°	0.366	104.05	0.36
6	-	39°	0.335	108.00	0.70

3-1 The Effect of tension on the yarn density of cheeses /cm³

Table 5 and fig 1 showed the effect of tension on the yarn density of cheese in the first three cheeses (1 , 2 , 3) where it was noticed that by increasing tension the yarn density of cheese increases because the increase of tension cause the increase of the yarn compact of the cheese that leads to a smaller cheese diameter than the cheeses those have low tension and this at equal weights of cheese it is clear that, cheese no. 1 has the highest tension compared with cheese 2 and 3 because of the decrease of the tension on cheeses 2 and 3 ,it is also clear that cheese 3 has the lowest tension so it has the lowest density

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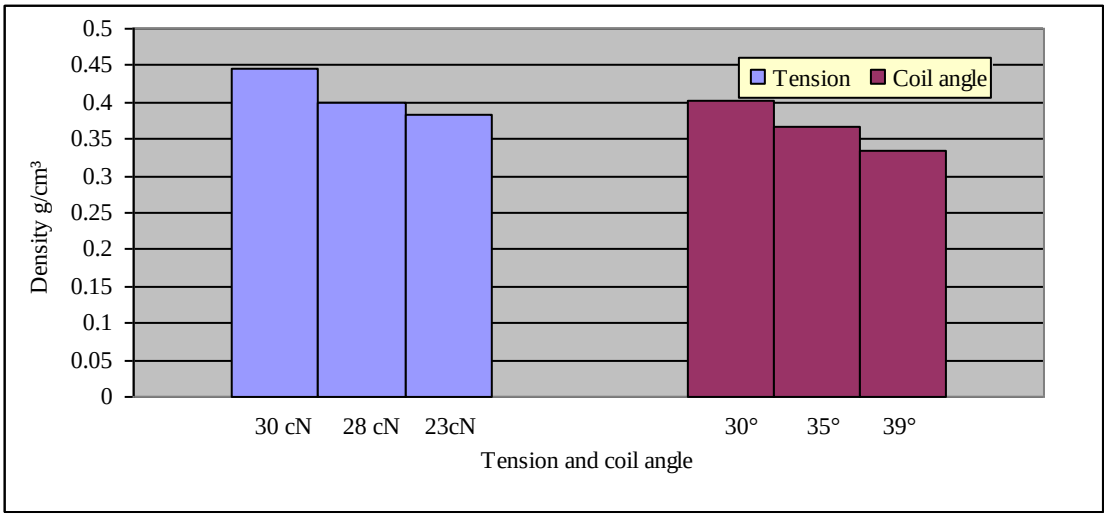

Figure: 1 The effect of tension and coil angle in the winding on the yarn density of cheese

3-2- the effect of coil angle on the yarn density of cheese g/cm³

Table 5 and fig .1 showed that the density of cheeses no. (4 , 5 ,6) is smaller than the density of cheeses no. (1 , 2, 3) and this is because that the coil angle is constant from the beginning to the end of the cheese and the number of coils at the end of cheese is less than that at the beginning that leads to the deviation of yarns on the cheese where by increasing the value of the coil angle the traverse ratio decreases that gives low density cheese so cheese no. 6 has the lowest density/ cm³ because it has the highest value of coil angle compared with cheeses no. 4 and 5 , Besides cheese no. 4 has the highest density because it has the lowest value of coil angle

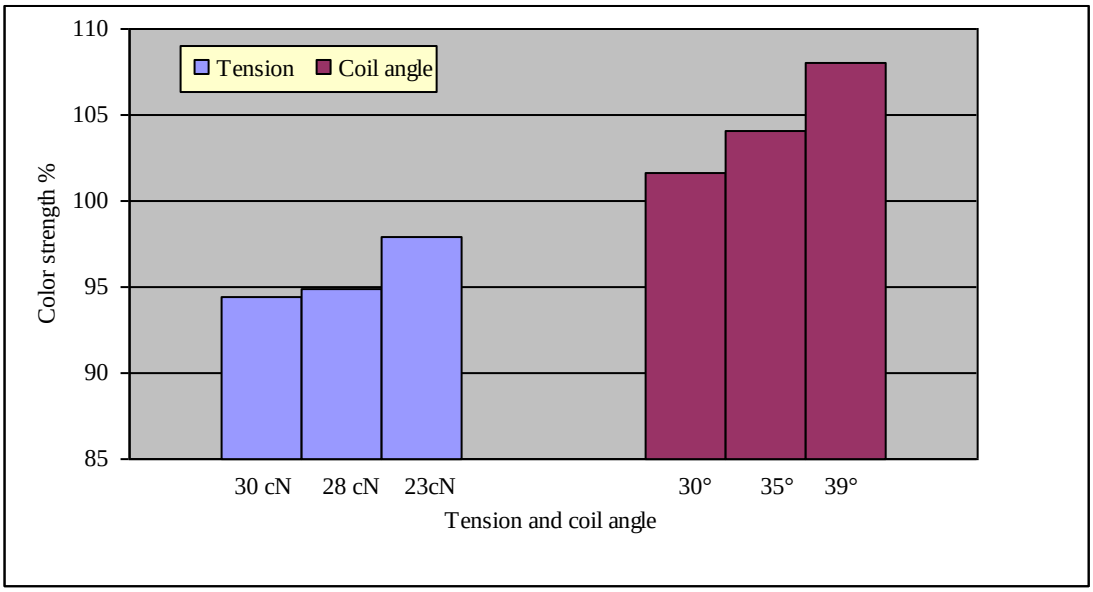

Figure: 2 The effect of tension and coil angle in the winding on the color strength %

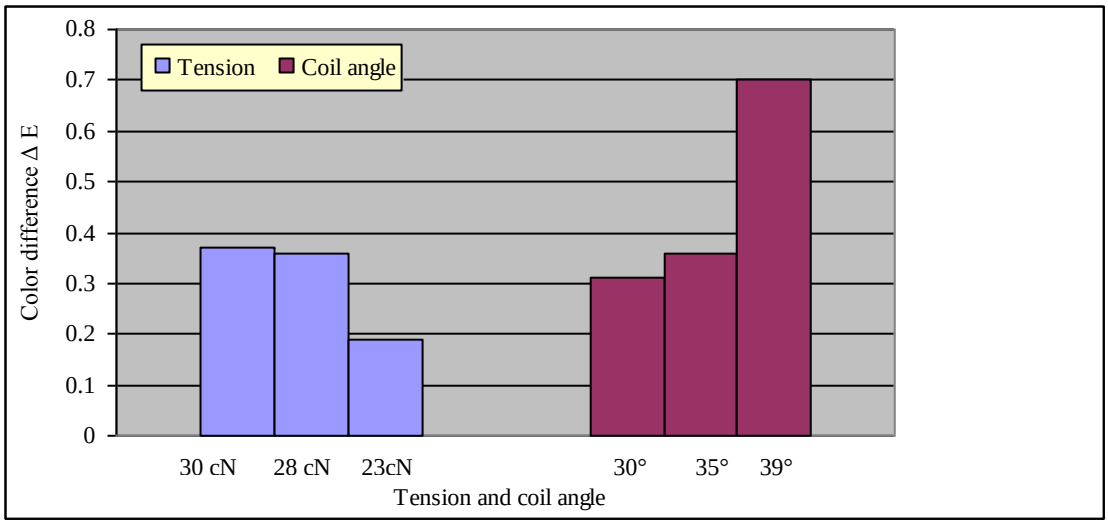

Figure: 3 The effect of tension and coil angle in the winding on color difference ΔE

3-3-The effect of tension and coil angle in the winding on the color strength % and ΔE

From table 5 and fig. 2,3by increasing the tension on the cheese the number of the yarns in cm³ increases That gives hard cheese that lead to low spaces between the yarns which do not allow the dye absorption sufficiently and therefore the color strength % decreases. by increasing the tension ΔE increase. This increase depend on the value of color strength %, where by increasing the color strength % ΔE decrease.

When the coil angle value increases the number of the yarns in cm³ decreases that gives soft cheese that lead to low spaces between the yarns which allow more dye absorption and therefore the color strength % increases . by increasing the coil angle ΔE increase, This increase depend on the value of color strength% . Where by increasing the color strength % ΔE increase.

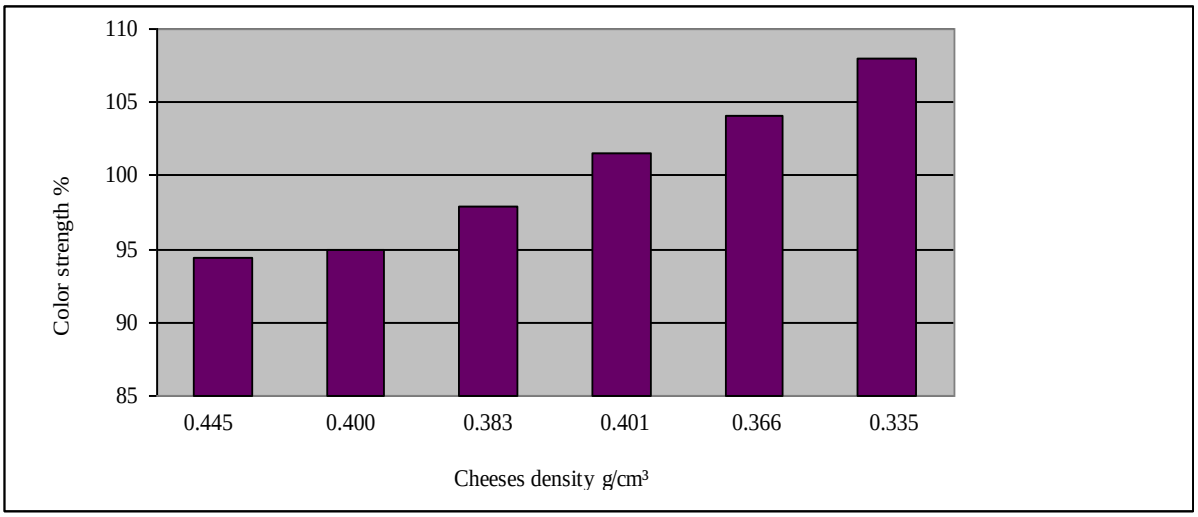

Figure 4 The effect of the cheese density g/ cm³ on the color strength %

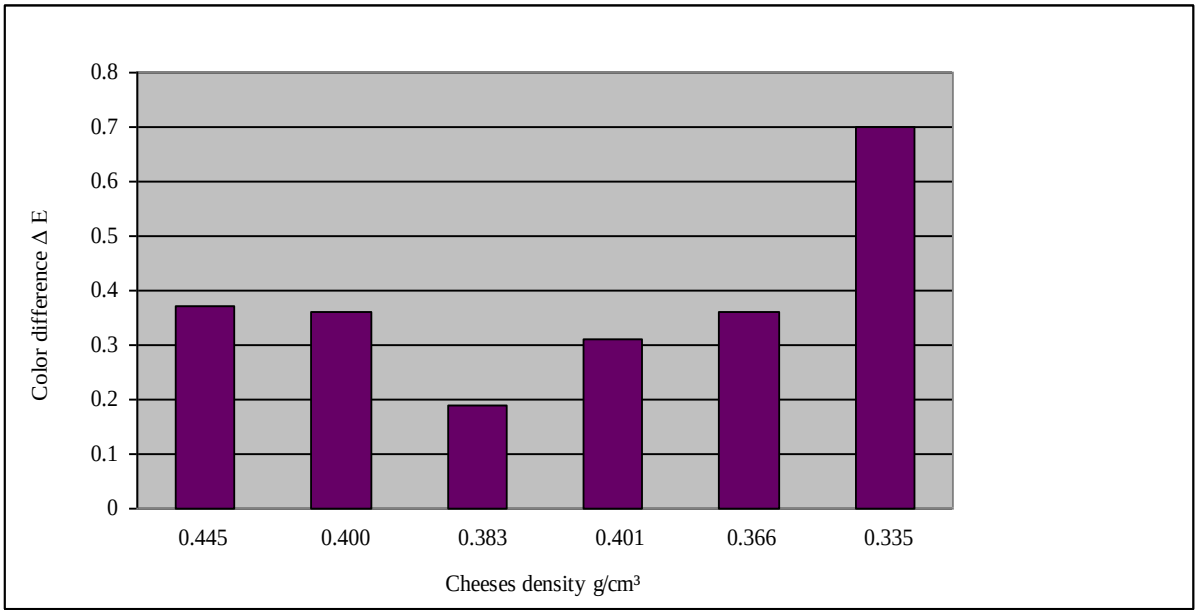

Figure 5 The effect of the cheese density g / cm³ on the ΔE

3-4- The effect of cheese density g / cm³ on color strength% and ΔE

Fig 4and table 5 show that the cheese density has a direct effect on the color strength % , where there is a inverse relationship between them and this relation depend on the variable weather it was tension or coil angle , the soft cheese is achieved whether by increasing coil angle values or decreasing tension values that leads to the easiness of dye spread and more absorption , cheeses no. (4,5 ,6) have extra dye absorption than the standard cheese and the cheeses no. (1, 2, 3) because the effect of the coil angle on the density is more than the effect of the tension, . Cheese 6 has the lowest density and the highest color strength % while cheese no. 1 has the highest density and the lowest color strength % .

.Fig 5 shows that the cheese density has an effect on the ΔE through the color strength % , where there is a direct relationship between cheese density and ΔE in the first three cheeses (1,2,3) where the variable is the tension , while there is an inverse relationship between them in the second three cheeses (4,5,6) where the variable is the coil angle, cheese 6 has the highest value of ΔE(color difference) because it has the highest value of the color strength % and it saturated and absorbed extra dye than the required limit

3-5 Fastness Properties

The durability of reactive dyes on knitted dyed fabrics at different numbers of cheeses was evaluated in term of fastness towards washing and light. Table 6 showed that the density of the yarn plays a determined role on the washing and light fastness of the dyed samples. It is clear that chees no 6 has the highest rating fastness towards washing and light, followed by cheese no 5. This may be arisen from the lower density of cheeses no 6 and 5 compared to the other samples. This lower density increase the dye penetration into the yarns, consequently,

decreases the dye accumulated on the surface of the yarn which lead to the washing off of the dyes in washing and decreases the resistance of the dye against the photo fading. Generally speaking, the washing fastness rating for all samples under investigation are ranged from excellent to very good, while the light fastness ranged from excellent to good.

Table 6. Fastness properties of knitted dyed cheeses

No of cheese	Washing fastness			Light fastness
	Alt.	Sc.	Sw.	
1	4	4	4	5
2	4	4-5	4-5	5
3	4	4-5	4-5	6
4	4-5	4-5	4-5	6
5	5	4-5	4-5	7
6	5	5	4-5	7

Alt. is the alteration, Sc is the staining on cotton, Sw is the staining on wool. a Washing fastness rating 1–5.bLight fastness rating 1**–8**

IV. CONCLUSION:

The study confirmed that the changing of tension and coil angles in the winding in the Open-end spinning leads to the existence of a relationship between tension and the yarn density of cheese where by increasing tension the yarn density of cheese increases , tension affect the color strength % where by increasing tension the color strength% decreases as a result of the increase of the cheese density , ΔE is affected by tension where by increasing tension the ΔE value increases and vice versa. .

There is an effect of the coil angle on the yarn density of cheese where by increasing the value of the coil angle the yarn density of yarn decreases and vice versa, the coil angle also affect the color strength% where by increasing the values of the coil angles the color strength% increase as a result of the decrease of cheese density, it also affect the ΔE where by increasing the values of the coil angles the ΔE increases and vice versa. ΔE increases because of the absorption of dye more than the required limit .The effect of the coil angle on the color strength% is more than the effect of tension on the color strength%.

In addition, the excellent fastness properties are relied to the decrease of density of examined cheeses. The possibility of using the resulted cheese from the winding of the Open-End spinning for direct dyeing instead of rewinding it to produce soft cheeses that leads to saving power, time and cost can be achieved.

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