138
384
THS

LIBRARY
Michigan State
University

PLACE IN RETURN BOX to remove this checkout from your record.
TO AVOID FINES return on or before date due.
MAY BE RECALLED with earlier due date if requested.

DATE DUE	DATE DUE	DATE DUE

6/07 p:/CIRC/DateDue.indd-p.1

MICHIGAN STATE UNIVERSITY

DISH TOWELING STUDY INCLUDING COTTON, COTTON AND RAYON BLENDS, LINEN AND RAMIE

Michigan State University
Department of Textiles, Clothing and Related Arts
Eleanor Mullikin

1958

THESIS
138
384
THS

TABLE OF CONTENTS

Introduction

Page

Purpose and Scope of Study 1
Procedures to be Followed 3
Test Methods 5

Evaluation of Test Data

Table 1 - Cost and Original Physical Properties of Test Fabrics 7
Table 2 - Original Breaking Strength Compared to Breaking Strength after Fifteen Launderings 8
Table 3 - Shrinkage in Laundering 9
Table 4 - Original Weight per Square Yard Compared to Weight per Square Yard After Five and Fifteen Launderings. . 1 . . 10
Table 5 - Original Absorbency Rate Compared to Absorbency Rates After Five and Fifteen Launderings 11
Sample - Toweling C-1, Original and After Fifteen Launderings 12
Cost, Physical Properties and Test Data - Fabric C-1 13
Evaluation of Test Data and Conclusions - Fabric C-1 14
Sample - Toweling C-2, Original and After Fifteen Launderings 18
Cost, Physical Properties and Test Data - Fabric C-2 19
Evaluation of Test Data and Conclusions - Fabric C-2 20
Sample - Toweling C-3, Original and After Fifteen Launderings 25
Cost, Physical Properties and Test Data - Fabric C-3 26
Evaluation of Test Data and Conclusions - Fabric C-3 27
Sample - Toweling CR-1, Original and After Fifteen Launderings 30
Cost, Physical Properties and Test Data - Fabric CR-1 31
Evaluation of Test Data and Conclusions - Fabric CR-1 32
Sample - Toweling CR-2, Original and After Fifteen Launderings 38

Page

Cost, Physical Properties and Test Data - Fabric CR-2 38
Evaluation of Test Data and Conclusions - Fabric CR-2 39
Sample - Toweling CR-3, Original and After Fifteen Launderings 43
Cost, Physical Properties and Test Data - Fabric CR-3 44
Evaluation of Test Data and Conclusions - Fabric CR-3 45
Sample - Toweling CR-4, Original and After Fifteen Launderings 48
Cost, Physical Properties and Test Data - Fabric CR-4 49
Evaluation of Test Data and Conclusions - Fabric CR-4 50
Sample - Toweling F-1, Original and After Fifteen Launderings 54
Cost, Physical Properties and Test Data - Fabric F-1 55
Evaluation of Test Data and Conclusions - Fabric F-1 56
Sample --Toweling F-2, Original and After Fifteen Launderings 60
Cost, Physical Properties and Test Data - Fabric F-2. 61
Evaluation of Test Data and Conclusions - Fabric F-2 62
Sample - Toweling R, Original and After Fifteen Launderings 65
Cost, Physical Properties and Test Data - Fabric R 66
Evaluation of Test Data and Conclusions - Fabric R 67

Conclusions

Summary and General Conclusions 71
Graph - Breaking Strength After Fifteen Launderings 76
Graph - Shrinkage 77

Related Literature

Review of Related Literature 78
Selected Bibliography 87

INTRODUCTION

PURPOSE AND SCOPE OF STUDY

The three groups, by fiber classification, of dish towelings selected for this study were representative of dish towelings found on the market in April of 1958. The study was initiated with the average homemaker's point of view on cost and serviceability in mind.

Group & type	Price per towel or linear yd.	Price per sq.yd.	Brand	Code No.
Cotton				
1 Printed	$ .44 yd.	$ .99	J.C. Penney	C-1
2 Crash	.25	.65	Cannon Kitchen	C-2
3 Crash	.15	.48	Cannon Dryfast	C-3
Cotton & Rayon				
1 Momie weave	.59	1.06	Kendall (Cunity)	CR-1
2 Momie weave	.39	.70	Cannon Magic-Dry	CR-2
3 Plain weave	.33	.45	Excello Rayton	CR-3
4 Basket var.	.10	.43	Japan-made	CR-4
Bast Fiber				
1 Linen (glass)	.49	1.10	Stevens	F-1
2 Linen crash	.39	.83	Stevens	F-2
3 Ramie	.33	.88	No infor.	R

This study was designed to compare the initial specifications of towelings in the three groups as well as their performance after 5 and 15 launderings, for changes in breaking strength, absorbency and dimensional stability. Conclusions are based upon changes

that occur as a result of laundering under controlled laboratory conditions. They do not pre-suppose changes which might occur in actual wear usage. In the final analysis, the towels will be evaluated in terms of cost and performance.

The emphasis placed upon certain properties considered desirable in dish toweling might vary with individuals. The property commonly considered most important is the ability of the toweling to absorb moisture. Durability, indicated by breaking strength and launderability properties are also considered important. Desirable, but of less importance, are resistance to shrinkage, low linting and a good "hand", that is softness or pliability.

PROCEDURES TO BE FOLLOWED

The evaluation of the towelings used in this study is to be predicated upon the initial properties of the fabrics and upon performance characteristics determined by laboratory testing. The initial properties to be evaluated include fiber content, yarn size, twist, yarns per inch and weight per square yard. Performance characteristics to be determined initially and after laundering are breaking strength, both wet and dry, rate of absorbency and dimensional change.

Rate of absorbency is to be determined both initially and after 5 and 15 launderings.

Breaking strength both dry and wet, for warp and filling is to be determined initially and after 15 launderings.

Dimensional change is to be caculated after 5, 10, and 15 launderings. Weight per square yard is to be determined initially, after 5 and 15 launderings.

There will be no attempt to determine amount of linting, staining or drying time in this study.

Evaluation of the data will include a comparison of the towelings on initial specifications and perfor-

mance characteristics. To aid this evaluation, each toweling will be given a rating of above average, average or below average on each of the performance characteristics including rate of absorbency, breaking strength and dimensional stability. The ratings will be based on a comparison of the towelings used in this study only. Data for a given characteristic will be tabulated for all towelings. Those towelings that group themselves in the middle range will be considered average. Those that are above this middle group will be designated above average and those below will be considered below average.

In the final analysis, an attempt will be made to compare the advantages and disadvantages of one toweling against the others and to make a recommendation relating this information to the cost of the particular toweling.

TEST METHODS

Methods for specification testing are in accordance with A.S.T.M. Standards.[1] Tests are to be carried out under standard conditions of 70 degree Fahrenheit temperature, plus or minus two degrees, and 65 percent relative humidity, plus or minus two percent. Test methods for performance characteristics including breaking strength and dimensional stability are to be in accordance with A.S.T.M. Standards. Rate of absorbency is to be determined by a modification of the Weirick test method, as described.

Fiber content - A.S.T.M. Designation D 276-37T PP. 73-82

Yarn size - Universal Yarn Numbering Balance Instructions for use

Twist direction and amount - A.S.T.M. Designation D39-49 Sec. 17, p. 175
Direction - A.S.T.M. Designation D123
Direct counting method A.S.T.M. Designation D1423-56T

Yarns per inch - A.S.T.M. Designation D39-40, Sec. 7 pp. 171-172

Weight per square yard - A.S.T.M. Designation D39-49 Sec. 6b, p. 171

Breaking Strength (raveled-strip method) - A.S.T.M. Designation D39-40, sec. 11 and 13, p. 173

---

[1] A.S.T.M. Standards on Textile Materials, American Society for Testing Materials, Philadelphia, Pa. 1957

Shrinkage - A.S.T.M. Designation D437-36. Modified in that a domestic, tumble-type washing machine was used.

Rate of Absorbency - Strips of fabric one inch in Width and ten inches in length were cut, both warp and filling directions. Each strip was suspended alongside a ruler with one inch immersed in the liquid. A water solution containing Calco identification stain was used so that the water level might be seen more readily. Measurement of the rise of the water was made from the level of the liquid. The heights to which the liquid rose in one and five minutes were recorded. An average of five specimens warp and filling was computed.

EVALUATION OF TEST DATA

Table 1. COST AND ORIGINAL PHYSICAL PROPERTIES OF TEST FABRICS

Group Classification and Fabric Number	Cost per sq. yd.	Weight per sq. yd.	Yarns per inch		Yarn number		Yarn Twist W	Yarn Twist F	Breaking Strength W		Breaking Strength F	
		ounces	W	F	W	F	Direction tpi	Direction tpi	Dry	Wet	Dry	Wet
Cotton												
C-1	$ .99	4.7	46	42	24	9	25Z	14Z	24	40	60	92
C-2	.65	5.2	39	29	14	8	16Z	9Z	64	82	41	60
C-3	.48	4.9	38	27	12	8	3Z	10Z	62	71	45	46
Cotton-Rayon Blend												
CR-1	1.06	6.1	125	65	23	19	22Z	23Z	94	59	48	31
CR-2	.70	6.3	121	63	22	20	22Z	22Z	67	53	32	35
CR-3	.45	4.3	54	49	19	17	29Z	23Z	29	34	23	34
CR-4	.43	3.6	70	33	19	22	25Z	18Z	50	24	28	18
Bast												
F-1*	1.10	6.4	30	26	15	16	11Z	11Z	91	175	98	147
F-2*	.83	8.7	26	21	11	9	8Z	12Z	121	162	78	141
R **	.88	4.9	65	38	46	37	15Z	13Z	117	153	77	112

* Towels made of flax fiber with small percent of cotton used in decorative thread
** Towels made of ramie

Table 2. ORIGINAL BREAKING STRENGTH COMPARED TO BREAKING STRENGTH AFTER FIFTEEN LAUNDERINGS

Group Classification and Fabric Number	Breaking Strength in pounds - Raveled-strip Method								Percent Change after 15 Launderings			
	Original				After 15 Launderings							
	Dry		Wet		Dry		Wet		Dry		Wet	
	W	F	W	F	W	F	W	F	W	F	W	F
Cotton												
C-1	27	60	40	92	35	70	38	82	+26	+17	-5	-11
C-2	64	41	82	60	55	46	65	56	-14	+12	-21	- 7
C-3	62	45	71	46	41	37	44	42	-35	-16	-38	-9
Cotton-Rayon Blend												
CR-1	94	48	59	31	77	58	60	43	-18	+20	+2	+39
CR-2	67	32	66	35	611	46	64	42	- 9	+44	-3	+20
CR-3	29	23	34	34	33	35	34	34	+14	+52	0	0
CR-4	50	28	24	18	44	17	24	7	-12	-36	-0	-61
Bast												
F-1*	91	98	175	147	79	72	156	126	-13	-27	-11	-14
F-2*	121	78	162	141	96	76	143	140	-21	-3	-12	-1
R **	117	77	153	112	114	97	82	70	-3	+26	-46	-38

* Towels made of flax fiber with small percent of cotton used in decorative thread
** Towels made of ramie
\+ Gain in strength
\- Loss in strength

Table 3. SHRINKAGE IN LAUNDERING

Group Classification and Fabric Number	Percent Shrinkage						Yarns Per Inch			
	5 Launderings		10 Launderings		15 Launderings		Original		15 Launderings	
	W	F	W	F	W	F	W	F	W	F
Cotton										
C-1	3.8	4.4	5.0	4.4	5.6	5.0	46	42	48	45
C-2	9.4	0	12.5	0	12.5	.6	39	29	39	33
C-3	11.9	.6	13.1	1.3	14.4	1.9	38	27	39	31
Cotton-Rayon Blend										
CR-1	6.3	13.8	5.6	13.8	6.9	15.6	125	65	139	76
CR-2	3.8	8.1	5.0	10.0	5.0	10.6	121	63	126	72
CR-3	3.1	0	3.1	0	5.0	.6	54	49	56	53
CR-4	6.9	7.5	8.1	10.6	9.4	12.5	70	33	77	36
Bast										
F-1*	5.6	4.4	6.9	4.4	8.1	6.3	30	26	32	29
F-2*	9.4	6.3	11.3	6.3	11.9	6.9	26	21	27	23
R **	5.6	2.5	6.3	2.5	6.2	2.5	65	38	67	42

* Towels made of flax fiber with small per cent of cotton used in decorative thread
** Towels made of ramie

Table 4. ORIGINAL WEIGHT PER SQUARE YARD COMPARED TO WEIGHT PER SQUARE YARD AFTER FIVE AND FIFTEEN LAUNDERINGS

Group Classification and Fabric Number	Weight per Square Yard, ounces		
	Original	After five Launderings	After fifteen Launderings
Cotton			
C-1	4.7	5.0	5.1
C-2	5.2	5.7	6.1
C-3	4.9	5.1	5.3
Cotton-Rayon Blend			
CR-1	6.1	7.4	8.0
CR-2	6.3	6.2	6.6
CR-3	4.3	4.3	4.8
CR-4	3.6	3.8	4.5
Bast			
F-1 *	6.4	7.1	7.5
F-2 **	8.7	9.9	10.7
R- **	4.9	5.4	5.2

* Towels made of flax fiber with small percent of cotton used in decorative thread

** Towels made of ramie

Table 5. Original Absorbency Rate Compared to Absorbency Rates After Five and Fifteen Launderings

Group Classification and Fabric Number	Rate of Absorbency, Inches											
	Original				After 5 Launderings				After 15 Launderings			
	1 minute		5 minutes		1 minute		5 minutes		1 minute		5 minutes	
	W	F	W	F	W	F	W	F	W	F	W	F
Cotton												
C-1	0	0	0	0	1-1/2	1-3/4	2-3/4	3	1-3/4	2	2-3/4	3-1/2
C-2	2	1-3/4	3-1/4	3	2	2	3-1/2	3-3/4	2	2	3-1/2	3-1/2
C-3	1	1-1/4	2-3/4	2-1/4	2	2	3-1/2	3-3/4	2	2	3-3/4	3-1/2
Cotton-Rayon Blend												
CR-1	2	1-1/2	3-1/4	2-1/2	2	2	3-3/4	3-3/4	1-3/4	1-1/2	3-1/4	2-1/2
CR-2	1-1/2	1	2-1/4	1-3/4	2-1/4	1-3/4	4-1/4	3-1/2	2-1/4	1-3/4	4	3-1/4
CR-3	0	0	1/2	1/2	1-3/4	2	3-1/4	3-1/2	2	2	3-1/2	3-3/4
CR-4	0	1/4	1/4	3/4	2-1/4	1-3/4	4	3	2-1/2	2-	4-1/4	3-1/4
Bast												
F-1*	0	0	0	0	1-1/2	1-1/2	2-1/2	2-1/4	1-1/2	1-1/2	2-1/2	2-3/4
F-2**	0	1/8	1/2	1/2	1-3/4	1-3/4	2-3/4	2-3/4	1-3/4	1-3/4	2-3/4	2-3/4
R	3/4	3/4	1-1/2	1-1/2	1-1/2	1-1/4	2-1/2	2	1-1/2	1-1/4	2-3/4	2-1/4

* Towels made of flax fiber with small percent of cotton used in decorative thread
** Towels made of ramie

Toweling C-1

Original

Toweling C-1

15 Launderings

COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC C-1

Cost per square yard	99¢	
Yarns per inch	Warp	Filling
Original	46	42
After 15 launderings	48	45
Yarn number	Warp	Filling
	24	9
Yarn twist and direction	Warp	Filling
	25Z	14Z
Weight per square yard (ounces)		
Original	4.7	
After 5 launderings	5.0	
After 15 launderings	5.1	
Shrinkage in Laundering (percent)	Warp	Filling
After 5 launderings	3.8	4.4
After 10 launderings	4.0	4.4
After 15 launderings	5.6	5.0
Breaking Strength (pounds)	Warp	Filling
Original		
Dry	24	60
Wet	40	92
After 15 launderings		
Dry	35	70
Wet	38	82
% Change after 15 launderings		
Dry	26	17
Wet	- 5	-11
Absorbency (rate in inches)	Warp	Filling
Original		
one minute test	0	0
five minute test	0	0
After 5 launderings		
one minute test	1-1/2	1-3/4
five minute test	2-3/4	3
After 15 launderings		
one minute test	1-3/4	2
five minute test	2-3/4	3-1/2

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC C-1

Original Physical Properties

Toweling C-1, a coton crash was found to be nearly balanced in construction with 46 yarns per inch in the warp and 42 in the filling. This number is above the minimum Federal Specification for cotton crash of 39 yarns per inch in the warp and 29 in the filling directions. The number is slightly under the Federal Specification for cotton toweling to be used for glassware of 54 in the warp and 38 in the filling directions. Toweling C-1 was fairly expensive and is printed with a pattern. It might be considered a toweling intended for glassware.

The original weight of 4.7 ounces per square yard approaches the Federal standard of 5.1 minimum for cotton toweling intended for use on glassware.

A very fine yarn was used in the warp, number 24, and a heavy yarn, number 9 in the filling. This was the finest yarn used in the seven toweling fabrics of cotton or a cotton blend. The warp had a twist of 25Z compared to 14Z in the filling. This is a relatively high warp twist, the range for the towelings tested being from 3 to 29. The high twist in the warp was used perhaps to give added strength to the fine yarn.

Dimensional Stability

Toweling C-1 showed a shrinkage of 3.8% in the warp and 4.4% in the filling after five launderings. This is well below the American Standard Minimum Performance Requirements for Institutional Textiles L24.2.2 which allows a maximum shrinkage of 14% in the warp and 5% in the filling after five launderings. When the shrinkage was compared with the other fabrics after 15 launderings, the shrinkage of 5.6% in the warp and 5.0 in the filling placed the toweling third for minimum warp shrinkage and fifth for filling shrinkage.

Breaking Strength

Federal specifications for breaking strength are based on the grab method rather than the raveled-strip method used in this study. Therefore, a direct comparison cannot be made. The standard for the grab method requires a minimum breaking strength dry and wet of 50 pounds in the warp and 40 pounds in the filling for cotton crash. Cotton toweling for glassware has a standard of 50 pounds both warp and filling.

The original dry strength of toweling C-1, 27 pounds in the warp, was the lowest of the ten towels. The filling strength of 60 pounds was average. The

original wet strength of 40 pounds in the warp also placed it in the below average group. An original filling wet strength of 92 pounds placed the toweling fourth in filling wet strength.

Toweling C-1 was 26% higher in dry breaking strength in the warp direction after 15 launderings and 17% higher in the filling direction. However, the warp strength of 35 pounds was still below average being next to the lowest of the towelings. The dry filling strength of 70 pounds was average. After 15 launderings, the wet breaking strength in the warp direction was 5% lower and the filling strength 11% lower. Thus, the toweling remained in the below average group for warp strength, but because of the original high wet breaking strength in the filling and slight loss, it placed above average for filling set wtrength.

Rate of Absorbency

In the test for rate of absorbency, toweling C-1 recorded a rise of 2-3/4 inches in the warp and 3-1/2 inches in the filling after 5 minutes compared with the Federal Specification minimum standard of 2-3/8 inches. Compared with the other 9 towelings, C-1 placed in the average group warpwise and above average group fillingwise. The one minute test showed similar results with the rise in the warp considered average and the rise in the filling direction above average.

Conclusions - Fabric C-1

Toweling C-1, a fine cotton would be in the high price group of the towels tested, being third from the highest in price.

Rate of absorbency, in the ten towelings tested, ranged fairly close. None fell in the below average group. Compared with the other 9 towelings tested, C-1 was average in absorbency in the warp and above average in the filling after 15 launderings in both the one and five minute tests.

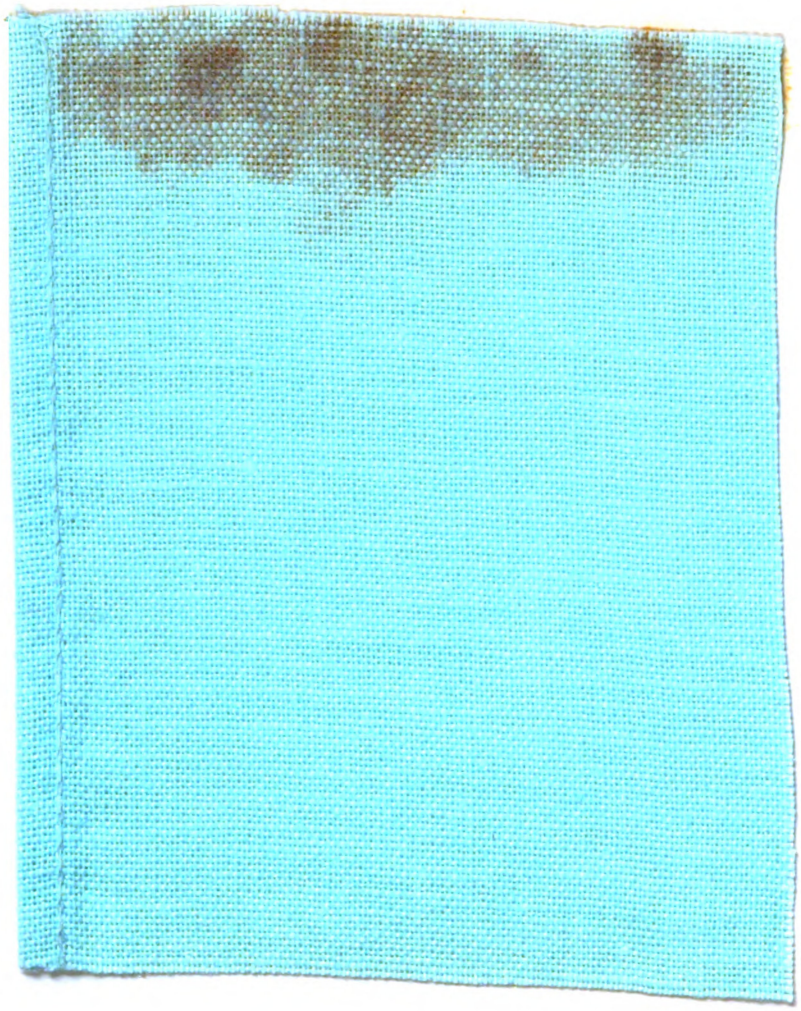
After 15 launderings, the dry breaking strength was below average in the warp and average in the filling when compared with the other towelings tested. The wet breaking strength of the warp was also below average and the filling wet strength above average.

Dimensional stability was above average in the warp and at the top of the average group for the filling.

Absorbency and breaking strength being the performance characteristics of primary consideration in toweling, it would appear that the breaking strength of toweling C-1 is unsatisfactory. In relation to the other towelings, this makes it a particularly poor buy as it was in the high price range.

Toweling C-2

Original



Toweling C-2

15 Launderings

COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC C-2

Cost per square yard	65¢	
Yarns per inch	Warp	Filling
Original	39	29
After 15 launderings	39	33
Yarn number	Warp	Filling
	11	8
Yarn twist and direction	Warp	Filling
	16Z	9Z
Weight per square yard (ounces)		
Original	5.2	
After 5 launderings	5.7	
After 15 launderings	6.1	
Shrinkage in Laundering (percent)	Warp	Filling
After 5 launderings	9.4	0
After 10 launderings	12.5	0
After 15 launderings	12.5	.6
Breaking Strength (pounds)	Warp	Filling
Original		
Dry	64	41
Wet	82	60
After 15 launderings		
Dry	55	46
Wet	65	56
% Change after 15 launderings		
Dry	-14	12
Wet	-21	-7
Absorbency (rate in inches)	Warp	Filling
Original		
One minute test	2	1-3/4
Five minute test	3-1/4	3
After 5 launderings		
One minute test	2	2
Five minute test	3-1/2	3-3/4
After 15 launderings		
One minute test	2	2
Five minute test	3-1/2	3-1/2

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC C-2

Original Physical Properties

Fabric C-2, a cotton crash, was found to be a nearly balanced fabric with 39 yarns per inch in the warp and 29 yarns per inch in the filling. This yarn count is comparable to the minimum standards for cotton crash set in Federal Specification DDD-T-511a of 38 yarns per inch in the warp and 30 in the filling.

The original weight per square yard of 5.2 ounces nearly meets the Federal Specification of 5.8 ounces for cotton crash.

A number 11 yarn was used in the warp and a slightly heavier yarn, a number 9 in the filling. Number 8 and 9 yarns were the heaviest used in the towelings tested and were used for the filling in four of the ten towelings. The twist of 16Z in the warp and 9Z in the filling is a relationship often found in toweling. Greater twist is used in the warp for strength and a lower twist in the filling for increased absorbency.

Dimensional Stability

Toweling C-2 showed a shrinkage of 9.4 percent in the warp after five launderings. This is within the American Standard Minimum Performance Requirements for Institutional Textiles L24.2.2 which al-

lows a maximim shrinkage of 14% in the warp and 5% in the filling after five launderings. Shrinkage in this fabric was nominal filling direction. However, shrinkage was progressive in the warp and after 15 launderings, totaled 12.5%. Although this amount of shrinkage is within the above mentioned standard, only one other toweling in the ten tested had a greater warp shrinkage after 15 launderings. Filling shrinkage after 15 launderings was.6% making this toweling one of the two lowest in filling shrinkage.

Breaking Strength

Federal specifications for breaking strength are based on the grab method rather than the raveled-strip method used. Therefore, a direct comparison cannot be made. The standard for the grab method requires a minimum breaking strength dry and wet of 50 pounds in the warp and 40 pounds in the filling for cotton crash.

The original dry strength of toweling C-2, 64 in the warp and 41 in the filling put it in the middle range of the ten towelings tested both for warp and filling. The original wet warp strength of 82 and filling strength of 60 again put this toweling in the middle range for wet strength. Breaking stren-

gth was slightly higher in the direction of the warp than in the filling, placing it fourth out of ten.

Toweling C-2 was 14% lower in dry warp strength after 15 launderings but the filling dry strength was 12% higher. This reflects the high warp shrinkage and consequent increase in number of yarns per inch in the filling. In wet strength, this toweling was 21% lower in the warp and 7% lower in the filling. The lower loss in the filling again reflects the increase in number of yarns per inch. When the dry strength after 15 launderings of 55 pounds warp and 46 pounds filling is compared with the other nine towelings, it ranks only sixth, but the wet strength after 15 launderings places it fourth warp direction and fifth filling direction.

Rate of Absorbency

Fabric C-2 would be considered above average in rate of absorbency when the rise of 3-1/2 inches both warp and filling directions is compared with the Federal Specification minimum standard of 2-3/8 inches in five minutes. Only one of the ten fabrics tested had a slightly greater rate of absorbency in the filling and three of the ten a greater rate in the warp. The one minute test resulted in a rise of 2 inches both warp and filling. This is also above average.

Absorbency during the first few minutes is important in a dish toweling fabric. Five of the ten towelings tested reached this same level in the warp direction and only two of the ten, reached a slightly higher level in the warp direction in one minute.

Conclusions - Fabric C-2

Toweling C-2, a cotton crash falls in the medium price range of the towelings tested.

It was above average in absorbency, both warp and filling in one and five minute tests. This rating is based on performance after the 15 launderings.

Breaking strength after 15 launderings compared with the other nine towelings tested, was average both dry and wet in warp and filling.

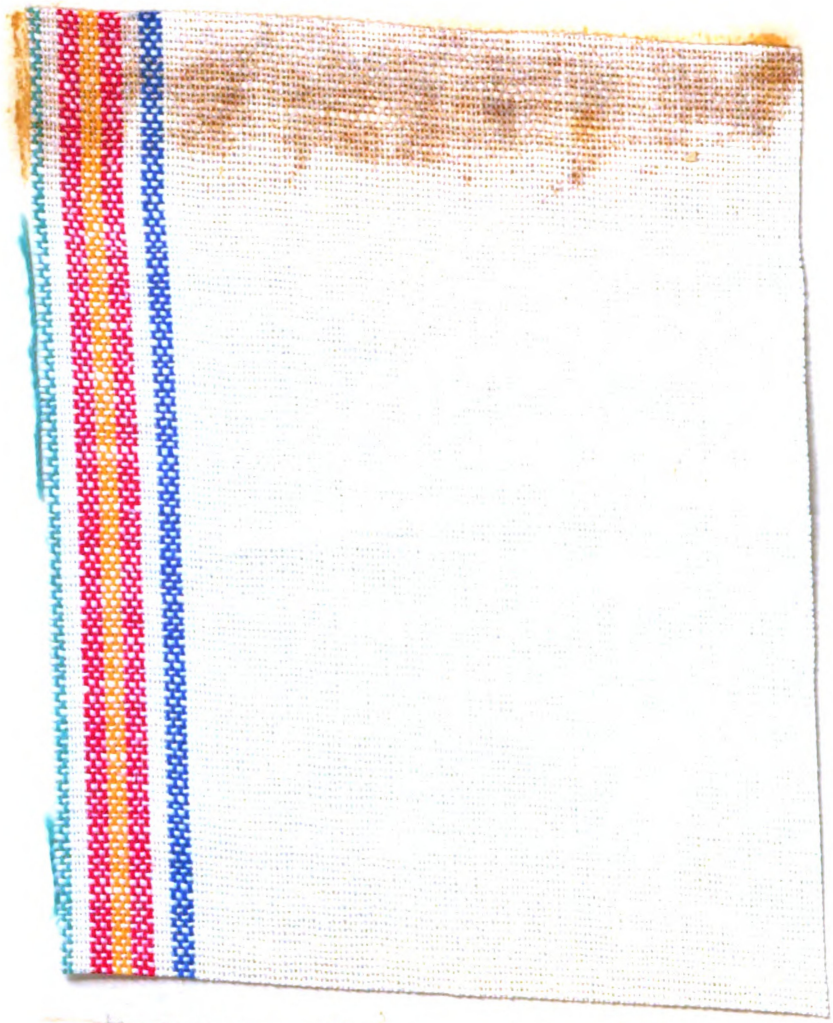
Dimensional stability would be considered only fair. Although shrinkage was above average in the filling direction, it was below average in the warp direction when compared with the other towelings.

This toweling might be acceptable in yardage since it has above average absorbency and average strength. A disadvantage in buying readymade towels of this fabric is the 12.5% shrinkage in the warp.

The towels originally measured 30 inches in length. Some feel 25-30 inches is a minimum for dish towels. After laundering 15 times, these towels would be approximately 26 inches in length.

Toweling C-3

Original



Toweling C-3

15 Launderings

COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC C-3

Cost per square yard	48¢	
Yarns per inch	**Warp**	**Filling**
Original	38	27
After 15 launderings	39	31
Yarn number	**Warp**	**Filling**
	12	8
Yarn twist and direction	**Warp**	**Filling**
	3Z	10Z
Weight per square yard (ounces)		
Original	4.9	
After 5 launderings	5.1	
After 15 launderings	5.3	
Shrinkage in Laundering (percent)	**Warp**	**Filling**
After 5 launderings	11.9	.6
After 10 launderings	13.1	1.3
After 15 launderings	14.4	1.9
Breaking Strength (pounds)	**Warp**	**Filling**
Original		
Dry	62	45
Wet	71	46
After 15 launderings		
Dry	41	37
Wet	44	42
% Change after 15 launderings		
Dry	-35	-16
Wet	-38	- 9
Absorbency (rate in inches)	**Warp**	**Filling**
Original		
One minute test	1	1-1/4
Five minute test	2-3/4	2-1/4
After 5 launderings		
One minute test	2	2
Five minute test	3-1/2	3-3/4
After 15 launderings		
One minute test	2	2
Five minute test	3-3/4	3-1/2

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC C-3

Original Physical Properties

Fabric C-3, a cotton crash was found to be a nearly balanced fabric with 38 yarns per inch in the warp and 27 yarns per inch in the filling. This yarn count is nearly comparable to the minimum standard for cotton crash set in Federal Specification DDD-T-511a of 38 yarns per inch in the warp and 30 in the filling.

The original weight per square yard of 4.9 is nearly one ounce under the above standard of 5.8 for cotton crash.

The yarn number of 12 for the warp and 8 for the filling places this toweling with the two heaviest of the seven cotton and cotton and rayon blends tested. The warp twist of 3Z is extremely low, the filling twist of 10Z average.

Dimensional Stability

Toweling C-3 showed a shrinkage of 11.9% in the warp after five launderings and a very nominal shrinkage in the filling. This amount of shrinkage is within the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2, which allows a maximum shrinkage of 14% in the warp and 5%

in the filling after five launderings. However, the toweling shrank progressively in the warp direction and after 15 launderings had a total shrinkage of 14.4% in the warp direction. Toweling C-3 had the highest shrinkage in the warp of the ten towelings tested. Shrinkage in the filling after 15 launderings was only .9% which is lower than the average of the towelings tested.

Breaking Strength

Federal specifications for breaking strength are based on the grab method rather than the raveled-strip method used. Therefore, a direct comparison cannot be made. The standard for the grab method requires a minimum breaking strength dry and wet of 50 pounds in the warp and 40 pounds in the fillingfor cotton crash.

The original dry strength of toweling C-3, 52 pounds in the warp and 45 pounds in the filling, was average in comparison with the other nine towelings. The original wet warp strength of 71 and filling strength of 46 was also average.

Toweling C-3 was lower in strength both dry and wet after 15 launderings as follows - dry warp 35%, dry filling 16%, wet warp 38% and wet filling 9%. The relatively high loss in strength put this fabric in

the below average group in wet and dry warp strength and dry filling strength when compared with the other nine towelings. Only in wet filling strength, did it fall in the lowest portion of the average group. In three instances, it was third from the bottom of the towelings in breaking strength.

Rate of Absorbency

Fabric C-3 had an above average rate of absorbency with a rise of 3-3/4 inches in the warp and 3-1/2 inches in the filling in five minutes. The Federal Specification minimum standard is 2-3/8 inches in five minutes. Only two of the towelings tested had a greater rate of absorbency in the warp and only one in the filling direction. During the one minute test, a rise of 2 inches both warp and filling was recorded. This is also above the average of the towelings tested.

Conclusions - Fabric C-3

Toweling C-3, a cotton crash, would be in the low price group of the towelings tested. It was a colored towel and retained its color after the 15 launderings.

This toweling was above average in absorbency both warp and filling in both one and five minute tests after 15 launderings.

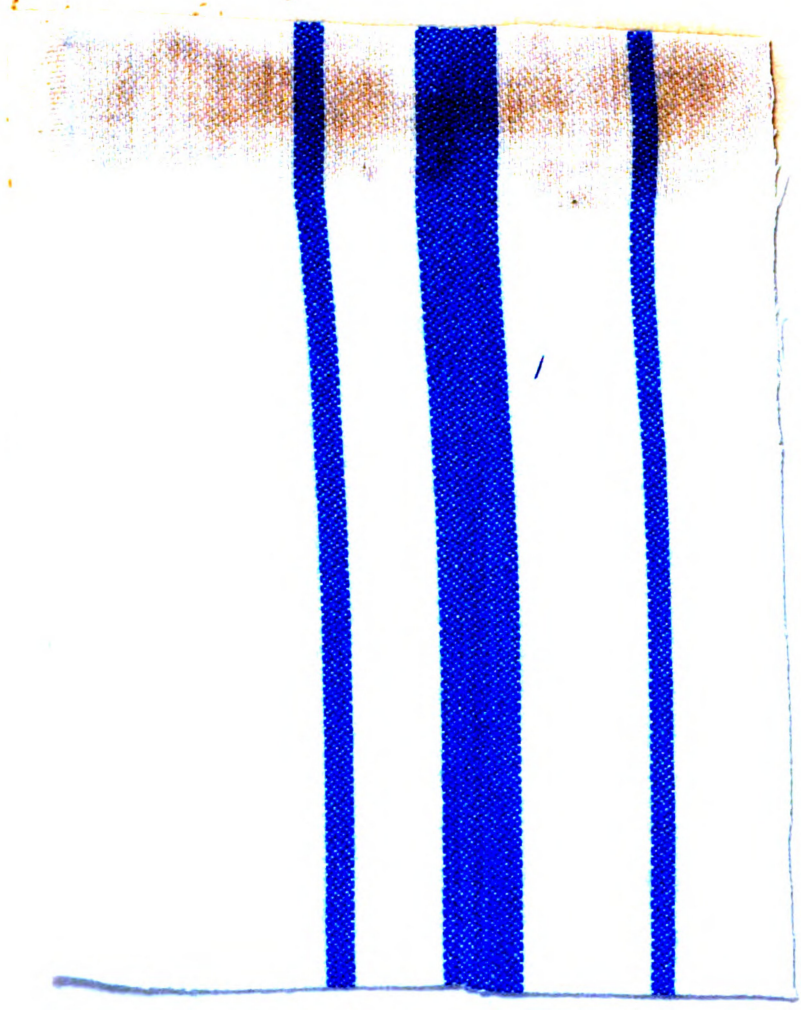
Breaking strength after 15 launderings, was below the average of the other nine towels tested in wet and dry warp strength and dry filling strength. This toweling fell at the bottom of the average group in wet filling strength.

Toweling C-3 had the highest shrinkage in the warp of the ten towelings tested. Filling shrinkage was nominal. This fabric was purchased in ready-made towels which were only 26 inches in length when purchased. After 15 launderings, they would be approximately 22 inches in length. This is considerably under the 28-30 inch length considered satisfactory for dish towels.

Although toweling C-3 was in the low price group and was above average in absorbency, the unsatisfactory breaking strength and excessive shrinkage in the warp direction make it a poor value.

Toweling CR-1

Original



Toweling CR-1

15 Launderings

COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC CR-1

Cost per square yard	$1.06	
Yarns per inch	Warp	Filling
Original	125	65
After 15 launderings	139	76
Yarn number	Warp	Filling
	23	19
Yarn twist and direction	Warp	Filling
	22Z	23Z
Weight per square yard (ounces)		
Original	6.1	
After 5 launderings	7.4	
After 15 launderings	8.0	
Shrinkage in Laundering (percent)	Warp	Filling
After 5 launderings	6.3	13.8
After 10 launderings	5.6	13.8
After 15 launderings	6.9	15.6
Breaking strength (pounds)	Warp	Filling
Original		
Dry	94	48
Wet	59	31
After 15 launderings		
Dry	77	58
Wet	60	43
% Change after 15 launderings		
Dry	-18	20
Wet	2	39
Absorbency (rate in inches)	Warp	Filling
Original		
One minute test	2	1-1/2
Five minute test	3-1/4	2-1/2
After 5 launderings		
One minute test	2	2
Five minute test	3-3/4	3-3/4
After 15 launderings		
One minute test	1-3/4	1-1/2
Five minute test	3-1/4	2-1/2

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC CR-1

Original Physical Properties

Fabric CR-1, a cotton and rayon blend was found to have approximately twice as many yarns per inch in the warp, 125, as in the filling, 65. This was due to the weave construction which was a type of momie weave.

The original weight per square yard was 6.1 ounces which is heavier than any of the cotton crash tow-elings.

The yarns used were light in weight with a number 23 in the warp and a number 19 in the filling. The yarns were given a high twist of 22Z in the warp and 23Z in the filling.

Dimensional Stability

Toweling CR-1 showed a shrinkage of 6.3% in the warp and 13.8% in the filling after 5 launderings. The warp shrinkage is just within the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2, which allows 14% in the warp but is considerably over the 5% minimum perforance allowed for the filling. This toweling shrank progressively and after 15 launderings, had the highest shrinkage fillingwise of the ten towels tested with 15.6%. This places it definitely below average in filling

dimensional stability. The warp shrinkage at this interval, 6.9, was average for the ten towels tested.

Breaking Strength

The presence of rayon was apparent in the difference between dry and wet breaking strength. The original dry breaking strength in the warp was 94 compared with a wet strength in the warp of 59. The filling dry strength of 48 compared with 31 pounds wet.

Breaking strength after 15 launderings was higher in the filling, both dry 20% and wet 39%, with a slightly higher warp wet strength. The warp dry strength was lower than the original strength. The higher breaking strength is due to the excessive shrinkage that occured in this toweling. The number of warp yarns had increased after the 15 launderings by 14 over the original number and the number of filling yarns had increased by 11. In comparison with the other nine towelings, CR-1 was in the middle group for breaking strength, both warp and filling wet and dry, giving it an average rating.

Rate of Absorbency

Toweling CR-1 was above the Federal Specification minimum standard of 2-3/8 inches with a rise of

3-1/4 inches in the warp direction and 2-1/2 inches in the filling in five minutes. In comparison with the other towelings tested, this toweling rated average in the warp and average in the filling. Toweling CR-1 recorded a greater rate of absorbency after the fifth than after the fifteenth laundering. In the one minute test, a rise of 1-3/4 inches was recorded for the warp and 1-1/2 inches for the filling. This was average in comparison with the other towelings.

Conclusions - Fabric CR-1

Toweling CR-1, a cotton and rayon blend, was next to the highest in price of the ten towelings tested.

After 15 launderings, CR-1 rated above average in the warp and average in the filling when rate of absorbency was compared with the other nine fabrics in the five minute test. This toweling rated average both warp and filling in the one minute test. The fact that it was more absorbent after five than after fifteen launderings, indicates that as high shrinkage occured in the filling, the fabric became more compact and less absorbent.

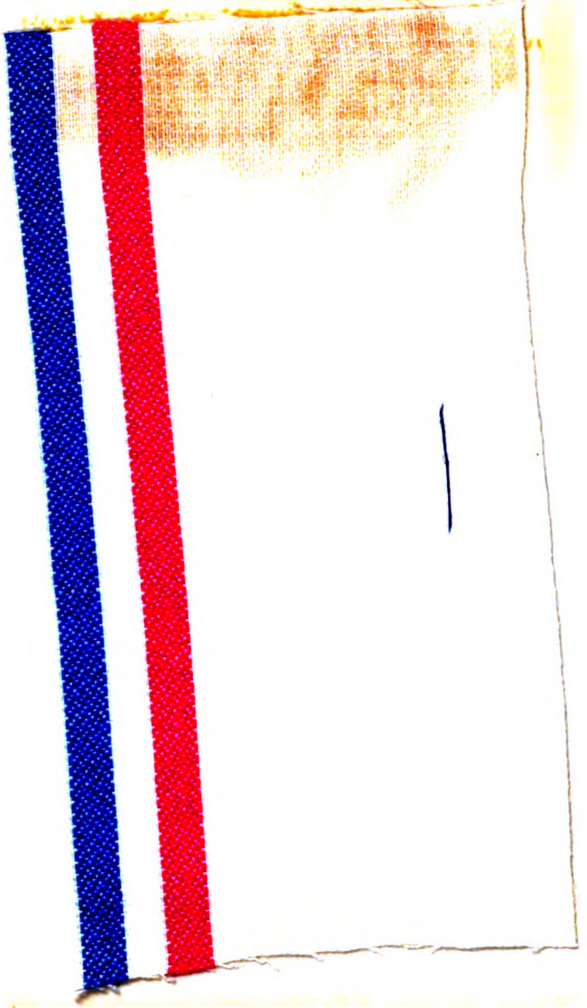
When compared with the other towelings for breaking strength after 15 launderings, CR-1 fell in the middle group, dry and wet warp and filling. Therefore it received an average rating.

Toweling CR-1 had the highest shrinkage in the filling of the towelings tested. The warp shrinkage was average. Although this towel was adequate in size after shrinkage occured, the excessive shrinkage seemed to affect absorbency adversely.

Considering all factors, with breaking strength only average, it appears the cost of this towel is not justifiable.

Toweling CR-2

Original



Toweling CR-2

15 Launderings

COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC CR-2

Cost per square yard	70¢	
Yarns per inch	Warp	Filling
Original	121	63
After 15 launderings	126	72
Yarn number	Warp	Filling
	22	20
Yarn twist and direction	Warp	Filling
	22Z	22Z
Weight per square yard (ounces)		
Original	6.3	
After 5 launderings	6.2	
After 15 launderings	6.6	
Shrinkage in Laundering (percent)	Warp	Filling
After 5 launderings	3.8	8.1
After 10 launderings	5.0	10.0
After 15 launderings	5.0	10.6
Breaking strength (pounds)	Warp	Filling
Original		
Dry	67	32
Wet	66	35
After 15 launderings		
Dry	61	46
Wet	64	42
% Change after 15 launderings		
Dry	- 9	44
Wet	14	32
Absorbency (rate in inches)	Warp	Filling
Original		
One minute test	1-1/2	1
Five minute test	2-1/4	1-3/4
After 5 launderings		
One minute test	2-1/4	1-3/4
Five minute test	4-1/4	3-1/2
After 15 launderings		
One minute test	2-1/4	1-3/4
Five minute test	4	3-1/4

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC CR-2

Original Physical Properties

Fabric CR-2, a cotton and rayon blend, was found to have approximately twice as many yarns per inch in the warp as in the filling with 121 and 63 respectively. The weave construction was a type of momie weave similar to that of CR-1.

The original weight per square yard was 6.3 ounces, which was similar to CR-1 and heavier than any of the cotton crash towelings.

The yarns used were light in weight as were those used in CR-1 with a number 22 warp and number 20 filling. The yarns were given a high twist as was true of CR-1 with 22Z both warp and filling.

Dimensional Stability

Toweling CR-2 showed a shrinkage of 3.8% in the warp and 8.1% in the filling after 5 launderings. The warp shrinkage was within the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2 which allows 14% in the warp. Filling shrinkage is considerably over the 5% standard. Shrinkage was progressive and after 15 launderings, 5.0% had occured in the warp and 10.6% in the filling. Compared with the other nine

this toweling ranked with one other in having the lowest shrinkage in the warp but it had the third highest filling shrinkage. It was below the average of the other towelings tested in shrinkage in the direction of the filling and only slightly better than toweling CR-1 a similar fabric.

Breaking Strength

Wet breaking strength was not appreciably lower in toweling CR-2 as it was in toweling CR-1. The original dry breaking strength in the warp was 67 pounds, compared to 66 pounds wet, and in the filling, the dry strength of 32 compared with 35 wet.

There was an increase in breaking strength after 15 launderings, in the direction of the filling both dry and wet of 44% and 32%, respectively. The wet warp strength was 14% higher but the dry strength was 9% lower. The increased strength is due to the comparatively high shrinkage in this toweling. The number of warp yarns had increased after the 15 launderings by 5 and the filling yarns by 9 over the original number. Comparing breaking strength with the other nine towelings tested, CR-2 fell in the middle group, wet and dry warp and filling, giving it an average rating.

Rate of Absorbency

Toweling CR-2 was well above the Federal Specification minimum standard of 2-3/8 inches, with a rise of 4 inches in the warp direction and 3-1/4 in the filling in five minutes. In comparison with the other towelings tested, it was next to the top one in absorbency in the warp and rated above average in the filling. Records of the one minute test again showed this toweling next to the top in warp absorbency but five of the ten towelings had a slightly greater absorbency in the filling.

Conclusions - Fabric CR-2

Toweling CR-2, a cotton and rayon blend, falls in the middle price group of the towelings tested.

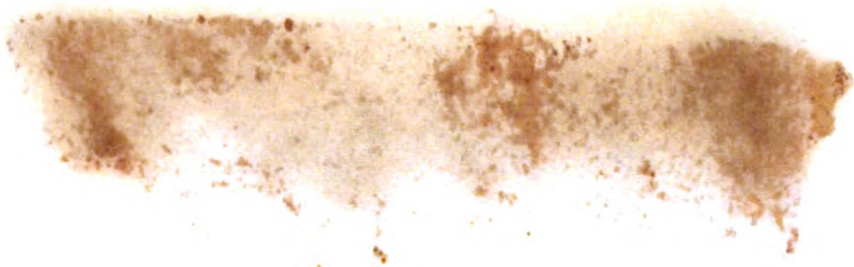
After 15 launderings, it was next to the top in warp absorbency and also in the above average group for the filling. In the one minute test, it also rated next to the top in warp absorbency but average in filling absorbency.

When breaking strength was compared with the other nine towelings tested after the 15 launderings, CR-2 fell in the middle group dry and wet, warp and filling giving it an average rating.

This toweling ranked with one other in having the lowest warp shrinkage, but it had the third highest filling shrinkage. This was below average in

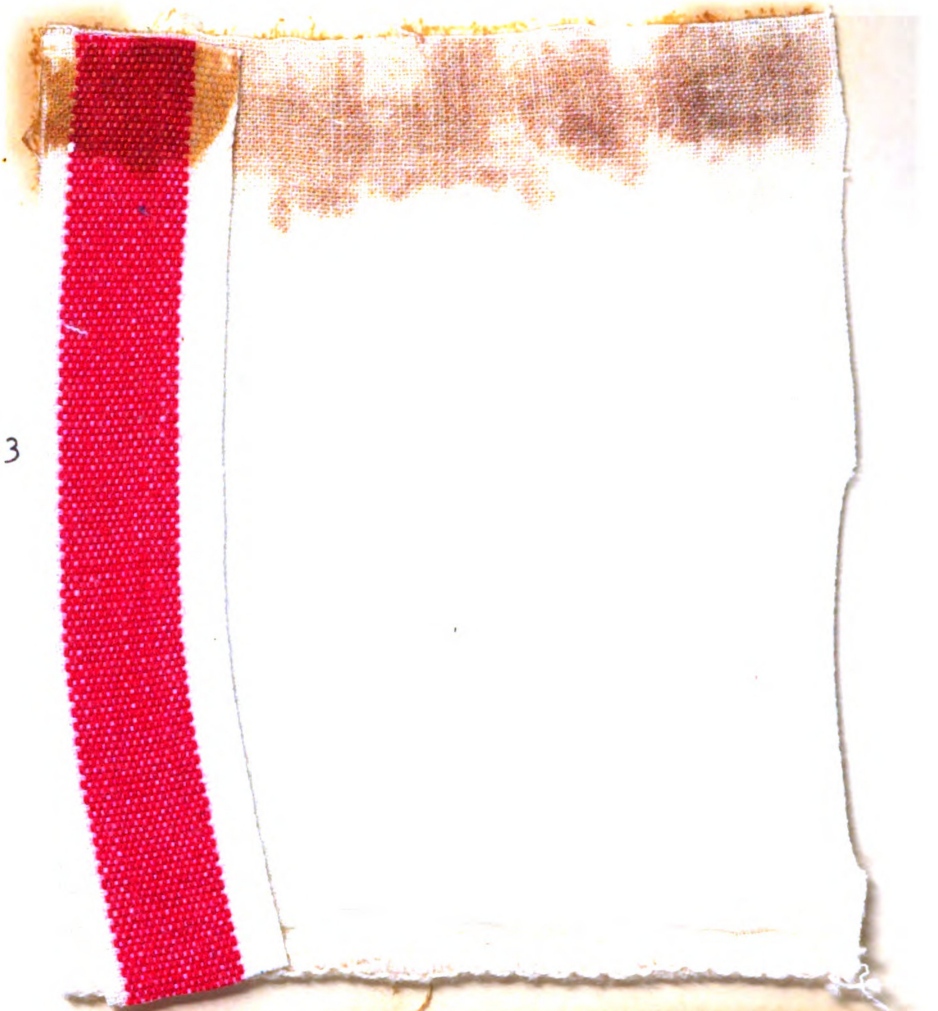
comparison with the other toweling. Because CR-2, a readymade towel, was large in size originally, this would not be disasterous.

Toweling CR-2 would be a better value than CR-1, a similar toweling. For a medium price, it offered above average absorbency and average strength. This toweling appears to be a fairly good buy. It would be interesting to see how it rated on other properties not tested, such as absence of linting, claimed for rayon blends, and drying time.



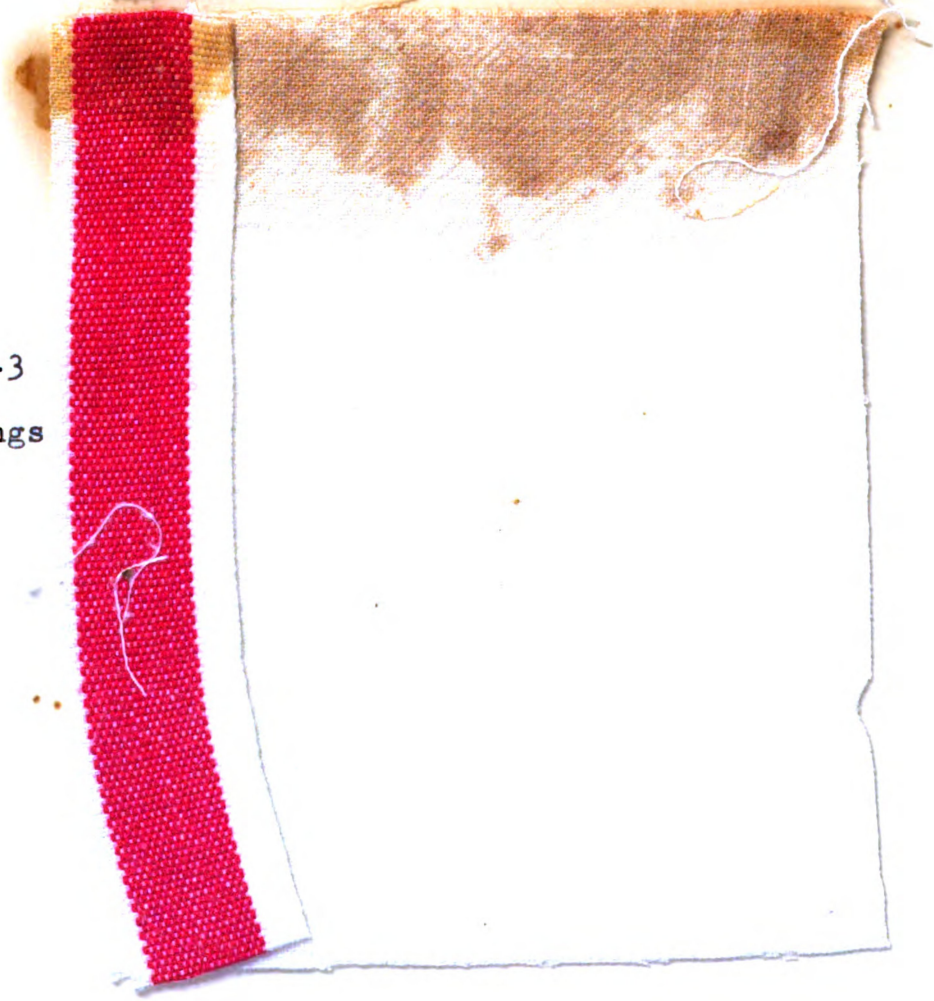
Toweling CR-3

Original



Toweling CR-3

15 Launderings



COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC CR-3

Cost per square yard	45¢	
Yarns per inch	Warp	Filling
Original	54	49
After 15 launderings	56	53
Yarn number	Warp	Filling
	19	17
Yarn twist and direction	Warp	Filling
	29Z	23Z
Weight per square yard (ounces)		
Original	4.3	
After 5 launderings	4.3	
After 15 launderings	4.8	
Shrinkage in Laundering (percent)	Warp	Filling
After 5 launderings	3.1	0
After 10 launderings	3.1	0
After 15 launderings	5.0	.6
Breaking strength (pounds)	Warp	Filling
Original	29	23
Dry		
Wet	34	34
After 15 launderings		
Dry	33	35
Wet	34	34
% Change after 15 launderings		
Dry	14	52
Wet	0	0
Absorbency (rate in inches)	Warp	Filling
Original		
One minute test	0	0
Five minute test	1/2	1/2
After 5 launderings		
One minute test	1-3/4	2
Five minute test	3-3/4	3-1/2
After 15 launderings		
One minute test	2	2
Five minute test	3-1/2	3-3/4

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC CR-3

Original Physical Properties

Fabric CR-3, a blend of two-thirds cotton and one-third rayon, was found to be nearly balanced with 54 yarns per inch in the warp and 49 yarns per inch in the filling. It was a light weight fabric with 4.3 ounces per square yard.

A fairly lightweight yarn was used both warp and filling, with a number 19 in the warp and 17 in the filling. The yarns were given a very high twist of 29Z in the warp and 23Z in the filling.

Dimensional Stability

Toweling CR-3 had the lowest shrinkage of any toweling, with 5.0% in the warp and .6% in the filling.

Breaking Strength

CR-3 was below average in original dry breaking strength, both warp and filling, with 29 and 32 pounds respectively. This toweling was also below average in original wet strength both warp and filling with 34 pounds in each direction. Wet strengthafter 15 launderings remained exactly the same, but the dry strength was 14% higher in the warp and 52% higher in the filling. However, in com-

parison with the other nine towelings tested, Cr-3 was still well below average. It was the lowest of the ten, in dry warp strength and next to the lowest in dry filling strength. Wet strength after 15 launderings, was also next to the lowest, both warp and filling directions.

Rate of Absorbency

Toweling CR-3 was above average in absorbency, with a rise of 3-1/2 inches in the warp and 3-3/4 in the filling in five minutes. This amount is well over the Federal Specification minimum standard of 2-3/8 inches in five minutes. CR-3 had the greatest absorbency in the filling and ranked third from the top in warp absorbency. This toweling ranked with several others at the top in both warp and filling absorbency in the one minute test.

Conclusions - Fabric CR-3

Toweling CR-3, a cotton and rayon blend, fell in the low price group of the towelings tested.

After 15 launderings, it was above average in absorbency for warp and filling in both the one and five minute tests.

This toweling was the lowest of the ten in dry warp strength and next to the lowest in dry filling strength after 15 launderings. It was also

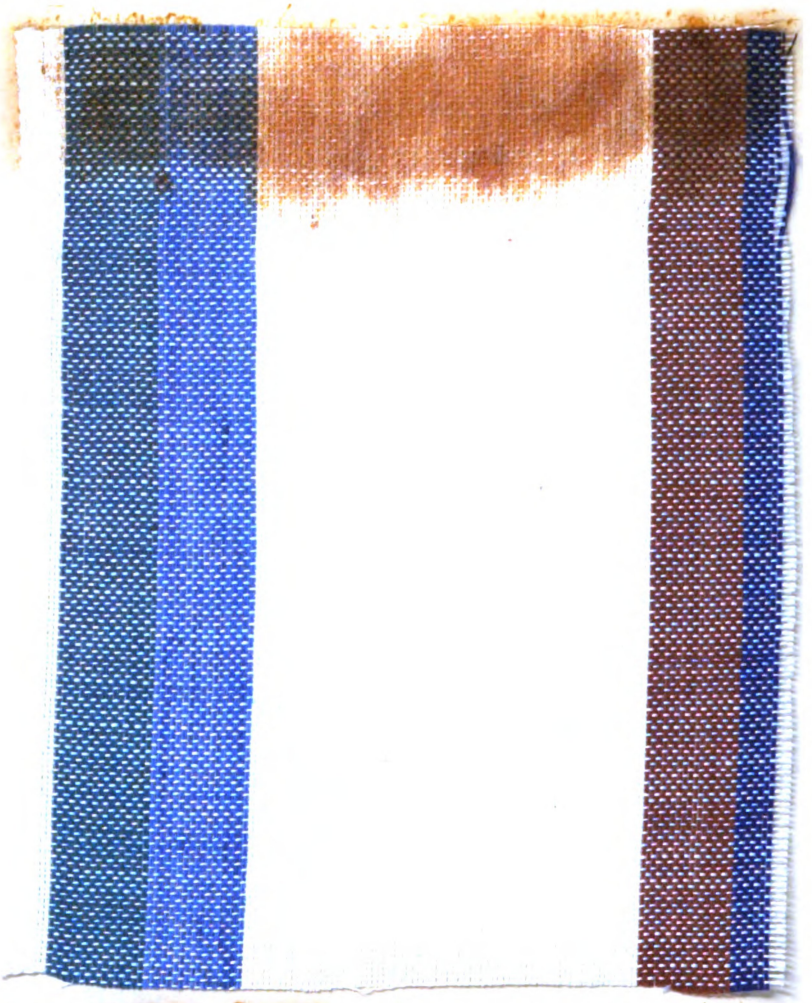
next to the lowest in wet strength both warp and filling. Thus it fell in the below average group.

Toweling CR-3 had the lowest shrinkage of any of the towelings tested and was of generous size when purchased as a readymade towel.

Price, absorbency and dimensional stability of this toweling were very favorable. However, since breaking strength is such an important performance factor, a toweling that rates below average would not be a good value.

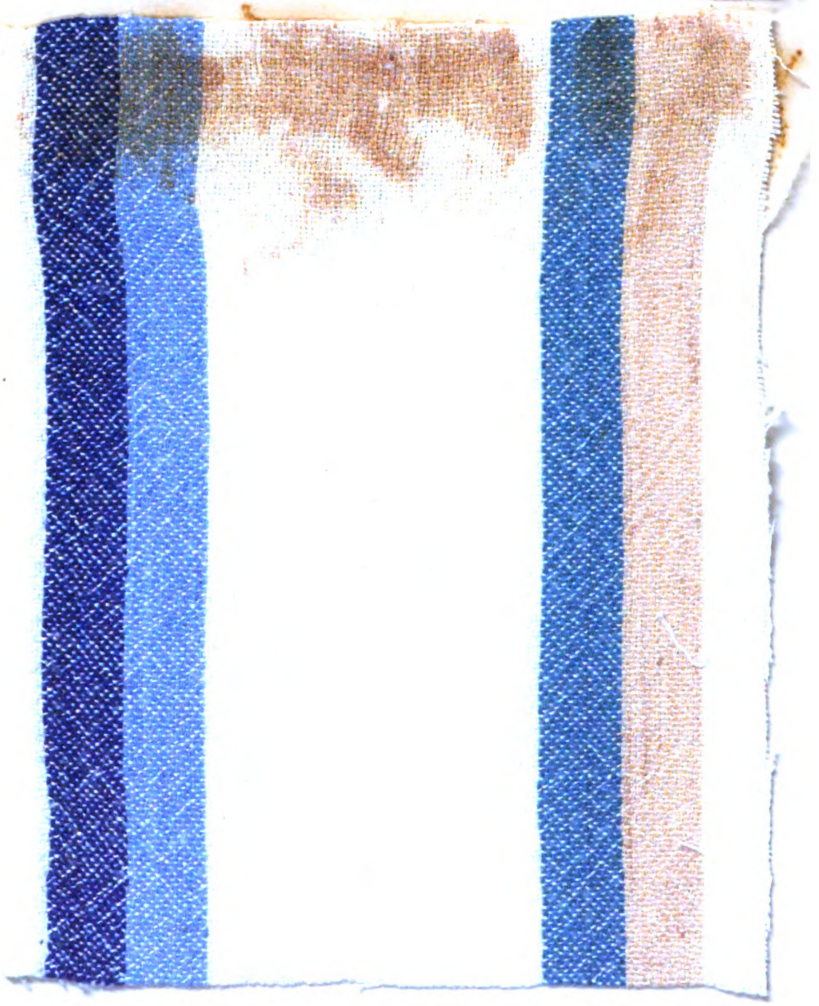
Toweling CR-4

Original



Toweling CR-4

15 Launderings



COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC CR-4

Cost per square yard	43¢	
Yarns per inch	Warp	Filling
Original	70	33
After 15 launderings	77	36
Yarn number	Warp	Filling
	19	22
Yarn twist and direction	Warp	Filling
	25Z	18Z
Weight per square yard (ounces)		
Original	3.6	
After 5 launderings	3.8	
After 15 launderings	4.5	
Shrinkage in laundering (percent)	Warp	Filling
After 5 launderings	6.9	7.5
After 10 launderings	8.1	10.6
After 15 launderings	9.4	12.5
Breaking strength (pounds)	Warp	Filling
Original		
Dry	50	28
Wet	24	18
After 15 launderings		
Dry	44	17
Wet	24	7
% Change after 15 launderings		
Dry	-12	-36
Wet	0	-61
Absorbency (rate in inches)	Warp	Filling
Original		
One minute test	0	1/4
Five minute test	1/4	3/4
After 5 launderings		
One minute test	2-1/4	1-3/4
Five minute test	4	3
After 15 launderings		
One minute test	2-1/2	2
Five minute test	4-1/4	3-1/4

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC CR-4

Original Physical Properties

Toweling CR-4, a cotton and rayon blend in the warp with a rayon filling, was an unbalanced toweling with 70 yarns per inch in the warp and 33 yarns per inch in the filling. This yarn count is above the Federal Specification of cotton crash of 38 yarns per inch in the warp and 30 in the filling.

The original weight per square yard of 3.6 ounces is over 2 ounces under the above standard for cotton crash of 5,8 ounces.

A yarn number of 19 for the warp and 22 for the filling makes this toweling one of the three with the lightest weight yarns. Yarn twist of 25Z in the warp and 18Z in the filling is relatively high, the range being from 3 to 29 twists per inch.

Dimensional Stability

Toweling CR-4 showed a shrinkage of 6.9% in the warp and 7.5% in the filling after 5 launderings. This is below the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2, for the warp as 14% is allowed but is over the standard of 5% allowed for the filling.

After 15 launderings, the warp shrinkage of 9.4% was still with in this standard, but the filling shrinkage of 12.5% was over twice the amount allowed in the standard. In comparison with the other towelings tested, CR-4 had next to the highest shrinkage in the filling and fourth from the highest shrinkage in the warp direction.

Breaking Strength

Federal Specifications for breaking strength are based on the grab rather than the raveled-strip method used. Therefore, a direct comparison cannot be made. The standard for the grab method requires a minimum breaking strength, dry and wet, of 50 pounds in the warp and 40 pounds in the filling for cotton crash.

The original dry strength of toweling CR-4, 28 pounds in the filling, was below average and the warp strength of 50 pounds placed it in the low average group. In original wet breaking strength, this toweling was very much below average and had the lowest wet breaking strength of the ten towelings tested. The filling wet strength being only 18.

After 15 launderings, the dry warp strength was 12% lower and the dry filling strength 36% lower. The wet filling strength was 61% lower but there was no

loss in wet warp strength. This placed toweling CR-4 the lowest of the ten tested with a dry warp strength of 24, dry filling strength of 18 and a wet filling strength of 7pounds. The toweling was in the below average group for wet warp strength with 44 pounds.

Rate of Absorbency

Fabric CR-4 had the highest warp absorbency with 4-1/4 inches in five minutes. The Federal Specification minimum standard is 2-3/8 inches in five minutes. The toweling was also above average in absorbency in the filling with a rise of 3-1/4 inches. CR-4 also had the highest warp absorbency after one minute with a 4 inch rise and rated above average in the fi lling with four other towelings recording a 2 inch rise.

Conclusions - Fabric CR-4

Toweling CR-4, a cotton and rayon foreign made toweling fellin the low price group of towelings tested.

After 15 launderings, it rated above average in absorbency both warp and filling in both the one and five minute tests. This toweling had the highest warp absorbency of the towelings tested in both one and five minute tests.

When compared in breaking strength with the other

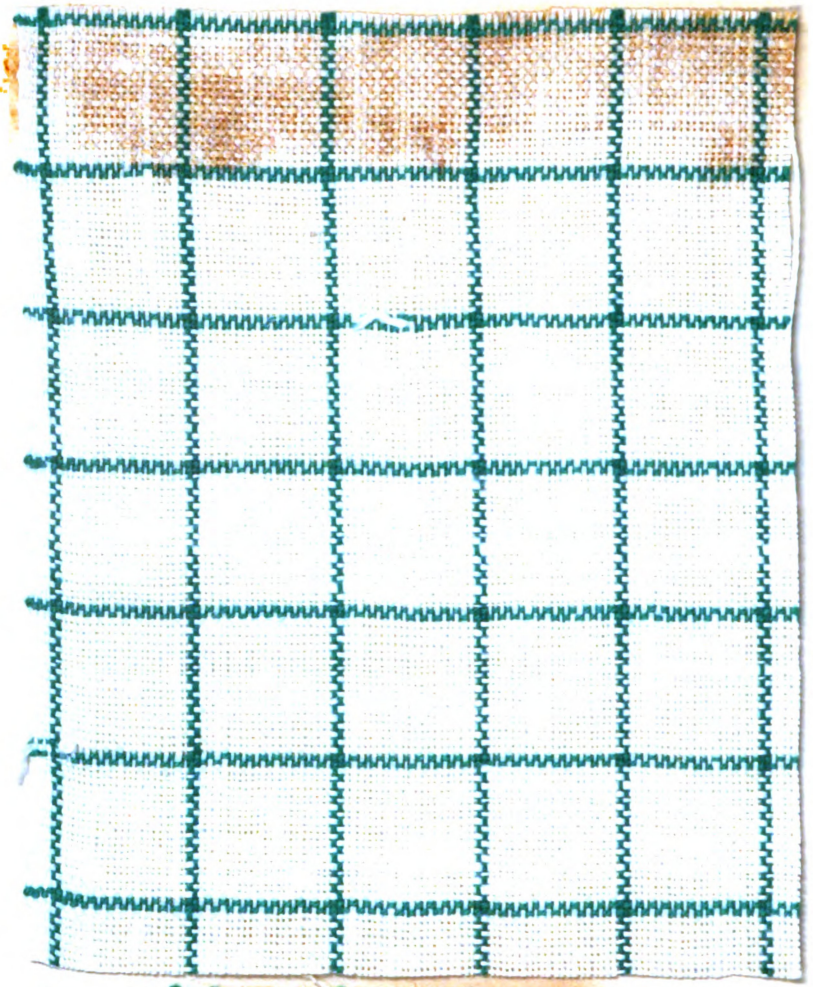
nine towelings after 15 launderings, CR-4 had the lowest dry strength, both warp and filling, and the lowest wet filling strength of only 7 pounds. It was below average in wet warp strength.

In comparison with the other towelings tested, CR-4 had an average shrinkage in the warp direction but below average shrinkage in the filling. Since this readymade towel was only approximately 23-1/2 by 13-1/2 inches when purchased, this amount of shrinkage would reduce the size to an ineffective point.

Toweling CR-4, although above average in absorbency would be very unsatisfactory because of the very low breaking strength. It would be a poor buy at any price.

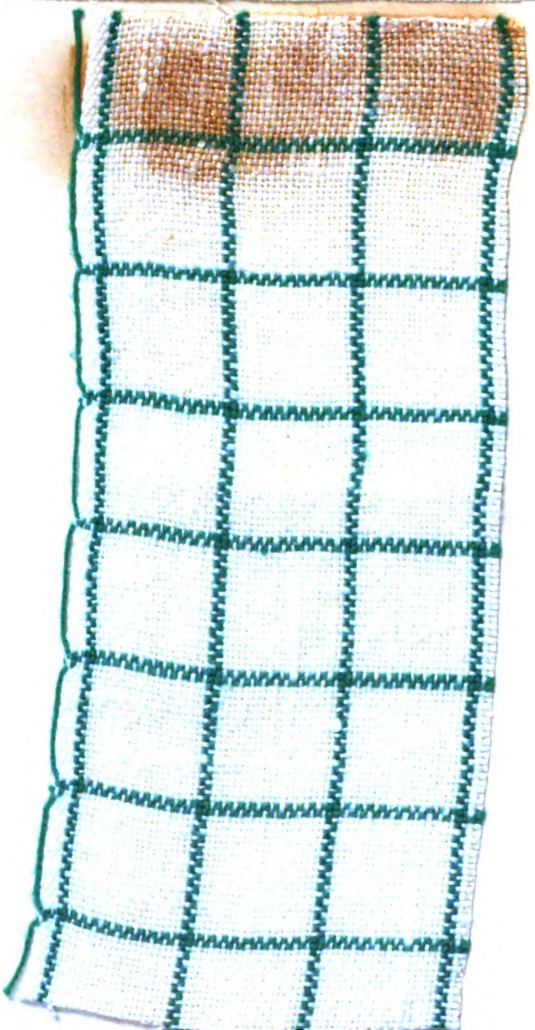
Toweling F-1

Original



Toweling F-1

15 Launderings



COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC F-1

Cost per square yard	$1.10	
Yarns per inch	**Warp**	**Filling**
Original	30	26
After 15 launderings	32	29
Yarn number	**Warp**	**Filling**
	15	16
Yarn twist and direction	**Warp**	**Filling**
	11Z	11Z
Weight per square yard (ounces)		
Original	6.4	
After 5 launderings	7.5	
After 15 launderings	7.5	
Shrinkage in laundering (percent)	**Warp**	**Filling**
After 5 launderings	5.6	4.4
After 10 launderings	6.9	4.4
After 15 launderings	8.1	6.3
Breaking strength (pounds)	**Warp**	**Filling**
Original		
Dry	91	98
Wet	175	147
After 15 launderings		
Dry	79	72
Wet	156	126
% Change after 15 launderings		
Dry	-13	-27
Wet	-11	-14
Absorbency (rate in inches)	**Warp**	**Filling**
Original		
One minute test	0	0
Five minute test	0	0
After 5 launderings		
One minute test	1-1/2	1-1/2
Five minute test	2-1/2	2-1/4
After 15 launderings		
One minute test	1-1/2	1-1/2
Five minute test	2-1/2	2-3/4

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC F-1

Original Physical Properties

Fabric F-1, a linen glass toweling, was above the Federal Specification DDD-T-536a for linen glass towels in having 30 yarns per inch in the warp and 26 in the filling. The minimum standard stated was 24 yarns per inch in the warp and 19 in the filling.

The original weight per square yard of 6.4 ounces is slightly over an ounce lower than the above Federal standard of 7.8 ounces.

The weight of the yarn used in the warp and filling was approximately the same with a number 15 in the warp and number 16 in the filling. The amount of twist, both warp and filling was 11Z, an average amount when compared with the other towelings tested.

Dimensional Stability

Toweling F-1 showed a shrinkage of 5.6% in the warp and 4.4% in the filling after 5 launderings. This amount is within the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2, which allows a maximum shrinkage of 14% in the warp and 5% in the filling after 5 launderings. There was some additional shrinkage and

15 laundering, a total of 8.1% in the warp and 6.3% in the filling was recorded. Thus, Toweling F-1 fell in the middle group compared with the other nine towelings tested making it average in dimensional stability.

Breaking Strength

Federal specifications for breaking strength are based on the grab rather than the raveled-strip method used. Therefore, a direct comparison cannot be made. The standard for linen glass toweling, grab method requires a minimum breaking strength of 70 pounds in the warp and 60 pounds in the filling.

Toweling F-1 was well above the standard with a dry warp strength of 94 pounds and a filling strength of 98 pounds. The original wet strength of 175 in the warp and 147 in the filling, made it the highest of the ten tested in original strength.

Breaking strength after 15 launderings was lower as follows; dry warp 13%, dry filling 27%, wet warp 11% and wet filling 14%. However, this decrease in strength would not be considered excessive and toweling F-1 rated third from the top in both warp and filling dry strengths when compared with the others in the test after 15 launderings.

This toweling was at the top in wet warp strength and second in wet filling strength at this interval.

Rate of Absorbency

Fabric F-1 met the Federal Specification minimum standard of 2-3/8 inches in five minutes for cotton crash. None was given for linen glass toweling. When compared with the other towelings tested, F-1 ranked average both for warp and filling. These in the average group had a variation of only 1/4 inch in the warp and 1/2 inch in the filling. It also ranked average when compared with the other nine towelings in the one minute test.

Conclusions - Fabric F-1

Toweling F-1, a linen glass toweling, was the highest in price of the towelings tested.

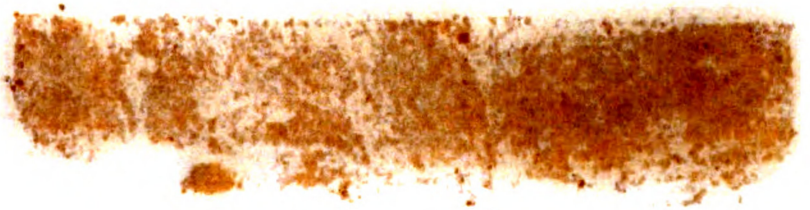
This toweling rated average in absorbency, both warp and filling directions in the one and five minutes tests when compared with the other towelings after 15 launderings.

Toweling F-1 fell at the top of the average group in dry breaking strength both warp and filling after 15 launderings. Actually, it was third highest of the towelings tested. It ranked first in wet warp strength and second in wet filling strength giving it an above average rating for wet strength.

Toweling F-1 was average in dimensional stability

both warp and filling directions when compared with the other towelings tested.

This toweling had no objectionable characteristics unless price is a determining factor. It was average in absorbency and dimensional stability and above average in strength. Since strength is one of the most important performance factors, this would be considered a good toweling. Other factors which might help justify the cost, such as absence of linting and drying time were not checked.



Toweling F-2

Original

Toweling F-2

15 Launderings

COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC F-2

Cost per square yard	83¢	
Yarns per inch	**Warp**	**Filling**
Original	26	21
After 15 launderings	27	23
Yarn number	**Warp**	**Filling**
	11	9
Yarn twist and direction	**Warp**	**Filling**
	8Z	12Z
Weight per square yard (ounces)		
Original	8.7	
After 5 launderings	9.9	
After 15 launderings	10.7	
Shrinkage in laundering (percent)	**Warp**	**Filling**
After 5 launderings	9.4	6.3
After 10 launderings	11.3	6.3
After 15 launderings	11.9	6.9
Breaking strength (pounds)	**Warp**	**Filling**
Original		
Dry	121	78
Wet	162	141
After 15 launderings		
Dry	96	76
Wet	143	140
% Change after 15 launderings		
Dry	-21	-3
Wet	-12	-1
Absorbency (rate in inches)	**Warp**	**Filling**
Original		
One minute test	0	1/8
Five minute test	1/2	1/2
After 5 launderings		
One minute test	1-3/4	1-3/4
Five minute test	2-3/4	2-3/4
After 15 launderings		
One minute test	1-3/4	1-3/4
Five minute test	2-3/4	2-3/4

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC F-2

Original Physical Properties

Fabric F-2, a linen crash, had 26 yarns per inch in the warp and 21 in the filling. It had an initial weight per square yard of 8.7 ounces.

A heavy yarn, number 11, was used in the warp and number 9 in the filling. The twist was comparatively low with 8Z in the warp and 12Z in the filling.

Dimensional Stability

Toweling F-2 showed a shrinkage of 9.4 in the warp and 6.3 in the filling after five launderings. The filling shrinkage is above the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2 which allows a maximum of 5% in the filling and 14% in the warp after five launderings. Shrinkage was progressive, particularly in the warp so that after 15 launderings, a total of 11.9% in the warp and 6.9% in the filling was recorded. When compared with the other nine towelings tested, F-2 was average in filling shrinkage but had the third highest warp shrinkage which was below average for this group of towelings.

Breaking Strength

Toweling F-2 had the highest dry warp strength of

121 pounds. The filling dry strength was second high, the other linen toweling being first. F-2 was also second to the other linen toweling in wet strength both warp and filling directions with 162 pounds in the warp and 141 in the filling.

Breaking strength after 15 launderings was lower as follows: dry warp 21%, dry filling 3%, wet warp 12% and wet filling 1%. However, when compared with the other towelings, F-2 was second in dry strength, both warp and filling, first in wet filling strength and second in set warp strength.

Rate of Absorbency

Fabric F-2 met the Federal Specification minimum standard of 2-3/8 inches in five minutes for cotton crash, none being given for linen. When compared with the other towelings tested, F-2 ranked average, both warp and filling in rate of absorbency. Towelings in the average group varied only 1/4 inch in the warp and 1/2 inch in the filling. This toweling also ranked average when compared in the one minute test.

Conclusions - Fabric F-2

Toweling F-2, a linen crash, fell in the middle price group of the towelings tested.

In comparison with the other nine towelings after 15 launderings, F-2 was average in absorbency both warp and filling in one and five minute tests.

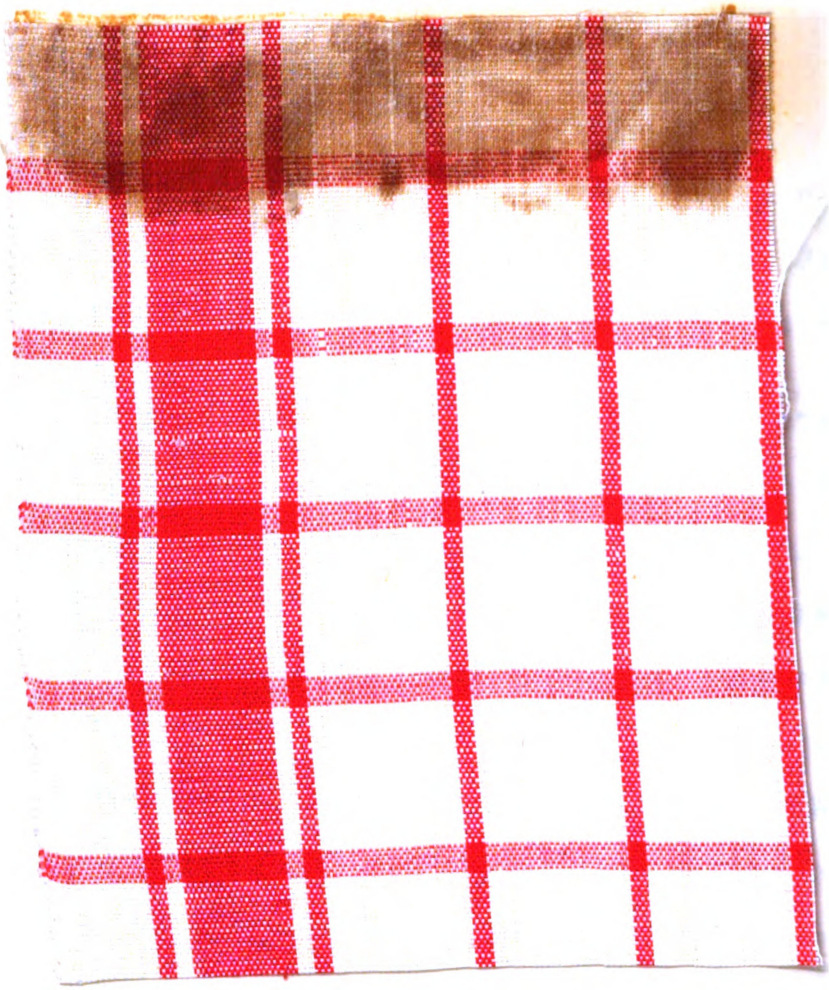
After 15 launderings, breaking strength was above average in comparison with the others tested. Toweling F-2 was second in dry warp strength as well as dry filling strength. It was also second in wet warp strength and ranked first in wet filling strength.

When compared with the other towelings, F-2 was average in filling shrinkage but had the third highest warp shrinkage. Warp shrinkage was considered below average.

Since absorbency and breaking strength are more important in towelings than dimensional stability, it appears this toweling is a good value at a medium price.

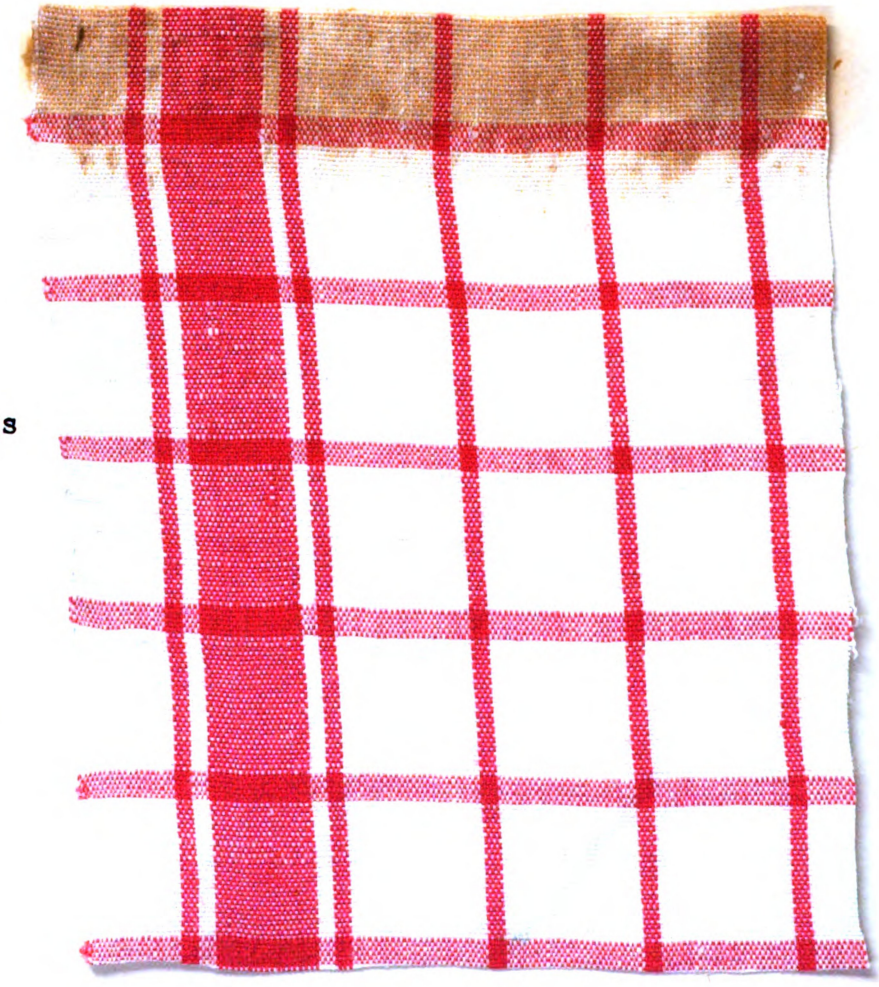
Toweling R

Original



Toweling R

15 Launderings



COST, PHYSICAL PROPERTIES AND TEST DATA - FABRIC R

Cost per square yard	88¢	
Yarns per inch	**Warp**	**Filling**
Original	65	38
After 15 launderings	67	42
Yarn number	**Warp**	**Filling**
	46	37
Yarn twist and direction	**Warp**	**Filling**
	15Z	13Z
Weight per square yard (ounces)		
Original	4.9	
After 5 launderings	5.4	
After 15 launderings	5.2	
Shrinkage in laundering (percent)	**Warp**	**Filling**
After 5 launderings	5.6	2.5
After 10 launderings	6.3	2.5
After 15 launderings	6.2	2.5
Breaking strength (pounds)	**Warp**	**Filling**
Original		
Dry	117	77
Wet	153	112
After 15 launderings		
Dry	114	97
Wet	82	70
% Change after 15 launderings		
Dry	- 3	26
Wet	-46	-38
Absorbency (rate in inches)	**Warp**	**Filling**
Original		
One minute test	3/4	3/4
Five minute test	1-1/2	1-1/2
After 5 launderings		
One minute test	1-1/2	1-1/4
Five minute test	2-1/2	2
After 15 launderings		
One minute test	1-1/2	1-1/4
Five minute test	2-3/4	2-1/4

EVALUATION OF TEST DATA AND CONCLUSIONS - FABRIC R

Original Physical Properties

Fabric R, a ramie towel, is a member of the bast fiber group, It was finer than the linen glass toweling. Teweling R was an unbalanced fabric with 65 yarns per inch in the warp and 38 in the filling. The initial weight per square yard of 4.9 ounces is 1.5 ounces less than the linen glass toweling.

A very fine yarn was used in the warp, number 46, and a number 37 in the filling. Twist was average with 15Z in the warp and 13Z in the filling.

Dimensional Stability

Shrinkage, after 5 launderings, of 5.6% in the warp and 2.5% in the filling was well under the American Standard Minimum Performance Requirements for Institutional Textiles, L24.2.2, which allows a maximum of 14% in the warp and 5% in the filling. After 15 launderings the shrinkage of 6.2% in the warp and 2.5% in the filling when compared with the other towelings tested, placed teweling R third from the top in dimensional stability of the filling and fourth from the top in warp dimensional stability. Thus the filling was above av-

erage and the warp might be considered average in comparing dimensional stability with the other towelings tested.

Breaking Strength

Federal specifications for breaking strength are based on the grab rather than the raveled-strip method used in this study. Therefore, a direct comparison cannot be made. The standard for linen glass toweling, grab method, requires a minimum breaking strength of 70 pounds in the warp and 60 pounds in the filling. Toweling R would be fairly comparable to a linen glass toweling.

Toweling R was second to the linen crash and above the linen glass toweling in initial warp dry strength with 117 pounds. It was third in initial filling dry strength but below the linen glass toweling with 77 pounds. Toweling R again placed third in initial wet strength, both warp and filling with 153 and 112 pounds respectively.

After 15 launderings, breaking strength was lower as follows: dry strength, warp 3%, warp wet strength 46% and filling wet strength, 38%. The filling dry strength was 26% higher. Thus toweling R had the highest dry breaking strength, both warp and filling with 114 and 97 pounds respectively. However in wet strength, after 15 launderings, toweling R dropped to third place for the warp with

82 pounds and fourth in the filling, with 70 pounds breaking strength. Dry strength at this interval would be considered above average and wet strength at the top of the average group, when compared with the other towelings.

Rate of Absorbency

Toweling R was average in rate of absorbency for the filling. The rise in the warp direction of 2-3/4 inches was also average when compared with the other towelings tested. Those in the average group had a variation of only 1/4 inch in the warp and 1/2 inch in the filling. Toweling R also ranked as average when compared with the other nine toweling in the one minute test.

Conclusions - Fabric R

Toweling R, of ramie, fell in the middle price group of towelings tested.

In comparison with the other towelings tested, it rated average in absorbency, both warp and filling, in one and five minute tests. This comparison is based upon the results obtained after 15 launderings.

Toweling R differed from the other bast fiber towelings tested, in that after 15 launderings, it ranked higher in dry breaking strength, while they ranked higher in wet breaking strength. This tow-

eling had the highest dry breaking strength, both warp and filling of the towels tested. In wet strength, the two linen towelings rated higher.

Toweling R had comparatively good dimensional stability, ranking in the above average group for the filling and in the average group for the warp. However, after 15 launderings, the 6.2% shrinkage in the warp would reduce the towel to approximately 26 inches in length since it was purchased as a readymade towel.

Toweling R would be a fairly good value as it is above average in breaking strength and average in absorbency at a medium price. At the present time, this toweling was not found on the market in yardage, should the size after shrinkage be considered a disadvantage.

CONCLUSIONS

SUMMARY AND GENERAL CONCLUSIONS

Conclusions and comments regarding the findings of this study take into account the fact that it was a laboratory rather than a serviceability study. Therefore, this study might be considered predictive rather than conclusive.

Absorbency, a significant characteristic required in toweling, was very similar in the ten towels tested. No toweling was considered below average in rate of absorbency in either one or five minute tests. The towelings tested did not gain appreciably in rate of absorbency between the fifth and the fifteenth launderings. Considerable change occured during the first five launderings. Several of the towelings when tested for absorbency before laundering, did not absorb any moisture due to the finish used on the toweling. It might be noted that rate of absorption is sometimes considered an indication of whether moisture will spread out quickly, making the towel uniformly dry or will not spread out so that it remains wet in spots and relatively dry in others.[1]

---

1 "Dish Towels" Consumers Research Bulletin, Vol. 31 Mar. 1953, pp.27-29

Contrary to popular belief, the linen towelings did not have a higher rate of absorbency than the other groups. Since laboratory tests showed relatively small differences in absorbency, less emphasis was given in the final rating to absorbency than to dnrability, as indicated by breaking strength.

The bast fiber group consistently rated above average in breaking strength. Although there was some loss in strength after 15 launderings, breaking strength remained high in comparison with the other towelings tested. The two linen towelings in this group were considerably higher in wet strength than dry. The ramie toweling ranked above the linen in dry breaking strength after 15 launderings, but considerably below in wet strength. The towelings in the cotton group rated average to below average in breaking strength after 15 launderings.

Two quality grades of toweling were apparent in the cotton and rayon blend group. Two of the towelings, CR-1 and SR-2, which were similar in construction rated average in breaking strength, both dry and wet, after 15 launderings. The other two cotton and rayon blends, CR-3 and CR-4, rated below average, both dry and wet. The rayon and cotton group was consistently lower in wet strength.

The highest shrinkage occured between the first and fifth launderings. However, shrinkage was progressive from the fifth to the fifteenth laundering. Shrinkage was excessive in the direction of the warp in two of the cotton towelings. It was excessive in the direction of the filling in two rayon and cotton blends, CR-1 and CR-2, and in the linen crash. Shrinkage is only a major consideration if it adversely affects absorbency, as was apparently the case in one of the rayon and cotton blends, or if readymade towels become too short for efficient use.

General agreement seems to indicate a 28-30 inch length as minimum for a dish towel. Seven of the towelings used in this study were purchased as readymade towels in order to get a sample of those on the market. Of these, four were either under the 28-30 indh length when purchased or after 15 launderings. The excessive shrinkage which occured in several of the towels would seem to indicate that it is better to buy yardage if readymade towels cannot be purchased in adequate lengths.

An evaluation of the test data showed the fellowing four towelings to be the best values in relation to cost: F-2, Stevens linen crash, R, the ramie, CR-2, Cannon's rayon and cotton blend and C-2, the more

expensive Cannon cotton crash. Cost of these towelings per square yard was 83¢, 88¢, 70¢ and 65¢ respectively.

It is interesting to note the above towelings were in the medium price group of towelings tested. All rated average or above average in breaking strength. These towelings rated average or above average in absorbency, as did all of the towelings tested. The ramie and the Cannon cotton crash, purchased as readymade towels, were approximately 26 inches in length after 15 launderings. This indicates the disadvantage of purchasing readymade towels unless length is sufficient to allow for excessive shrinkage.

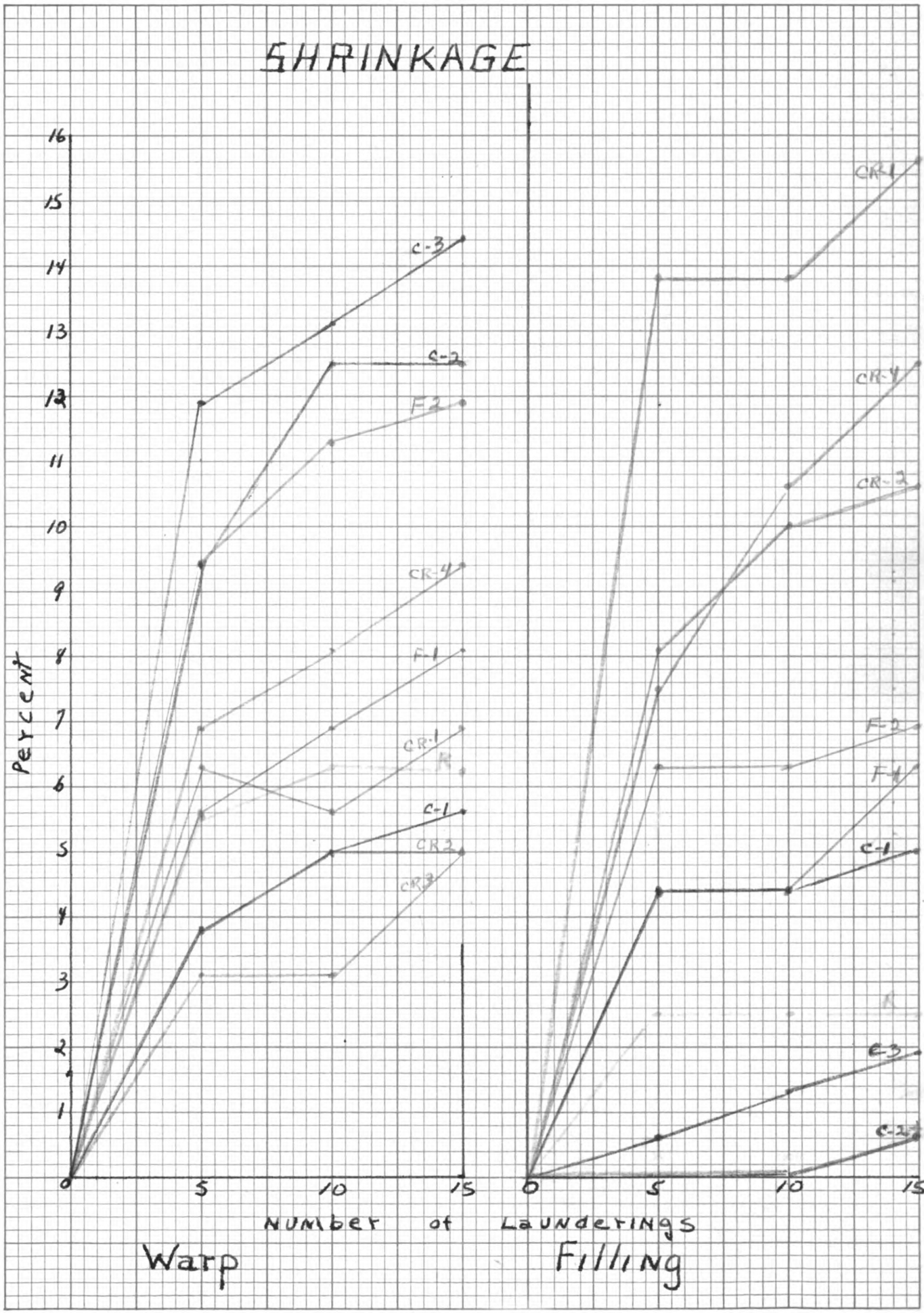
Although the cost of the Stevens linen glass toweling was greater than the other towelings, it's performance was excellent. If additional study on linting, rate of drying and ease of stain removal were carried out, it is possible that the cost of the linen glass toweling would be further justified. We might find, however, that in actual use, all homemakers might not place the same value on each individual characteristic.

Additional study needs to be done to validate the laboratory findings recorded here. A serviceability study which would involve additional launderings and

wear would yield more complete information. Additional tests on drying time, linting and staining would also prove valuable.

BREAKING STRENGTH AFTER FIFTEEN LAUNDERINGS

12-280
5760 10
10 SQUARES TO THE INCH



5780 10
10 SQUARES TO THE INCH

COTTON —— Flax

REVIEW OF RELATED LITERATURE

REVIEW OF RELATED LITERATURE

Linen no longer has a monoply on the dish toweling market. Other fabrics are being finished in such a way as to minimize linting and increase absorbency.

Mixtures of fibers are being used to gain some of the desirable properties of linens. "Spun rayon, when combined with cotton and linen is claimed to add absorptive and non-linting properties comparable to all linen, but at a much lower cost".[1]

M.B. Hays and R.E. Rogers reported a study using a toweling of 45% spun rayon, 38% cotton and 17% linen.[2] Two laundry procedures were used. Seven of twenty towels laundered by the more strenuous method had to be discarded at 39 out of 50 periods. The conclusions drawn as a result of this study were that rayon in high percentages (45%) is not suitable for a fabric such as dish toweling, which needs to be laundered frequently and by a method for soiled clothes.

---

1 Better Buymanship Bulletin No.2, Household Finance Corp. and Subsidiaries, p. 35

2 Hays, M.B. and Rogers, R.E. "Serviceability of a Dish Towel Fabric", Rayon Textile Monthly, Vol. 23 1942, pp. 289-290

Scheithauer has stated that the launderability of such textiles as tablecloths, handkerchiefs and towels made from two-thirds cotton and one-third rayon was satisfactory, although the shrinkage was greater than with all cotton fabrics.[1]

Ginter reported a study in which rayon absorbed the most moisture after one and fifty launderings. After fifty launderings, cotton ranked the lowest of four groups.[2]

A previous study from the University of Missouri Agricultural Experiment Station, included an all cotton, all linen and a group of mixtures of fibers.[3] Remarks were, that "While linen is generally claimed to be the most absorptive fiber, in this study, cotton was found to be superior to linen in the amount of water absorbed. Mixed fiber towels and toweling ranged widely, being below cotton and linen in most cases". Considered individually, the most absorptive piece was of novelty construction, having loosely twisted yarns in the filling and tightly twisted yarns in the warp.

---

[1] Scheithauer, Mischgewebe fur Waschestoffe "Mixed Textile Fabrics for Wash Material", Spinner U Weber 55(20) 1-8, illus. 1937

[2] Ginter, Adella, "A Serviceability Study on Kitchen Towelings of Various Fiber Content", Missouri Agri. Exp. Sta. Research Bul. No. 448, August 1949

[3] Bennett, N.G. & Keeney P.E., "A Study of Towels and Toweling of Consumer Use", Univ. of Missouri Agri. Exp. Sta. Bul. No.452, Aug. 1942, pp. 18-32

Petzel found that cotton generally took up more moisture than linen during the early part of the absorption period.[1] However, when the towel absorbed to the point of saturation, linen took up more moisture. Linen had the advantage of increased absorbency with increasing laundering up to a point. Later, as the fabric decreased in weight, absorbency decreased.

Since tests showed absorbency differed little, Consumer's Research felt strength was the most important characteristic.[2] Breaking strength in their opinion should not be less than 50 pounds per inch in the warp and 40 in the filling. They found no relationship between the kind of fabric (fiber) and the strength of the towel.

Bennett and Keeney also stated that as a whole, there was a wide range in the strength of linen as well as cotton.[3] This indicates fiber is not a dependable guarantee of strength and serviceability. Neither can thread count be used as an indication of durability, due to variation in size of yarns. Breaking strength seems to depend upon fiber content, yarn

---

1 Petzel, Florence E. "Absorption of Water by and Drying of Untreated, Laundered, and Used and Laundered Cotton and Linen Toweling", American Dyestuff Reporter, 46:569, 1957

2 "Dish Towels", Consumer Research Bul., 31:27-29 March 1953

3 Bennett & Keeney, loc. cit.

size and amount of twist as well as the number of yarns to the inch.

Bennett and Keeney further stated that the wide variation in strength in each fiber group indicates good and poor materials in all groups.[1] They also found that price was no indication of durability or strength.

Petzel reported that after repeated launderings, cotton decreased relatively little in breaking strength.[2] Linen towelings in her study had the disadvantage of decreasing more markedly in breaking strength than cotton as a result of laundering and use.

Cranor and Dorsey also reported that at the end of eight months wear in a home management practice house, the cheaper linen had the most holes and worn places.[3] The more expensive linen was somewhat worn, but not so badly. The cotton and linen toweling and the all cotton showed almost no signs of broken or thin threads at the end of eight months wear. Students commented that they disliked the cotton and cotton and linen towelings. They claimed they did not absorb moisture, left lint

---

1 Bennett & Keeney, loc. cit.

2 Petzel, loc. cit.

3 Cranor, R.T. & Dorsey, I.B., "Wearing Tests of Kitchen Toweling", Journal of Home Economics, May 1925 pp. 254-259

on the dishes, lacked softness, were difficult to launder and looked badly. There was no complaint against the linen except that the less expensive one left lint.

In regard to shrinkage, Bennett and Keeney reported that only 8 out of 53 towelings tested shrank appreciably.[1] Considered individually, there was very little shrinkage. Materials of linen had less tendency toward shrinkage. In the majority of cases, the small amount of shrinkage would not be detrimental to appearance or service.

Standards were not available for all types of towelings tested. When applicable standards were found, they were used as a guide in the evaluation.

Standards for fabrics containing more than 50% by weight of rayon or acetate or both, including combination of these fibers with any other fiber natural or man-made to be used for dish toweling, include the following:[2]

Breaking strength in the ground weave 35 pounds

Shrinkage maximum - 3%

Federal Specifications for all cotton crash, bleached are as follows:[3]

---

1 Bennett & Keeney, loc. cit.

2 American Standard Minimum Requirements for Rayon and Acetate Fabrics, American American Standard Asso., N.Y.

3 Federal Specification DDD-T-511a, Aug. 1955

Weight per square yard, minimum - 5.8 ounces

Yarns per inch, minimum - Warp 38, filling 30

Breaking strength, minimum (grab method) - warp 50, filling 40

Rate of absorbency - 6 centimeters in 5 minutes

Federal Specifications for cotton toweling to be used for glass wear include the following:

Weight per square yard, minimum - 5.1 ounces

Yarns per inch, minimum - warp 54, filling 38

Breaking strength, minimum (grab method) - warp 50, filling 50

Federal Specifications for linen glass toweling include the following:[1]

Weight per square yard, minimum - 7.8 ounces

Width - 16 inches

Number of yarns per inch, minimum - Warp 24, filling 19

Breaking strength, minimum (grab method) - warp 70, filling 60

American Standard Minimum Performance Requirements for Institutional Textiles include the following:

Dish towels - L24.2.2

Weight per square yard, minimum - 5.63 ounces

Breaking strength, minimum (grab method),-Wet and dry, warp 50 filling 40

Shrinkage (after 5 launderings)- warp 14%filling 5%

---

1 Federal Specification DDD-T-563a, August 1955

Glass Towels L24.2.3

Weight per square yard, minimum - 5.02 ounces

Breaking strength, minimum (grab method), wet and dry - warp 50, filling 40

Shrinkage (after 5 launderings) - warp 14%, filling 5%

"Ramie, problem child of the fiber family, was introduced into Europe from the Orient in 1845".[1] Ramie is one of the oldest textiles used by the human race and had been used for several thousands of years in the Orient. It is not definitely known whether claims that Ramie was used along with linen in ancient Egypt are true.

Ramie is also known as Rhea or China Grass.[2] China grass is the commercial name used to designate the decorticated material as it is exported from China. Ramie is regarded as the strongest of all the bast fibers (linen, hemp, jute) and in fact the strongest of all vegetable fibers. Ramie's strength is the least affected by moisture and it is stronger wet than dry. The fiber is exceptionally white and has a high luster, excelling linen. Ramie is highly resistant to abrasion, is resistant to mold or mil-

---

1 Dall, Wm. B. "Ramie Has Tantalized Textile Men for One Hundred Years" Textile World, Dec. 1945 p.93

2 Mauersberger, H.R. Matthew's Textile Fibers. New York (5th ed.) pp. 345-354

dew, and when properly processed will not shrink or stretch.

Brittleness is one of the principal objections to the fiber. It is stiff and low in resiliency, hence wrinkles easily. It also tends to break if folded repeatedly in the same place.[1]

In the United States, ramie is grown in the Everglades region of Florida. Today, Newport Industries Inc. are the world's largest single producer. One-third of their production is sold to domestic mills in staple form. The rest is exported to mills in Europe and Japan as raw fiber. At present, the Japanese are the largest ramie spinners, Germany ranks second and France third.

Beautiful fabrics have been produced by hand controlled processes used in the Orient. However, machine processes have had difficulty establishing themselves. Ramie is difficult to decorticate or to degum. Retting has not been successful as it has for flax. The chief reason for limited production is the need for an efficient mechanical decorticator.

Ramie fibers are very long. If handled in their

---

[1] Holden, N. and Sadler, J. Textiles. New York (1955) pp. 26-27

original length, flax spinning machinery would be required, of which virtually none exists in the United States. The degummed fiber produced in this country is used in staple form primarily in blends with nylon, cotton, viscose and mohair for furniture and automobile upholstry. The main use of ramie is in fabrics resembling linen, such as suiting, shirting, tablecloths, napkins and handkerchiefs.

SELECTED BIBLIOGRAPHY

American Standard Minimum Performance Requirements for Institutional Textiles, American Standards Asso. New York

American Standard Minimum Requirements for Rayon and Acetate Fabrics, American Standard Asso. Inc., New York

A.S.T.M. Standards on Textile Materials, American Society for Testing Material, Philadelphia, Pa. 1957

Bennett, N. G. and Keeney P. E., "A Study of Towels and Toweling of Consumer Use", Univ. of Missouri Agri. Exp. Sta. Bul. No. 452, Aug. 1942, pp.18-32

Better Buymanship Bulletin No. 2, Household Finance Corp. and Subsidiaries, p. 35

Coles, Jessie V., "Consumer Demand in Missouri for Selected Articles of Household Textiles", Missouri Exp. Sta. Bul. 301, 1939, pp. 41-43

Consumer Research Bulletin, "Dish Towels", 31:27-29 March 1953

Craner, R. T. and Dorsey, I. B., "Wearing Tests of Kitchen Toweling", Journal of Home Economics, May 1925, pp. 254-259

Dall, Wm. B., "Ramie Has Tantalized Textile Men for One Hundred Years" Textile World, Dec. 1945 p.93

Federal Specification DDD-T-511a, "Cotton Crash and Cotton and Linen Mixed Crash Towels", Aug. 1955

Federal Specification DDD-T-536a, "Linen Glass Toweling", Aug. 1955

Ginter, Adella, "A Serviceability Study on Kitchen Towelings of Various Fiber Content", Missouri Agri. Exp. Sta. Research Bul. No. 448, Aug. 1949

Good Housekeeping, "A Good Dish Towel" 131:175, Oct. 1950

Hays, M. B. and Rogers, R. E. "Serviceability of a Dish Towel Fabric", Rayon Textile Monthly, Vol. 23, 1942 pp. 289-290

Holden N. and Sadler J., Textiles, MacMillan Co., New York (1955) pp. 26-27

Hoye, John Staple Cotton Fabrics. McGraw-Hill Book Co. Inc. New York 1942

Mauersberger, H. R. Matthew's Textile Fibers. John Wiley and Sons Inc., New York (5th ed.) pp.345-354

Petzel, Florence E. "Absorption of Water by and Drying of Untreated, Laundered, and Used and Laundered Cotton and Linen Toweling", American Dyestuff Reporter 46:569, 1957

MICHIGAN STATE LIBRARIES
3 1293 02211 3199