College Bulletins
Issued Quarterly
Vol. 14, No. 2 8-1-14-10,000

Utah Agricultural College
SCHOOL OF HOME ECONOMICS

Pure Textiles and Clothing

A Preliminary Study of Wool, Silk and Linen Fabrics

on the

Utah Markets

by the

U. A. C. Home Economics' Faculty

Under the Direction of
C. W. PORTER

Entered as second class matter, July 8, 1901, at P. O. at Logan, Utah, under act of July 16, 1894

PRESS OF
THE F. W. GARDINER CO.
SALT LAKE

President John A. Widtsoe,
Logan, Utah.

Sir:—I have the honor to submit herewith an article on textiles which includes a report of the composition of ma fabrics that are on sale in this State. Most of the analytical work was done by Miss Blanche Cooper, Mrs. Rhoda B. Cook, Miss Coral Kerr, and Miss Alice Dunford.

I recommend its publication as a contribution from the Home Economics faculty.

C. W. PORTER, Director.

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PURE TEXTILES AND CLOTHING

The three chief necessities of life are food, clothing, and shelter. Other factors contribute to the happiness of man, but his comfort is dependent very largely upon his ability to secure proper nourishment, good clothes, and a comfortable home.

Modern industrial development has rendered necessary a division of labor that makes it impossible for each family to produce its own food or manufacture its own clothing. We are therefore dependent upon others for these things.

This dependent position has placed us more or less at the mercy of the manufacturer, who in turn has been forced by popular demands for cheaper goods to incorporate in his products adulterants and raw material of inferior quality. Several years ago the fact was revealed to the people, chiefly through the labors of Harvey W. Wiley, that foods were being adulterated. Goods of inferior quality were canned in unsanitary factories and the decay of the unsavory preparation prevented only by the addition of poisonous preservatives. Peas were made to present a fresh green color by the addition of blue vitriol, a poisonous salt. Olive oil, so labeled, proved to be cottonseed oil or peanut oil. Meats that otherwise would decay appeared fresh indefinitely under the germicidal influence of sodium benzoate. In a thousand ways unscrupulous manufacturers exploited an innocent public. But these conditions are changed. When the people were made aware of these dangerous and fraudulent practices they were not slow to enact laws to overcome the evil. In consequence, we have the pure food and drug laws that make necessary the accurate labeling of all preparations sold for food or medicine. We may still buy oleomargarine, or we may buy butter if we prefer it. But we are no longer in any great danger of getting a package of oleomargarine labeled butter when the latter is ordered from the grocer. We may still buy peas made green with copper sulphate, but the fact that a poison has been used to produce the effect must be on the label on the can, or the factory is liable to prosecution for a criminal act. In other words, the food and drug act has placed upon the manufacturer the responsibility of truthfully advertising his goods.

With textiles, misrepresentation is still the rule. Public sentiment has not yet been stirred to the point of legislating for honest clothing. Merchants buy goods for all wool and sell them for all wool when as a matter of fact they may contain only enough wool to respond to the tests generally applied by the purchaser. So perfect are the imitations of silk, wool, and linen that the uninitiated cannot hope to discover the fraud. Cotton can be so treated in the process of manufacture that it resembles wool in texture and by the use of a little wool in the weave it responds perfectly to the burning test for wool. Cotton can be made to resemble linen so closely that only by chemical and microscopical methods can the two be distinguished.

HOW TEXTILES ARE ADULTERATED

Artificial Silk

Cotton may be treated with nitric acid; then dissolved in alcohol and ether, forced through capillary tubes, hardened in water, and the result is a fibre in which the physical characteristics of the cotton have disappeared and the properties of silk so closely imitated that only by chemical means can the difference be detected. This artificial silk lacks the wearing qualities of true silk and can be made cheaper; but it sells for pure silk with no reduction in price.

Mineral Matter in Silk

Various means of adulterating pure silk are also employed. Ordinary silk as reeled from the cocoons consists of from 20 to 35% sericin or silk gum. Before the fibre is woven, this gum, or the most of it, must be removed. Usually the raw silk is sent to a house that makes a business of "boiling off" and dyeing silk. It has become the practice of these houses, after boiling off the gum, to load the fibre with mineral matter until it weighs as much or more than the original silk, including the gum. A certain amount of weighting is allowable; indeed, some mineral salt is often necessary to impart a particular shade in dyeing or to guarantee fastness in the color. But the only purpose of excessive weighting is to give the customer the impression that she is buying a good heavy grade of silk when in reality the fabric is a thin flimsy piece of silk cloth holding from one to three times its own weight of such substances as tin phosphate or compounds of iron, aluminum, silica, or even sugar and starch.

Samples of silk have been investigated in this laboratory that contained so little silk and so much mineral matter that it was found impossible to set fire to the cloth. And after such samples have been subjected to the intense heat of the electric oven, the mineral residue maintained in the original form and size closely resembled a piece of fine wire gauze. Silk is soft and pliable; but when loaded with inorganic salts it cracks or splits easily and all who have had to deal with silks have had experience with just such fabrics.

Cotton in Wool

Wool is commonly mixed with cotton. Very often the mixture is made by spinning together a cotton and a wool fibre so that the cloth woven from such yarn will contain wool in every thread. The burning test ordinarily employed would be useless in such cases, for every thread in both warp and weft would contain enough wool to give the characteristic odor.

In other instances cotton yarn is used for the warp and wool is employed as filling. Such weaves are usually sold as mixed goods and not as pure wool.

Mineral Salts in Wool

Like silk, the wool fibre is capable of absorbing and mechanically holding large quantities of inorganic salts and these salts give weight and firmness to the fabric. They are, however, of no permanent value, for they add nothing to the wearing quality of the cloth and often wash out the first time the piece is placed in water.

Cotton in Linen

Cotton is the only fibre commonly employed in the adulteration of linen fabrics and starch is the weighting material most frequently employed.

Linen is the finest, strongest, and best of the vegetable textile fibres. It also claims the distinction of being one of the first fibres to be spun and woven into cloth. The first appearance of linen, cotton, and wool in woven fabrics dates back to the remote past. But ancient writings clearly indicate that linen was the most highly prized textile of antiquity.

King Lemuel (Proverbs 31), speaking of woman's work, said:

> "She seeketh wool and flax and worketh willingly with her hands. * * * She maketh fine linen and selleth it and delivereth fine girdles unto the merchant."

The remarkable strength and endurance of linen and its ability to resist destructive agencies is shown in the fact that

Egyptian mummy-cloths more than 4000 years old have been found in a fairly good state of preservation.

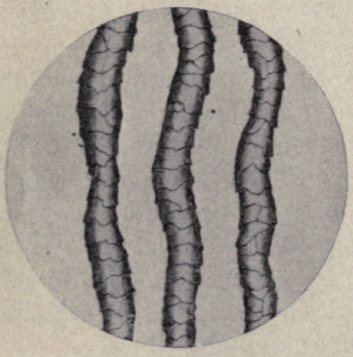
It should be kept in mind also that a cotton linen mixture is worth very little more than an all cotton cloth. For the chief advantage of linen is its endurance or wearing qualities. A cloth made of cotton and linen mixed is gone as soon as the cotton threads wear out.

METHODS OF ANALYSIS

Chemical as well as mechanical and microscopical methods are employed in detecting adulterants in textiles and a brief description of a few processes will be given.

UNDER THE MICROSCOPE

In the first place it must be understood that the various textile fibres present characteristic appearances when examined under the microscope.



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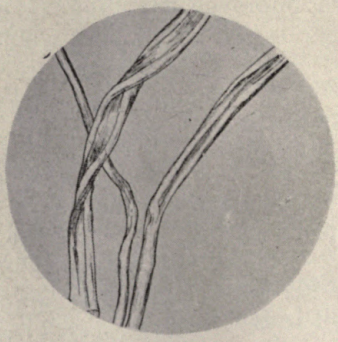

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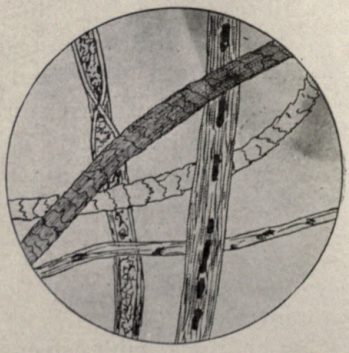


IV

FIGURE I* represents wool fibres. They look like small tubes covered with scales. In some of the finer varieties of Merino wool each scale extends entirely around the fibre while in coarser types two, three, or more make up the circumference. The scales overlap each other much like the imbricated structure of a pine cone.

FIGURE II† is a micrograph of cotton fibres. They appear like ribbons. They closely resemble thin rubber tubes that have flattened out and become twisted as a result of drawing out the air from the tubes.

FIGURE III* shows the appearance of flax under the microscope. It consists of thin, jointed, semi-transparent rods.

Silk, jute, and other textile fibres also present characteristic forms under the microscope, so that a mechanical separation and estimation of the various fibres in mixed goods is possible.

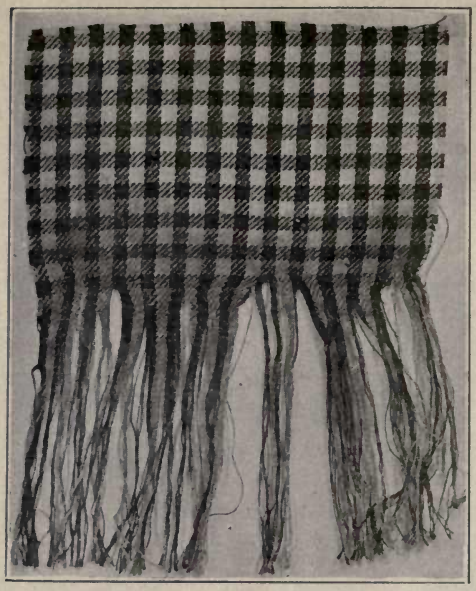
FIGURE IV† shows the appearance of shoddy under the microscope. In it can be detected both cotton and wool and some of the wool fibres appear split and broken, indicating that it is wool obtained from old clothing. Worn out woolen clothing furnishes thousands of pounds of "regenerated" wool fibre annually for the manufacture of shoddy.

CHEMICAL TESTS

Wool and Cotton

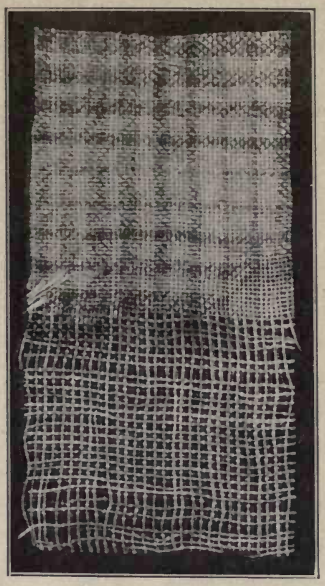
Wool dissolves completely within fifteen minutes in a hot five per cent solution of potassium hydroxide. Cotton fails to dissolve in this reagent. On the other hand cotton dissolves in a strong solution of sulphuric acid and wool remains unchanged. These chemical characteristics afford convenient means of estimating the quantity of wool and cotton in mixed goods. The ordinary test made by burning the cloth and observing the odor is of little value, for yarn containing a very small percentage of wool gives the distinct odor of burning wool.

*Bowman's "Structure of the Cotton Fibre."
†Matthew's "Textile Fibres."



V

FIGURE V is a photograph of a sample of cloth sold for all wool. The piece was 36 inches wide, weighed 1.5 ounces a yard, and retailed for $1.50 a yard. The upper end of the sample photographed has not been subjected to the action of any chemical reagent. It is sample No. 5, reported in the table on page 12. The lower half was immersed for fifteen minutes in hot potassium hydroxide. The warp in this sample is made up entirely of cotton and remains undissolved. The weft is wool and in the portion treated the wool has dissolved out.



VI

FIGURE VI is a photograph of cloth sold as all wool flannel. Analysis proved it to be 41.05 per cent wool and 49.80 per cent cotton. In this case the warp and weft were alike. The yarn used in weaving the piece had been made by spinning cotton and woolen threads together. In the lower half of the sample shown, the wool has been removed and a gauze-like structure of cotton remains. This piece is sample No. 38. Width 53 inches, weight 2.12 ounces a yard, price $1.50 a yard.*

The wearing quality of the dress goods is not a question under consideration at the present time. Sample No. 5 shown in Figure 5 gave entire satisfaction to the purchaser and it very often happens that a wool-cotton mixture will give better service than a pure wool or a pure cotton fabric. But we should be able

*It is thought best to suppress the names of the dealers who furnished the samples and also the names of the mills where they were woven, until a more complete report can be issued. It may be purely accidental that the samples analyzed from one factory have been uniformly good and from another very poor. Until more samples from each mill have been analyzed recommendation of one and condemnation of the other would be premature.

to buy pure wool or half wool as we choose and not be given a clever imitation with a false claim as to its real nature.

Silk

Many tests are known for the detection in silk of artificial fibres, cotton and wool. Unfortunately these tests cannot be applied by the layman. It requires the skill of the chemist to determine with certainty the composition of silk fabrics.

Silk dissolves completely in cold concentrated hydrochloric acid, whereas wool is not affected by this treatment. It dissolves in basic zinc chloride in which cotton remains unchanged. Silk also dissolves readily in an ammoniacal solution of nickel oxide, a reagent which fails to act upon either cotton or wool. And it likewise dissolves in an alkaline solution of copper oxide in glycerine. There are, therefore, many methods for estimating silk, but as none of these are practical home tests the methods of procedure will not be described here. By far the most accurate and satisfactory way of estimating the quantity of pure silk in mixed goods is known as the Kjeldahl method. This method consists of an ultimate analysis of the sample for nitrogen and calculation of the quantity of silk from the nitrogen content of the cloth. By this method all analyses of silk, reported in this bulletin, were made.

Sample No. 46 was sold with the dealer's spoken guarantee that it was pure silk free from all substitutes and artificial fibre. An exact analysis revealed the fact that the sample was 80.5 per cent cotton, 4.10 per cent mineral weighting and only 15.40 per cent silk.

Linen

Bleached linen, like cotton, is composed almost entirely of cellulose, so that chemical reagents react upon both in about the same way. It is therefore difficult to make a quantitative analysis of mixtures of linen and cotton. The microscope affords the most reliable means. A few chemicals, however, give characteristic reactions that help in differentiating cotton and linen. One of the best of these is rosolic acid. When immersed in an alcoholic solution of rosolic acid and then in a sodium hydroxide solution and subsequently washed in water, linen acquires a rose color and cotton remains white.

The ordinary test applied to linen, that of wetting the finger and touching the cloth to see if the moisture strikes through is not reliable. A fifty per cent linen will respond to the test

almost as readily as will pure linen. A better test is to fringe out the sample and burn the separate fibres. The burned ends of cotton appear tufted or frayed; the linen fibres appear rounded. Or the sample may be immersed in concentrated sulphuric acid, then washed in water and finally in dilute ammonia. Cotton dissolves and linen remains. This method cannot be used for a quantitative separation, for if the treatment with the acid is continued long enough to dissolve all the cotton a large percentage of the linen is also destroyed.

NOT ALL BAD

From the foregoing discussion it must not be assumed that all textiles are unreliable. Many of the samples sold for all wool were actually all wool, though in some samples the fibres were short and coarse and the weave so loose that the material would constitute a poor bargain at any price. Most of the samples of silk analyzed contained no other textile fibre than silk, but nearly all were heavily weighted with mineral salts and a few of them contained cotton in some form. Six pieces of linen were examined and five of them were partly cotton. No adulteration was found in goods sold as "all cotton."

Samples of men's clothing secured from sample books in clothing stores revealed the fact that goods marked all wool and selling for as much as $5.00 a yard were made of regenerated fibre, that is, fibres that had been secured from clothing previously worn out and in many cases contained besides wool a considerable quantity of cotton, hemp, and jute.

The so-called Merino underwear contains not a single thread of wool, it is mercerized cotton only.

A word of warning should be given here against the purchase of very cheap all wool garments. Cloth containing wool only can be bought for 35 cents a yard, but an all wool fabric at that price will never give the same service that a cotton-wool mixture of the same weight and price would give. Short, coarse, wool fibres, regenerated wool, and shoddy are made up to meet the popular demand for an all wool cloth at a low price. A good substantial piece of cloth made of fine long fibres, closely woven and unadulterated cannot be retailed for thirty-five cents a yard. If all wool is wanted it is often a matter of good economy to pay $1.50 or more a yard for a serviceable dress.

The same is true of silk. A good quality of pure silk cloth cannot be retailed at a very low price, and the purchaser should remember that the twenty-five cent silks are not more than twenty-five per cent silk.

Often, when purchasing materials, width is not taken into consideration by the purchaser. The buyer will pay $1.25 a yard for serge forty-two inches wide when she will not consider paying $2.25 for a better piece of material fifty-six inches wide. The advantages of the cutting of a garment in wide material over that of narrow will often make it much cheaper to invest in the wider and higher priced piece.

In the following table, mineral matter, starch and other weighting materials have been listed with the moisture contained in the air-dried sample. Unless the value reported in this column exceeds ten per cent the fabric may be regarded as unadulterated if the analysis, as shown in the other columns, shows no other textile fibre present than one for which the fabric was sold. Wool, silk, and cotton will absorb from the atmosphere from three to ten per cent of their own weight of water.

Sample No.	Sold for	Price a yd.	Width.	Weight a yd.	COMPOSITION				
					% Silk	% Cotton	% Wool	% Linen	% Moisture and Weighting, Filling or Sizing
			In.	Oz.					
1	Silk	$2.50	30	1.70	87.55	.....	.....	.....	12.45
2	Silk	.75	26	1.25	65.41	.....	.....	.....	34.59
3	Silk	1.75	30	1.25	70.00	.....	.....	.....	30.00
4	Silk	1.75	30	2.10	55.50	.....	.....	.....	44.50
5	Wool ...	1.50	36	1.50	.....	49.60	45.03	.....	5.37
6	Wool ...	1.50	36	.75	.....	.....	88.00	.....	12.00
7	Wool ...	1.25	52	2.75	.....	.....	90.00	.....	10.00
8	Silk	.18	4	.78	80.80	.....	.....	.....	19.20
9	Silk	.50	27	.50	93.34	.....	.....	.....	6.66
10	Wool ...	.35	24	2.60	.....	.....	88.25	.....	11.75
11	Wool ...	.35	24	1.50	.....	.....	89.70	.....	10.30
12	Wool ...	.35	24	2.50	.....	.....	84.80	.....	15.20
13	Wool ...	.35	24	2.20	.....	.....	83.43	.....	16.57
14	Wool ...	.60	36	2.80	.....	20.00	74.28	.....	5.72
15	Wool ...	1.75	52	6.10	.....	.....	92.70	.....	7.30

Sample No.	Sold for	Price a yd.	Width	Weight a yd.	COMPOSITION				
					% Silk	% Cotton	% Wool	% Linen	% Moisture and Weighting, Filling or Sizing
			In.	Oz.					
16	Wool	$1.75	48	6.10	.....	.....	92.70	.....	7.30
17	Wool	1.75	48	6.00	.....	.....	88.27	.....	11.73
18	Wool	1.75	51	7.20	.....	.....	92.15	.....	7.85
19	Silk	.60	18	1.20	61.30	.....	.....	.....	39.70
20	Silk	.75	18	1.80	60.00	.....	.....	.....	40.00
21	Wool	2.50	56	10.30	.....	.....	93.00	.....	7.00
22	Wool	2.50	56	8.90	.....	.....	94.00	.....	6.00
23	Silk	.40	6	1.30	17.50	.....	.....	.....	82.50
24	Silk	.25	6	1.40	11.00	.....	.....	.....	89.00
25	Silk	.25	6	.50	63.15	.....	.....	.....	26.85
26	Silk	1.50	21	.....	67.94	.....	.....	.....	32.06
27	Silk	1.50	36	2.18	65.00	.....	.....	.....	35.00
28	Silk	1.50	24	2.70	18.80	75.20	.....	.....	6.00
29	Linen	1.00	69	9.27	.....	51.10	.....	40.00	8.90
30	Cotton	.50	58	5.85	.....	96.00	.....	.....	4.00
31	Linen	2.50	72	12.28	.....	18.80	.....	77.00	4.20
32	Wool	2.50	58	11.45	.....	.....	93.90	.....	6.10
33	Wool	2.50	54	9.93	.....	.....	89.60	.....	11.40
34	Linen	.50	36	7.65	.....	30.00	.....	65.00	5.00
35	Linen	.50	35	7.10	.....	20.00	.....	74.90	5.10
36	Linen	.90	22	6.20	.....	20.00	.....	73.90	6.10
37	Wool	1.25	52	2.50	.....	55.00	40.00	.....	5.00
38	Wool	1.50	53	2.12	.....	49.80	41.05	.....	9.15
39	Wool	1.50	48	4.80	.....	.....	85.00	.....	15.00
40	Wool	1.50	52	4.90	.....	.....	84.30	.....	15.70
41	Wool	65	36	5.25	.....	.....	82.58	.....	17.42
42	Wool	1.25	40	5.35	.....	.....	92.10	.....	7.90
43	Silk	1.00	27	1.26	76.43	.....	.....	.....	23.57
44	Silk	1.25	26	1.68	77.17	.....	.....	.....	22.83
45	Silk	1.25	30	.70	89.00	.....	.....	.....	11.00
46	Silk	1.75	26	4.28	15.40	80.50	.....	.....	4.10
47	Silk	2.00	36	4.56	20.70	74.00	.....	.....	5.30
48	Silk	2.25	36	3.90	64.40	20.60	.....	.....	15.00
49	Silk	.85	18	.62	74.00	.....	.....	.....	26.00
50	Linen	1.25	51	8.90	.....	.....	.....	90.00	10.00
51	Wool	1.65	56	12.10	.....	.....	86.00	.....	14.00
52	Wool	2.50	56	10.08	.....	.....	90.70	.....	9.30
53	Wool	1.60	55	7.84	.....	72.00	21.50	.....	6.50
54	Wool	2.00	52	8.10	.....	.....	92.00	.....	8.00
55	Wool	1.60	50	8.20	.....	.....	87.00	.....	13.00
56	Wool	.65	36	2.77	.....	.....	86.10	.....	13.90

Sample No.	Sold for	Price a yd.	Width	Weight a yd.	COMPOSITION				
					% Silk	% Cotton	% Wool	% Linen	% Moisture and Weighting. Filling or Sizing
			In.	Oz.					
57	Silk . . .	$ .15	3	.51	65.75	.....	.....	.....	34.25
58	Silk	.15	2½	.39	57.17	.....	.....	.....	42.83
59	Silk	.15	2½	.32	80.10	.....	.....	.....	19.90
60	Wool . . .	1.50	56	7.84	.....	.....	90.00	.....	10.00
61	Velvet . .	2.00	18	.....	.....	.....	.....	.....	.....
62	Wool . . .	1.25	41	6.00	.....	30.00	62.00	.....	8.00
63	Silk	1.00	18	1.22	60.41	.....	.....	.....	39.59
64	Silk	1.00	18	1.15	45.25	.....	.....	.....	54.75
65	Cotton .	.25	32	6.60	.....	95.00	.....	.....	5.00
66	Silk	1.00	24	.92	90.00	.....	.....	.....	10.00
67	Wool . . .	1.00	50	8.00	.....	.....	85.00	.....	15.00
68	Wool . . .	.80	50	6.10	.....	40.00	42.10	.....	7.90
69	Wool . . .	2.25	56	9.21	.....	.....	92.00	.....	8.00
70	Wool . . .	1.00	30	4.85	.....	.....	92.50	.....	7.50
71	Silk	1.50	42	1.30	30.90	.....	60.00	.....	9.10
74	Silk	1.75	36	1.86	62.20	.....	.....	.....	37.80
75	Silk	1.90	30	1.10	82.17	.....	.....	.....	17.83
80	Silk Floss (5c a skein)				.....	96.00	.....	.....	4.00
81	Silk Floss (5c a skein)				.....	95.00	.....	.....	5.00

WHO IS RESPONSIBLE FOR FRAUD?

The retail dealer is not to be blamed for making the same claims for his goods as were made to him by the manufacturer and, therefore, our protest is not directed against the dealer. The purpose of this bulletin is to place before the people the facts with reference to woven goods in order that they may see the necessity of requiring the manufacturer to place a reliable label on every bolt of cloth and of enacting laws making misrepresentation in textiles at least as serious an offense as misrepresentation in foods.

The consumer is not able to protect himself by testing the fabrics before buying. The tests can be made successfully only by analytical chemists. But with a law compelling accurate labeling of every bolt of cloth that leaves the mill and a few chemists on the alert to detect fraudulent labeling, the people would soon have reliable clothing.

THE LINDQUIST BILL

Congressman Lindquist has introduced a bill (H. R. 10080) which provides that it shall be unlawful to misrepresent in manufacturing, selling, or trading any fabric or article made in whole or in part of wool, silk, cotton, linen, or leather. The bill provides that the manufacturer shall properly label every bolt of cloth that leaves his mills; that the label shall give the percentage of each kind of fibre in the fabric. Failure to do this or any misrepresentation on the label is made a criminal act.

The people should demand this protection. The Lindquist Bill should become a law.

GROWTH OF THE TEXTILE INDUSTRY

In Colonial times the spinning wheel and loom could be found in almost every household. Wool and cotton were carded, spun and woven into cloth, and dyed and made into wearing apparel in almost every home. Indeed, it is within the memory of many living today when Utah's isolation made necessary the same thing, and men, women, and children were dressed in homespun garments. Every operation from shearing the sheep to finishing the suit or dress was performed by members of the family.

The textile industry in America has been rapidly developing for just about one hundred years. A century ago the hand loom was almost entirely displaced by the power loom. The old spinning wheel relinquished its claim to a place of honor in favor of the modern "mule" and the mill with its complex machinery and specialized labor assumed the duty of providing cloth for all purposes.

Today there are in operation in the United States 34,000,000 spindles, most of them employed in spinning cotton. 4,000,000 of them are engaged in the manufacture of woolen and worsted goods and 2,000,000 are busy with silk. With reference to capital invested, and wages paid, the textile industry holds second place when compared with all other industries in America. The value of the textiles manufactured in the United States, $1,300,000,000, annually, is surpassed only by the value of the total food products of the country. We have 4000 mills giving employment to 800,000 wage earners who receive annually $250,000,000. And the capacity of each wage earner in the mills of today is equal

to the work of an entire community of an earlier period. Twenty-five weavers today are able to run 200 power looms and turn out as much cloth in a given time as could have been made by 60,000 workmen with the hand looms of Colonial times. In a single city (Lowell, Mass.) there are in operation today nearly one million spindles and more than 20,000 power looms with a daily output that with hand looms and the old spinning wheels would require the labor of 15,000,000 craftsmen.

We are justly proud of this remarkable growth and nothing should be done to check its progress; but for the protection of 90,000,000 consumers we believe that every bolt of cloth should be labeled with a true statement of its composition.
