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A PRELIMINARY STUDY OF THE BLEACHING OF
OATS WITH SULPHUR DIOXID.¹

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CONTENTS.

	Page.
Introduction.....	1
Method of Bleaching Oats Commercially.....	2
Character of Investigations.....	3
Summary.....	8
Appendix.....	9

INTRODUCTION.

BLEACHING OATS with sulphur dioxid is a practice that has caused a great deal of controversy and discussion during the past few years. During the past score of years the commercial bleaching of oats and barley has greatly increased until, at the present time, this process is carried on to a considerable extent in nearly all of our larger oat-producing sections, the fundamental object being to improve the appearance of the product which is to be placed upon the market, and it was with a view to ascertaining the merits of this practice that these investigations were undertaken.

The character of the seasons in which oats are grown, and particularly the weather conditions prevailing at harvest time, have an influence upon their quality, condition, and appearance and deter-

¹ Other publications pertaining to this subject are:

Circular 40, Bureau of Plant Industry, U. S. Department of Agriculture: "A Simple Method of Detecting Sulphured Barley and Oats," by W. P. Carroll.

Circular 74, Bureau of Plant Industry, U. S. Department of Agriculture: "The Sulphur Bleaching of Commercial Oats and Barley," by LeRoy M. Smith.

Reprint from Circular 111, Bureau of Plant Industry, U. S. Department of Agriculture: "Improved Apparatus for Detecting Sulphured Grain," by George H. Baston.

Food Inspection Decision 145, Bureau of Chemistry, U. S. Department of Agriculture: "Bleached Oats and Barley".

Service and Regulatory Announcements 15, Bureau of Chemistry, U. S. Department of Agriculture: "Oats Bleached with Sulphur."

Service and Regulatory Announcements 16, Bureau of Chemistry, U. S. Department of Agriculture: "Oats Bleached with SO₂ and Oats Containing Added Barley."

mine quite largely the manner in which they are subsequently handled. Oats grown and harvested in a dry season are usually sufficiently bright and bleaching is not necessary to give them a good salable appearance. It is only upon oats which are harvested in a wet season that sulphur bleaching is practiced to any considerable extent, although a certain percentage of the lower grades of oats of all crops have been bleached during the past several years.

These investigations were begun in 1915, and it is deemed advisable to present at this time the data in reference to the methods most commonly used, the results obtained by these methods, and the effects of bleaching on the grain itself. Many phases of the problem have not been investigated as yet, or sufficient data has not been obtained to justify their publication at this time. The attitude of the Department of Agriculture regarding the sulphur bleaching of oats is given in Service and Regulatory Announcements Nos. 15 and 16 of the Bureau of Chemistry.

METHOD OF BLEACHING OATS COMMERCIALY.

The method of bleaching oats and barley commercially is practically the same throughout the country, with the occasional exception of a few changes in the technique that have been made by the individual operator, either better to adapt the process to his peculiar needs, or to give him what he considers a product of better quality. Two methods generally are in use, and these methods are practiced interchangeably by individual operators. These two processes are known as the cold process and the warm process, the only difference being that in one case steam is used to moisten the grain, and in the other cold water is used. The apparatus consists of a tower which is constructed of wood or concrete, an oven for burning the sulphur, a cooling chamber, a suction fan for drawing the fumes from the cooling chamber to the tower, where they are brought in contact with the oats, and a jet for injecting steam or water as the oats enter the tower. Fumes resulting from burning sulphur are drawn up through the moist grain while at the same time the grain runs from the top of the tower to the bottom, bringing as nearly as possible every kernel in contact with the sulphur fumes. Fumes of burning sulphur are sulphur dioxide (SO_2), which when combined with water form sulphurous acid (H_2SO_3), SO_2 plus $\text{H}_2\text{O} = \text{H}_2\text{SO}_3$, an active bleaching agent. It can readily be seen that the addition of water in some form is necessary for the formation of sulphurous acid and an ultimate bleaching of the product. After the oats have passed through the bleaching tower, they are usually run into a bin and allowed to stand over night, when they are cooled or dried as necessity may require. In the event that any considerable amount of water has been added during the process, it is usually necessary to dry out this excess moisture before the

grain can be shipped with safety. Some operators prefer to add as little moisture as possible, in which case the product merely requires cooling before shipment. Others maintain that they get a better-appearing product by adding considerable moisture, and then drying out the excess before shipment.

The bleaching of oats and barley as practiced at the present time is a continuous process after the apparatus has once been set in motion, and very little attention is required except to see that the proper supply of sulphur is kept in the furnace, the proper amount of water is added, and that the grain is kept at a uniform flow. Some of the largest and most efficient bleaching plants have capacities of 2,000 bushels of grain per hour. Photographs of sulphur-bleaching apparatus are shown in figures 1, 2, and 3, which illustrate some of the leading types of commercial bleachers.

CHARACTER OF INVESTIGATIONS.

In the fall of 1915, samples of oats were collected from representative sections in which the commercial bleaching of oats is practiced to a considerable extent, and these samples were carefully examined and analyzed. The analyses of samples from the same lots of grain before and after bleaching were compared. Using these data as a basis for further investigations, additional experiments were undertaken. Visits were made to some of the most important elevators throughout the Middle West that operate bleachers. Samples of as many different grades and qualities of oats as possible were obtained and studied. These were bleached by the regular process in vogue at the elevator, and also by modifications of this method which suggested themselves to the writer or were suggested by the operator of the elevator. Careful attention was paid to the amount of water absorbed, the atmospheric conditions, and the condition and appearance of the oats before and after bleaching. An endeavor was made at all times to improve if possible the appearance of the final product.

Each different grade or quality was carefully studied before and after treatment, and as many types of damaged oats as possible were obtained and examined. The effect of bleaching on each kind

FIG. 1.—A modern grain bleacher.

of damaged grain, such as weather stained, heat damaged, bin burned, and ground damaged, was carefully noted. This same line of experimentation was carried on at several representative points in order to

FIG. 2.—A grain bleaching apparatus with square tower. This type is in very common use throughout the Middle West.

get the benefit of varying conditions. Acknowledgment of appreciation is made for the assistance and cooperation given by the owners and operators of the elevators where experiments were conducted.

In studying the comparisons between the natural and the sulphur-bleached grain, careful consideration was given to many sides of the problem. The comparisons, however, in this publication are those

FIG. 3.—A modern bleaching plant with round tower, showing the intake for oats which leads from the elevator to the bleaching tower.

of laboratory tests—chemical, mechanical, and physical. The comparison of the value of the grain as a food product before and after bleaching is a separate problem, the study of which has but recently been undertaken by the Department of Agriculture.

On examination of the table shown, in detail, in the appendix, it is found that almost the same conclusions hold true for the entire table. The percentage of germination, which is a very important factor from the standpoint of the planter, is in almost every case reduced by bleaching, and in some instances the power of germination is killed entirely. It will be noted that the percentage of kernels appearing damaged to the eye is less after bleaching. There is a larger difference, however, in the percentage of kernels damaged by agencies other than heat, although the heat-damaged kernels are considerably less in number in the bleached grain. As will be noticed in pages 10 and 11 of the table, badly bin-burned oats were bleached, and in these two particular lots the oats appearing sound to the eye were increased in lots Nos. 89242 and 89245 from 14.4 per cent before bleaching to 26.6 per cent after bleaching, and in lots Nos. 88672 and 88679 from 28 to 56 per cent, showing that the appearance of even badly bin-burned grain can be substantially raised by the bleaching process.

By examining the table closely, several very interesting facts will be observed. The germination of oats is shown to be materially reduced by sulphur bleaching. The largest reduction is in sample No. 88087, which germinated 97.5 per cent before treating and 9.5 per cent after treating, or a total reduction in germination of 88 per cent caused by sulphuring. In nearly every set of samples in this table, however, a large reduction will be noticed in the percentage germination of samples that have been sulphured. The fact that in almost every instance the bleaching of oats reduced the germination to some extent, and in some instances killed the power of germination entirely, is a serious factor whenever the grain is to be considered for seed. Thanks are due to the seed-testing laboratory of the Bureau of Plant Industry for making the germination tests.

Too much attention can not be paid to the quality of seed, for the same amount of time, labor, and money is required to sow a field of oats, whether the viability of the seed oats be high or low, and the product will be influenced directly by the percentage germination of the seed. A casual observer is probably more likely to be misled as to the true quality of oats than of any other grain for seeding purposes, because oats that have been sulphured present a very bright, clean appearance; therefore special care must be taken to ascertain whether this appearance is due to bleaching by sulphur or whether it is natural. It is not an uncommon practice throughout the smaller oat-growing areas for farmers to use for seed, oats that have been purchased for feeding purposes, especially when these oats appear to be of good quality. Usually very poor yields are secured when this is done because these oats may have been sulphur bleached and the con-

sumer not be aware of the fact. Seed men generally buy their oats under contracts stipulating that such oats shall germinate not less than a specific percentage, and further that they shall not be sulphur bleached. This provision, of course, safeguards the farmer when he buys oats from a seedsman who states that such oats are suitable for seed. However, as at present there is no general regulation governing oat handling in intrastate transactions which requires that sulphured oats are to be labeled as such, the farmer generally is without protection and often sows oats that have been sulphured because he has no knowledge of such condition. Some growers are not acquainted with the sulphur-bleaching process, and do not know that this process injures the germination.

In the column headed "Sulphur reaction" are shown the results of a qualitative determination, indicating whether the oats in question had been sulphured or not.¹ In the column above referred to four designations are shown, namely: None, Slight, Medium, and Heavy, which indicate whether or not the oats have been sulphured, and if so, approximately to what degree. The moisture percentages will be found to vary considerably in the samples before and after sulphuring, according to the particular kind of method used. The weight per bushel, while not influenced materially, is found to be a little higher in most instances after sulphuring.

In the column headed "Oats appearing sound," it will be noticed that the percentage of such oats is increased considerably by bleaching, and in the column headed "Total oats appearing damaged," it is noticed that there is a corresponding decrease. In the column headed "Oats damaged by agencies other than heat," it is shown that in the sulphured samples the damage appears much less. In the last column, headed "Heat damaged oats," it is seen that while the percentage of heat damage in many instances is small, there is a corresponding reduction in this factor by the bleaching process.

By examining the table in detail, it is noted that the facts set forth in each set compare favorably with those in each of the other sets. In samples Nos. 88783 and 88830 it is shown that the total amount of oats appearing heat damaged was reduced from 54.8 to 31.4 per cent, a reduction of 23.4 per cent. In samples Nos. 89242 and 89245, however, it is seen that the total amount of oats appearing bin burned before sulphuring was 62 per cent while those appearing bin burned after sulphuring was 64.6 per cent.

¹ This method is given in detail in Circular 40, Bureau of Plant Industry, U. S. Department of Agriculture: "A Simple Method of Detecting Sulphured Barley and Oats," by W. P. Carroll, 1909; and in Circular 111, Bureau of Plant Industry, U. S. Department of Agriculture: "Improved Apparatus for Use in Detecting Sulphured Grain," by George H. Baston, 1913.

SUMMARY.

1. The sulphur bleaching of oats has been practiced during the past score of years, but the practice has increased during the last few years.

2. Investigations show that it is possible to bleach weather-stained, discolored, and damaged oats, giving them the appearance of natural oats of good quality.

3. It is possible to improve slightly the appearance of badly bin-burned and ground-damaged oats, thereby concealing a part of the damage.

4. The viability of oats is materially reduced by sulphur bleaching.

5. The methods used for bleaching are practically uniform throughout the oat-bleaching sections, with an occasional modification to meet the needs of individual operators.

6. The character of the season in which oats are harvested, whether a wet or dry season, has a direct influence upon the subsequent handling of the crop. Oats harvested in a dry season are rarely bleached, because they show little if any damage.

APPENDIX.

TABLE I.—A comparison of oats before and after bleaching.

[The figures shown in the table represent the analysis of samples as received, and the determination of other grain, seed, dirt, and foreign material has been omitted from the table.]

	Laboratory No.	Sulphur reaction.	Germination.	Moisture.	Weight per bushel.	Oats appearing sound.	Total oats appearing damaged.	Oats appearing damaged by agencies other than heat.	Oats appearing heat damaged.
Before sulphuring.....	87897	None....	<i>P. ct.</i> 56.0	<i>P. ct.</i> 12.9	<i>Lbs.</i> 30.25	<i>P. ct.</i> 50.4	<i>P. ct.</i> 45.2	<i>P. ct.</i> 39.2	<i>P. ct.</i> 6.0
After sulphuring.....	87898	Medium....	5	14.7	31.9	66.3	28.8	24.8	4.0
Before sulphuring.....	87899	None....	64.0	15.2	32.5	25.2	71.6	71.6	.....
After sulphuring (5 hours' standing).	87901	Medium....	.....	15.7	33.1	37.6	56.4	56.4	.....
After sulphuring, after cooling....	87900	do....	5	15.6	32.25	42.8	52.8	52.8	.....
Before sulphuring.....	87935	None....	64.0	14.0	33.7	49.2	48.8	47.6	1.2
After sulphuring (24 hours' standing).	87937	Medium....	3.0	15.5	34.8	63.2	32.4	31.2	1.2
After sulphuring, after cooling....	87936	do....	10.0	15.5	34.0	70.6	23.6	22.8	.8
Before sulphuring.....	88074	None....	91.0	14.8	35.0	76.2	19.7	19.0	.7
After sulphuring, before cooling....	88075	Slight....	38.0	16.0	36.0	84.2	12.0	11.6	.4
After sulphuring, after cooling....	88076	Medium....	45.2	15.7	34.9	86.0	11.0	11.0	Trace.
After sulphuring, cooling, and clipping.	88077	do....	49.0	15.3	36.5	84.4	11.6	11.0	.6
Before sulphuring, before clipping.	88087	None....	97.5	14.2	36.3	88.2	8.9	8.9	.....
Before sulphuring, after clipping....	88088	do....	94.5	14.4	39.25	88.1	8.9	8.9	.....
After sulphuring, after clipping....	88089	Medium....	17.5	15.2	39.6	94.1	2.0	2.0	.....
After sulphuring, cooling, and clipping.	88090	do....	9.5	14.4	39.75	94.0	2.7	2.7	.....
Before sulphuring.....	88322	None....	93.6	14.2	39.25	83.0	12.0	12.0	.....
After sulphuring, before cooling....	88323	Medium....	26.0	14.6	40.4	87.4	6.8	6.8	.....
After sulphuring, after cooling....	88324	do....	33.0	14.9	40.4	84.2	9.6	9.6	.....
Before sulphuring.....	88338	None....	91.5	13.8	38.0	77.8	19.6	19.2	.4
After sulphuring, before cooling....	88339	Slight....	1.5	14.3	38.6	88.2	9.3	9.3	.....
After sulphuring, after cooling....	88340	do....	5.5	13.8	38.25	87.2	9.5	9.5	Trace.
Before sulphuring.....	88460	None....	95.5	14.6	37.2	89.0	7.6	7.6	.....
After sulphuring, before cooling....	88461	Heavy....	39.0	14.9	37.7	93.1	2.6	2.6	.....
After sulphuring, after cooling....	88462	do....	29.5	15.1	37.7	92.5	4.2	4.2	Trace.
Before sulphuring.....	88528	None....	95.0	14.4	38.7	73.8	22.9	22.9	.....
After sulphuring, before cooling....	88529	Slight....	82.0	15.4	40.9	92.6	5.2	5.2	.....
After sulphuring, after cooling....	88530	do....	77.0	14.8	40.5	87.9	9.8	9.8	.....
Before sulphuring.....	88531	None....	94.5	14.5	39.9	83.8	13.6	13.6	.....
After sulphuring, before cooling....	88532	Medium....	73.0	15.3	38.7	92.0	5.4	5.2	.2
After sulphuring, after cooling....	88533	Slight....	78.0	15.2	39.0	89.2	8.5	8.2	.3
Before sulphuring.....	88534	None....	94.0	14.6	39.0	82.6	14.6	14.2	.4
After sulphuring, before cooling....	88535	Medium....	5	16.0	39.0	93.6	4.4	4.4	.....
After sulphuring, after cooling....	88536	do....	44.0	15.2	39.3	90.8	7.2	7.2	.....
Before sulphuring.....	87796	None....	53.0	-----	-----	53.2	43.2	36.8	6.4
After sulphuring (from sulphur tower)	87798	Heavy....	-----	-----	-----	66.9	29.2	23.8	5.4
After sulphuring (24 hours' standing).	87797	Medium....	5	-----	34.0	67.9	29.2	16.4	12.8
Before sulphuring (dried and clipped).	87799	None....	46.0	-----	38.0	45.3	52.7	28.5	24.2
After sulphuring (from sulphur tower).	87801	Medium....	13.0	-----	38.0	48.6	48.5	23.4	25.2
After sulphuring (24 hours' standing).	87800	Heavy....	13.0	-----	37.5	60.2	38.2	20.2	18.0
Before sulphuring (dried and clipped).	87802	None....	41.0	-----	37.5	46.4	51.2	29.6	21.6
After sulphuring (from sulphur tower).	87804	Medium....	21.0	-----	35.5	56.8	40.8	17.2	23.6
After sulphuring (24 hours' standing).	87803	Slight....	24.0	-----	36.0	71.2	27.6	12.8	14.8

TABLE I.—A comparison of oats before and after bleaching—Continued.

	Laboratory No.	Sulphur reaction.	Germination.	Moisture.	Weight per bushel.	Oats appearing sound.	Total oats appearing damaged.	Oats appearing damaged by agencies other than heat.	Oats appearing heat damaged.
Before sulphuring (clipped).....	87843	None....	P. ct. 44.0	P. ct.	Lbs. 39.0	P. ct. 46.4	P. ct. 51.6	P. ct. 26.4	P. ct. 25.2
After sulphuring (from sulphur tower).	87844	Slight....	-----	-----	38.0	46.6	51.8	29.2	21.6
After sulphuring (24 hours' standing).	87845	do....	9.0	-----	38.25	45.8	52.2	27.8	24.4
Before sulphuring.....	87869	None....	1.0	15.7	33.5	12.2	85.8	7.6	77.2
After sulphuring (from sulphur tower).	87870	Heavy....	-----	17.2	34.5	18.5	80.5	8.6	71.9
After sulphuring (24 hours' standing).	87871	do....	-----	16.5	33.5	26.0	72.4	8.4	64.0
Before sulphuring.....	87892	None....	61.0	12.2	32.9	60.8	36.5	24.6	11.9
After sulphuring (from sulphur tower).	87893	Heavy....	-----	21.3	32.75	73.6	24.8	18.4	6.4
After sulphuring (24 hours' standing).	87894	do....	7.0	15.4	36.0	77.5	21.7	15.1	6.6
Before sulphuring.....	87902	None....	50.0	13.3	38.5	49.3	49.6	19.2	30.4
After sulphuring (from sulphur tower).	87903	Medium....	22.0	17.8	36.5	61.3	36.7	17.5	19.2
After sulphuring (24 hours' standing).	87904	do....	14.0	17.1	36.5	55.2	43.6	18.8	24.8
Before sulphuring.....	87939	None....	80.0	-----	-----	49.6	48.8	48.8	-----
After sulphuring.....	87940	Medium....	.5	-----	-----	70.8	28.0	25.2	2.8
After sulphuring and clipping.....	87941	do....	58.0	-----	-----	68.6	29.8	29.0	.8
Before sulphuring.....	87942	None....	14.0	-----	-----	20.0	75.4	22.3	53.1
After sulphuring.....	87943	Heavy....	.5	-----	-----	60.3	37.0	21.2	15.8
After sulphuring and clipping.....	87944	do....	.5	-----	-----	58.5	39.9	18.5	20.4
Before sulphuring.....	87945	None....	88.0	-----	-----	59.2	39.4	38.8	.6
After sulphuring.....	87946	Medium....	3.0	-----	-----	71.2	24.2	19.6	4.6
After sulphuring and clipping.....	87947	None....	80.0	-----	-----	65.0	33.2	28.4	4.8
<i>Graded No. 3 White oats.</i>									
Before sulphuring.....	88605	do....	89.0	14.3	36.0	79.6	16.0	11.2	4.8
After sulphuring (from sulphur tower).	88639	Medium....	84.0	15.7	36.5	92.6	5.2	5.2	Trace.
After sulphuring (1 hour's standing).	88606	do....	76.0	15.4	37.0	92.4	4.8	4.8	Trace.
After sulphuring, before cooling....	88607	do....	56.5	15.0	36.0	90.8	6.0	5.2	.8
After sulphuring, after cooling....	88608	do....	89.0	14.6	40.75	84.4	12.4	10.0	2.4
After sulphuring and clipping.....	88609	do....	67.0	14.8	41.0	83.2	13.6	12.0	1.6
<i>Graded No. 3 White oats.</i>									
Before sulphuring.....	88610	None....	63.0	15.2	37.0	88.8	8.8	7.2	1.6
After sulphuring (from sulphur tower).	88611	Medium....	9.0	15.7	39.8	92.8	6.0	5.6	.4
After sulphuring, before cooling....	88640	do....	53.5	15.7	40.5	90.6	7.8	7.0	.8
After sulphuring, after cooling....	88612	do....	66.0	15.3	39.5	88.0	8.8	8.0	.8
<i>Bin-burned oats.</i>									
Before sulphuring.....	88672	None....	21.0	14.0	35.5	28.0	69.2	18.4	50.4
After sulphuring (from sulphur tower).	88673	Medium....	-----	14.7	35.5	44.4	51.6	12.8	38.8
After sulphuring, before cooling....	88696	do....	-----	15.0	35.8	54.0	43.2	10.8	32.4
After sulphuring, after cooling....	88697	do....	-----	14.5	35.6	56.0	41.2	8.8	32.4
<i>Graded No. 3 White oats.</i>									
Before sulphuring.....	88670	None....	79.5	14.2	32.0	62.4	35.6	33.6	2.0
After sulphuring (from sulphur tower).	88671	Medium....	22.5	15.1	32.0	26.0	21.6	20.4	1.6
After sulphuring, before cooling....	88698	do....	26.0	15.3	31.8	79.6	17.6	16.4	1.2
After sulphuring, after cooling....	88699	do....	44.5	15.4	32.25	80.2	17.4	14.0	3.4

TABLE I.—*A comparison of oats before and after bleaching—Continued.*

	Laboratory No.	Sulphur reaction.	Germination.	Moisture.	Weight per bushel.	Oats appearing sound.	Total oats appearing damaged.	Oats appearing damaged by agencies other than heat.	Oats appearing heat damaged.
<i>Graded No. 4 White oats.</i>									
Before sulphuring.....	88781	None....	<i>P. ct.</i> 61.0	<i>P. ct.</i> 12.3	<i>Lbs.</i> 33.25	<i>P. ct.</i> 76.0	<i>P. ct.</i> 22.8	<i>P. ct.</i> 21.6	<i>P. ct.</i> 1.2
After sulphuring (from sulphur tower).	88782	Slight....	17.5	17.1	33.25	82.4	15.6	14.8	.8
<i>Graded No. 4 White oats, clipped.</i>									
Before sulphuring.....	88757	None....	67.5	13.6	35.0	79.2	19.6	16.8	2.8
After sulphuring (from sulphur tower).	88758	Heavy....	9.5	16.6	38.0	94.8	4.0	4.0	-----
After sulphuring (24 hours' standing).	88773	Slight....	45.5	16.0	37.6	89.6	8.8	8.0	.8
After sulphuring (24 hours' standing—steam).	88774	---do....	27.5	16.5	37.5	89.8	9.4	7.6	1.8
<i>Bin-burned oats.</i>									
Before sulphuring.....	88783	None....	10.5	12.1	33.25	28.0	69.6	14.8	54.8
Before sulphuring, clipped.....	88784	---do....	14.5	12.2	36.0	26.0	71.2	13.2	58.0
After sulphuring, clipped (from sulphur tower).	88785	Medium....	1.5	18.2	33.0	45.0	52.0	13.6	38.4
After sulphuring, clipped (from sulphur tower—steam).	88786	Heavy....	-----	25.5	30.25	39.8	55.6	12.8	32.8
After sulphuring, clipped (24 hours' standing).	88830	---do....	9.0	16.7	35.7	53.0	45.0	13.6	31.4
<i>Clipped White oats.</i>									
Before sulphuring.....	88846	None....	82.0	14.5	40.4	92.4	6.4	4.4	Trace.
After sulphuring (from sulphur tower).	88847	Heavy....	-----	18.6	36.7	92.4	6.4	5.6	.8
After sulphuring (24 hours' standing).	88848	---do....	14.5	18.3	37.3	89.2	9.6	8.0	1.6
<i>Graded No. 3 White oats.</i>									
Before sulphuring.....	88726	None....	70.5	14.2	-----	87.6	11.6	10.0	1.6
After sulphuring (from sulphur tower).	88727	Medium....	-----	14.8	-----	72.0	23.6	13.2	10.0
After sulphuring (loading into car)	88728	---do....	33.0	16.0	-----	71.6	25.2	14.4	10.8
<i>Graded No. 3 White oats.</i>									
Before sulphuring.....	89231	None....	90.5	12.4	33.0	82.0	12.8	12.4	.4
After sulphuring (from sulphur tower).	89232	Slight....	84.5	12.8	34.0	93.0	3.6	3.2	.4
After sulphuring, before cooling....	89240	---do....	82.5	13.0	35.3	89.2	4.4	4.4	-----
After sulphuring, after cooling....	89241	---do....	77.0	12.7	34.7	86.8	6.0	6.0	-----
<i>Bin-burned oats.</i>									
Before sulphuring.....	89242	None....	5.5	12.7	34.6	14.4	82.8	20.8	62.0
After sulphuring (from sulphur tower).	89243	Slight....	-----	13.1	34.6	34.6	62.4	8.4	54.0
After sulphuring, before cooling....	89244	---do....	-----	13.1	36.5	37.6	61.2	17.2	44.0
After sulphuring, after cooling....	89245	---do....	1.5	13.1	35.6	26.6	70.2	5.6	64.6
<i>Graded No. 3 White oats.</i>									
Before sulphuring.....	89139	None....	90.0	12.0	30.0	81.2	14.0	14.0	-----
After sulphuring (from sulphur tower).	89140	Slight....	77.0	12.7	27.3	87.0	7.6	7.2	.4
After sulphuring (24 hours' standing).	89143	---do....	84.0	15.5	25.0	78.0	10.8	10.8	-----
<i>Graded No. 3 White oats, clipped.</i>									
Before sulphuring.....	89141	None....	95.5	12.6	32.3	86.0	9.2	9.2	-----
After sulphuring (from sulphur tower).	89142	Slight....	-----	17.8	27.3	88.0	9.2	9.2	-----
After sulphuring (24 hours' standing).	89144	---do....	42.0	19.1	28.7	88.8	7.2	7.2	-----

70.58

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270