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BLEACHING OF FLOUR

By E. F. LADD and R. E. STALLINGS

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BLEACHING OF FLOUR

BY E. F. LADD AND R. E. STALLINGS.

The question has been frequently asked of this Department whether the bleaching of flour, as now practiced in some of the flour mills, would make the product in violation of the law in this state, or of the National pure food law.

The attention of this Department was first called to the matter of flour bleaching in 1905, and there have been made investigations and observations since that date to determine just what attitude the Department should assume with regard to this important question. Now that the National law will soon come into force, it is very important that some decision be made in order that millers as well as dealers may know whether their products are in violation of the food law.

As showing the attitude and opinion of other investigators it may be said that Professor Fleurent, in an address before the International Congress of Millers in Paris, stated that flour bleaching is primarily due to the absorption of nitrous products by the fatty matters. That the gases which are efficient agents in bleaching flour are identical whether produced by electrical or chemical processes. That ozone is a useless bleaching agent, and positively harmful. In his experiments he showed that the character of the fats was changed, as indicated by its iodine absorption. That the acidity of the flour was by treatment increased, and that there was from 20 to 50 milligrams of the nitrogenous matter absorbed by the flour to 1000 grams, and that in the bread itself, produced from such flour, there was found from 15 to 38 milligrams. He then raised the question as to whether the presence of nitrous acid or of nitrites would be considered harmful or physiologically active as consumed in the bread and various other food products containing flour.

Brehm, as the result of a critical study of the Alsop

method of bleaching flour states that the method depends upon the formation of nitrogen dioxide which is allowed to act upon the flour, and that the odor and baking quality of the flour were unfavorably affected and its acid contents increased.

According to this author the color was not improved by bleaching, and he concluded that ozone cannot be used as a bleaching agent, since it imparts an odor to the flour which renders it unfit for use.

Snyder (Bulletin *85, University of Minnesota Agricultural Experiment Station) concludes, as a result of experiments before the method had been commercially adopted in this country, "that color is an important characteristic in determining the commercial value of flour and because of this, processes have been devised for bleaching and improving the color of inferior flours." He says that bleaching did not improve the bread making qualities of the flour; the loaves from the bleached flours being smaller and lighter in weight. And he concludes that there appears to be no gain in bleaching purified flours made from a good quality of wheat.

Dr. Fischer of Wisconsin, in personal correspondence says:

"Several years before I became connected with the Wisconsin Dairy and Food Commission, I did a little work on the bleaching of flour with nitric acid for a friend of mine who was in the milling business, and at that time concluded that the practice was a fraudulent one, and so informed my friend."

It will thus be observed and it is generally maintained that the process of bleaching is a questionable practice.

Tasker, in an address before the London Flour Trade Association, said: "The process of bleaching should be carefully avoided or it will do the trade great harm." And he then quotes the opinion of an English baker who says: "Bleaching is no good to any one except to the miller who wants to deceive his buyers and then hunt around for fresh ones." To which Tasker adds: "That is the general opinion, though it may not be put so straight very often."

One clause in the rules and regulations for the enforcement of the National food and drug act reads:

"The term 'stain' includes any change produced by the addition of any substance to the exterior portions of foods which in any way alters their natural tint."

It is, therefore, difficult to see how flour should escape being brought under the term of this clause when the same has been bleached.

Again, the clause with regard to the application of preservatives would seem to provide that if there remains a harmful residuum in the prepared product the sale of the food would be illegal.

Fleurent concludes that bleaching acts as a preservative for the flour. If this be true, and there is present an appreciable quantity of nitrous oxide, nitrous acid, or of the salts of nitrous acid, then the flour becomes illegal.

The National Standard Dispensary says with regard to the action of nitrites, under amyl nitrite, that they produce cyanosis, throbbing in the head, vertigo, staggering, roaring in the ears, hurried and deep or occasional respiration, increase in the force and rapidity of the heart, decrease in blood pressure and temperature, and finally complete relaxation." Medicinal amounts depress the motor centres of the spinal chord, and over-doses depress the motor nerves and sensory centres of the chord and muscles." The dose of amyl nitrite is from three to five drops. The medicinal dose of sodium nitrite is from one to two grains which acts similar to amyl nitrite, but somewhat more slowly.

It becomes, therefore, important to determine the effect on flour of the bleaching, and whether nitrous oxide or nitrites are present in the bleached flour; and further, whether these products remain as a constituent of the bread when the same is ready for consumption. It is also important to determine whether the process of bleaching has in any way injured the quality of the flour, and whether the process as practiced permits of fraud in the handling and sale of flour.

After having made some preliminary investigations with flours as found upon the market, and with samples of known quality from the mills, before and after bleaching, it seemed

desirable to conduct an investigation under the personal supervision of a member of our staff, and therefore Mr. R. E. Stallings was authorized to make certain investigations, the results of which are presented herewith:

Nov. 12, 1906.

Prof. E. F. Ladd:

Dear Sir:—In accordance with your instructions I visited Valley City on October 13th and investigated the bleaching of flour both by the Williams and the Alsop process. I secured samples of their patent unbleached, bleached for sale, and two samples, at my request overbleached one for 5 minutes and the other for 15 minutes. I also secured samples of their "clear" or second grade under the same conditions as the Patent. The methods of bleaching by both processes are essentially the same, by passing an electric current through the air and forcing this air into agitators where the flour is exposed to this air for about 1 minute. The samples were brought to this laboratory where they were carefully tested to note the influence of bleaching. Enclosed will be found a formal report of these tests together with tests of other flours known to have been bleached.

Very respectfully,

(Signed)

R. E. STALLINGS, Asst. Chemist

TESTS FOR NITROUS ACID.

In all the bleached samples the presence of nitrous acid was found and the absence of nitrous acid in the unbleached. It was found in large quantities in the overbleached. A quantitative estimation was ascertained in several cases as follows:

- No. 1.—Patent bleached for trade in 5 grams.....0034 Mgs. of N.
This calculated as Sodium nitrite (5 grams).....01671 Mgs.
Calculated in flour for making 1 loaf (373
grams).....1.24656 Mgs. NaNO₂
- No. 2.—Patent over-bleached for trade in 5 grams.....0300 Mgs. of N.
Calculated as Sodium nitrite in 5 grams.....014785 Mgs.
Calculated in flour for making 1 loaf (373
grams).....11.0296 Mgs. NaNO₂
- No. 3.—"Clear" bleached for trade in 3 ½ grams.....0046 Mgs. of N.
Calculated as Sodium nitrite in 3 ½ grams.....02267 Mgs.
Calculated in flour for making 1 loaf (373
grams).....2.4159 Mgs. NaNO₂

The above samples are from Valley City.

The following samples taken in the Moorhead Mill.
(Williams Proc.)

- No. 4.—Patent bleached for trade in 3 ½ grams.....0025 Mgs. of N.
Calculated as Sodium nitrite in 3 ½ grams.....01232 Mgs.
Calculated as NaNO₂ in 1 loaf (373 grams).....1.313146 Mgs.

The question arose whether the nitrous acid or nitrites remained in the bread. After baking, the bread was cut in small pieces treated with water in the case of the patents shown above and nitrous acid reaction was plainly gotten. An attempt was made to determine quantitatively the amount, but I do not believe the results obtained are accurate but fall short of the amount contained in the bread as it would be difficult to extract the total amount by treating with water as it would not easily penetrate every portion and dissolve it out readily. Following are the results obtained however:

Patent bleached for trade, same as No. 1.

- N.....0025 Mgs. in ½ oz. of bread.
NaNO₂.....01232 Mgs. in ½ oz. of bread.
1 loaf of 18 oz.....44352 Mgs. of NaNO₂

Patent overbleached, same as No. 2.

- N.....0200 Mgs. in ½ oz. of bread
NaNO₂.....0985 Mgs. in ½ oz. of bread
1 loaf of 18 oz.....3.546 Mgs. of NaNO₂

The method of the determination of nitrites was as follows:

A given amount of flour or bread, as the case may be, was weighed, placed in a flask and a given amount of pure distilled water was added. The flasked was then corked and agitated at short intervals for 30 minutes; the solution was then filtered and an aliquot portion taken and treated as follows: One drop of concentrated hydrochloric acid was added, 1 cc. of the sulphanilic acid solution was added, followed by 1 cc. of a solution of hydrochloride of naphthylamine; this mixture was shaken, covered with a watch glass and set aside and allowed to stand for 30 minutes. At the same time a known amount of the standard solution of sodium nitrite was treated in the same manner. At the end of 30 minutes these solutions were compared with the standard in the colorimeter.

BAKING TESTS.

Two bakings were made to see if there was any difference in the size of the loaves from bleached and unbleached flours. The amount of flour was carefully weighed in each case and the same amount of sponge was added and the results are as follows:

Baking	Size	Amt. of flour.
Baking October 23.		
Unbleached (Honey Bros.) Patent	23¼x18¼ in.	373 grams.
Bleached (Honey Bros.) Patent	23¼x18¼ in.	373 grams.
Unbleached (Valley City) Patent	25x20 in.	373 grams.
Usual Bleached (Valley City) Patent	24½x19¾ in.	377 grams.
Overbleached (5 min. Valley City) Patent	24½x20½ in.	380 grams.
Overbleached (15 min. Valley City) Patent	24½x19¾ in.	379 grams.
Baking October 25.		
Unbleached (Valley City) "Clear"	25¼x20½ in.	378 grams.
Bleached (Valley City) "Clear"	25x20 in.	378 grams.
Over-bleached (Valley City) "Clear" (5 min.)	25½x20 in.	379 grams.
Over-bleached (Valley City) "Clear" (15 min.)	25¼x20¾ in.	378 grams.

It will be noted that in the above baking a slightly larger amount of flour was used in some cases than in others. This is due to the fact that with the same sponge added the bleached flours having less absorptive power were sticky and it became necessary to add a small amount of flour so they could be easily handled. Some test bakers report that they can make larger loaves from bleached flour than unbleached. This can be easily manipulated as the amount of yeast added in all cases is large and a large loaf can be obtained from any kind or grade of flour. Again, the temperature of the oven will make quite a difference. If the treatment is exactly the same as regards the amount of flour, time of pulling, time of raising, and the same temperatures of baking, *unbleached flours will make larger loaves.*

In regard to the color the bleached flours were whiter than the unbleached. The bread was slightly whiter. Several who tested the bread noted that there was a decided difference in the taste and odor of the breads from bleached and unbleached flours. Personally I do not think they are improved in odor and taste by bleaching and the majority of the people who tested them agree with me. The difference in odor can be noted in the flours. As one visitor to the

laboratory remarked that the unbleached flours smelled like flour, while the treated samples had a pungent smell. In doughing the bleached flours were much more sticky than the unbleached.

EFFECT ON THE GLUTEN.

The glutens were tested together with their expansion. The method used as follows: One ounce of flour was weighed out and 280 grains of water were added to the flour in a cup; these were mixed thoroughly with a spatula and all particles were collected into a ball of dough. The cup was covered and allowed to stand for 30 minutes. The starch was then washed out in a stream of luke warm water. The glutens obtained in the case of the unbleached were creamy in color while the bleached were whiter. The glutens were then placed in the Foster tester and baked for 25 minutes in the oven at 200 degrees C. The weights were removed after the first ten minutes. The following shows the results of these tests:

EXPANSION.

No.	Flour	Expansion (inches)	Tester	Flour Used
No. 1	Patent Overbleached	2.8	} Alsop	31 grams
	Patent Unbleached	3.6		
No. 2	Patent Bleached	3.5	} Williams	31 grams
	Patent Unbleached	4		
No. 3	Patent bleached for trade	3	} Alsop	31 grams
	Patent Unbleached	3.6		

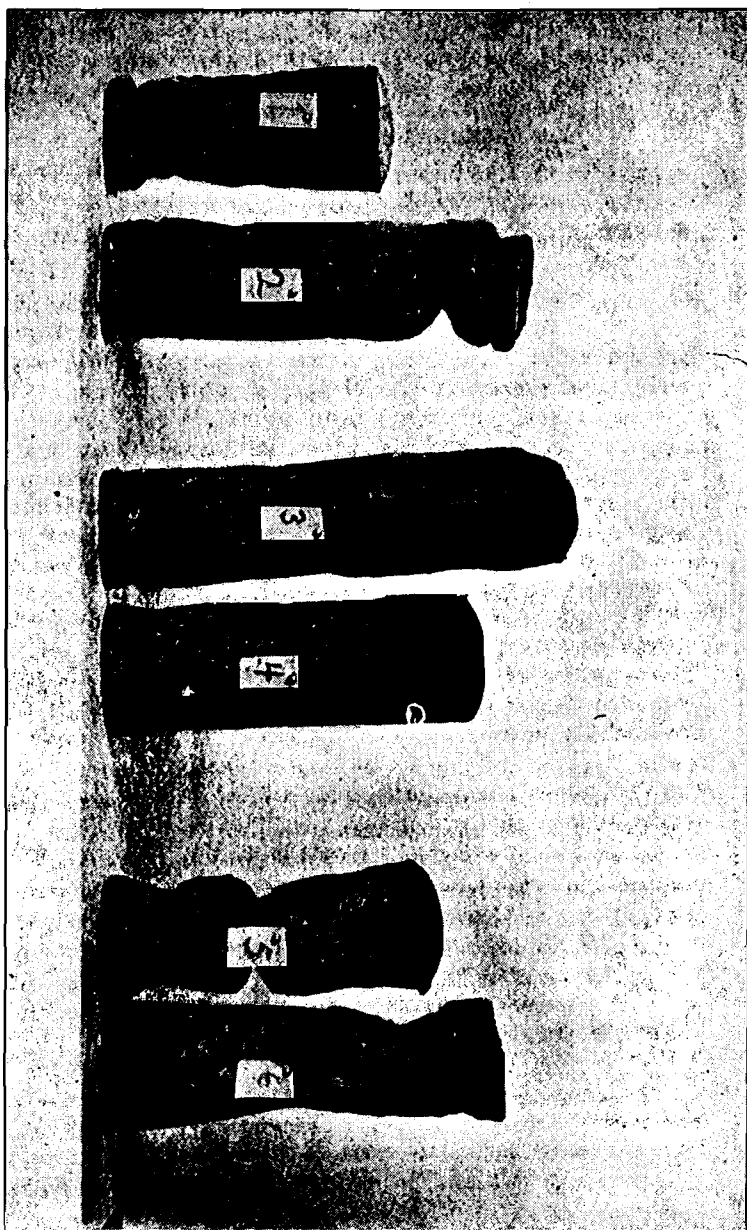
A test on the absorption of water by flours proves beyond a doubt that unbleached flour will absorb more water than the bleached flour. On this absorption one of the bread making values of a flour depends. The following shows the result of the test:

Flour	Absorption (Per Cent)	Tester
Patent unbleached	69.5	} Alsop
Same Patent bleached for market	64.	
Same Patent overbleached	60.	
Patent unbleached	68.	} Williams
Same Patent bleached for market	63.5	

CONCLUSIONS.

The only excuse offered by the millers for the use of bleaching processes is that it makes their flour whiter. Snyder says (Bulletin 85 Minn. Ex. Sta.): "The bleaching of flours only tends to destroy the characteristic and natural color which is desirable as indicating character." The processes for bleaching have been devised for bleaching and "improving" the color of inferior flours. The manufacturers of these processes openly claim that they (the millers) can increase the percentage amount of patent produced. From our tests it would seem that this could be done without the purchaser becoming any the wiser because the clear grade of flour was susceptible of being "improved" as well as the patents. The absorptive and expansive powers of the glutes are decreased and the bread will make a smaller loaf after being bleached. The presence of nitrous acid in the flour not only gives the bread a decided odor and taste but it would seem that the amount present in the bread would be harmful physiologically. In the overbleached there is approximately about 1-6 of a grain calculated as sodium nitrite in the flour used for 1 loaf of bread. While the results obtained indicate that there is a loss of nitrous acid in the bread from that in the flour, I do not believe such to be the case. I do not think that there would be any loss whatever in the process of baking and the amount present in the bread would be equal to the original amount in the flour. We have had occasion previously to examine flours on the market that were overbleached and gave reaction as strong as the one overbleached by myself.

The claim is made that nitrous acid will form in flour from the air. Our experiments do not indicate this to be the case. Two samples of flour were taken from the Fargo Mill, one a patent and the other a "straight." They had been on hand in the mill for at least five months and possibly longer. In these no trace of nitrous acid was found. In a sample brought up by Oscar Dahlgren which he had had on hand for two months and claimed to be unbleached showed on examination to contain a slight trace, but not enough to even read in the colorimeter. There can be no doubt that



No. 1. Overbleached
No. 2. Same unbleached

No. 3. Unbleached
No. 4. Bleached for trade

No. 5. Bleached for trade
No. 6. Same unbleached

unbleached flours lying along side of bleached flours or unbleached flours from a mill where bleaching is practiced will become contaminated, as it is a well known fact that flours have the power of readily absorbing any gas or foreign odor in which it is placed.

The preceding data by Mr. Stallings, are only confirmations of results which have been secured repeatedly on samples of flour and bread made therefrom in this laboratory for the past eight months. In the foregoing table the sample marked as "overbleached" does not contain a larger amount of nitrites than has been found in some of the commercial samples of flour on the market in this State before the present agitation began on the question of bleaching. At the present time the flour is not being bleached to the extent that it formerly was.

That the gluten of the flour is injured by the process of bleaching would seem to be clearly shown by the data presented, and in the plate showing the expansion of the baked gluten as already given. The experiments have also clearly shown that flour kept in a mill where the process of bleaching is conducted may be expected, as the result of absorption, to give a reaction for nitrous acid. Samples of unbleached flour in our laboratory (contained in bags) gave no reaction for nitrous acid or nitrites, but when placed between two bags containing flour which had been bleached soon absorbed a determinable quantity of the nitrous acid. On the other hand, samples of flour have been examined which have been kept for the past eight months in our laboratory away from the fumes of nitrous acid, and give no reaction at the present time for this product.

In further confirmation of the fact that nitrous acid is not generally absorbed by the flour under ordinary conditions our examinations of a flour which had been kept for at least five months in a flour mill where there had been no bleaching showed clearly no reaction for nitrous acid or nitrites; neither does the bread produced in this laboratory from such flour give any reaction for these ingredients. Every sample of bread produced from bleached flours, however, has shown clearly a reaction for nitrous acid, and the product was

present in all cases in determinable quantities. And while in most cases our results were not quite as high as those of Professor Fleurent, nevertheless the relation between the nitrous acid in the flour and that in the bread prepared from the same corresponds closely with his figures.

OPINIONS REGARDING THE BLEACHING OF FLOUR.

It seemed desirable to gather, as far as possible, from the several millers, information with regard to the claims set forth for the bleaching of flour. Also the expression of those who have looked into the matter, or were using the processes of bleaching, therefore, a letter, together with the accompanying questions were submitted to a large number of millers throughout the Northwest:

1. What are the advantages of bleaching flour?
2. Is there danger of over-bleaching flour?
3. What are the effects of over-bleaching?
4. Does bleaching effect the bread producing capacity of flour?
5. What method, if any, do you employ for bleaching flour?
6. By bleaching is it possible to dispose of the lower grades for a better price?
7. Has it been your experience that bleached flours have given consumers as good satisfaction as the unbleached flour?
8. By bleaching can wheats be milled to better advantage and, if so, for what reason?
9. If bleaching is beneficial how do you account for the opposition from European bakers, and leading Eastern bakers in this country?
10. Any further information or suggestions will be much appreciated.

In reply many answers were furnished, some of which were very evasive and others straight forward. In some instances manufacturers declined to furnish information,

Much fault has been found by buyers with bleached flours, and bleaching makes it impossible for buyers to judge of the quality of the flours by the recognized standards, and are thus led to purchase inferior flour which is over-bleached and will give an endless amount of trouble. And the only advantage seems to be that to the miller, who desires to give his trade an inferior product in the hopes of increasing his profits but he is bound to lose in the long run."

No. XIV. "Bleaching is done principally to deceive; it takes the strength from the flour; the loaf of bread is smaller and sickly looking, especially when over-bleached. The process is not beneficial, and while a majority of mills bleach, 99 in every 100 are sorry that bleaching was ever invented."

No. XV. "There is no advantage in bleaching; it destroys somewhat the rising quality of the dough when over-bleached."

No. XVI. "No advantage in bleaching; does away with the strength of the flour, and the unbleached flour always gives the best satisfaction, and the process is not beneficial."

No. XVII. "At the very commencement of the new crop bleaching enables the miller to remove the natural bloom and produce a uniform tint. Over-bleaching commonly results in a dead white flour and a great loss of flavor. We do not believe in bleaching, and bakers in the old country will not use bleached flours knowingly, but are probably using much bleached flour not being able to detect it, but bleached flours are not as good as the natural article."

No. XVIII. "The principal advantage of bleaching seems to be in the aging of the flour and, if over-bleached, gives to the flour a bluish tint, and an unpleasant taste in the bread. It enables the mixing of the better lower grades with the high grades. 'But you cannot fool all the people all the time.' Bakers prefer to do their own plending and bleaching."

No. XIX. "The chief advantage is that it enables the miller to sell the flour made from the cheaper and undesir-

able grades of wheat as flour made from higher priced grain. He often mixes five per cent. or ten per cent. or twenty-five per cent. as may be safely done of the low grade, with the patents and sells it all as patent flour. Over-bleaching flour shows upon the face of it that it has been treated with some villainous process which has destroyed its character. It is lacking in bloom, is a deception wherein the miller has attempted to profit. It enables the miller to avoid skill, and the bread producing quality of the flour is damaged just in proportion as the miller cheats by this artificial means. The despised yellow berry can be milled and bleached and passed off as a product of the highest grade spring wheat.

We do not consider bleaching to be beneficial in the true sense of the word, and intelligent bakers and consumers do not like to be deceived and are, therefore, opposed to this process. And aging produced in the flour by the quick process does not correspond to that produced by nature. The bleaching destroys the essential oil and the consequent yellow of the flour is thereby destroyed, as is also the flavor, and any expert would at once detect a bleached flour by the taste as compared with the unbleached.

Bleaching is a reproach to the milling trade comparable to nothing that has obtained general acceptance, and will defeat its own purpose. It is an abomination, a deceit, a serious commercial venture; this is the first process to which millers have yielded in this country, and in five years hence no intelligent miller will confess that he ever owned a bleaching machine."

No. XX. "The merry miller with his devious bleaching machine maketh the age to grow upon his flour beyond its years, and the patient buyer he carrieth the bag."

No. XXI. "I have never had any hesitancy in saying that if a flour is bleached only sufficiently to remove the yellow or cream color, or, in other words, if it is not over-bleached, that the quality of the flour is not injured in any way. The change from a creamy white to a dead white is not an improvement, and is particularly undesirable in spring wheat flours (which have always commanded a premium) for they lose

their distinctive appearance. Over-bleaching is injurious, and produces dough of less volume or absorption. Bleaching enables the miller to produce a slightly larger percentage of higher grades."

Information given by one of the leading flour laboratories throws some light on this subject when they say:

"We have found it is not necessary to bleach all flours; in fact soft winter wheat flours are not improved by bleaching as they already have a very high color and if this color is intensified it makes the product look sickly." They further state that "certain varieties of Kansas and Oklahoma wheats have always sold at a more or less lower figure than other wheats for the reason that they make a flour of a dark yellow color."

One would infer from this then that these wheats not recognized as the equal of Northwestern spring wheats can, by the process of bleaching, be made to resemble the Northwestern spring wheat flours and to be sold as such, but it is questionable whether they pay the farmer anything additional.

In a circular gotten out by one of the promoters of electrical bleaching they say:

"The degree of bleaching is regulated by the amount of current flowing through the cell and is controlled by a rheostat, and when adjusted any variation is impossible."

"Flour treated by this process, after a thorough analysis of the tints by the use of tintometers, was pronounced by flour inspectors to have the spring wheat tinge that is so desirable in flour. All varieties can be whitened, without the loss of the bloom."

In personal correspondence with one of the firms producing the bleaching apparatus they stated: "By bleaching more of the berry can be utilized for patents." Again, "When bleaching processes were first introduced, some millers being enthused by the great improvement in the appear-

ance of their flours, endeavor to substitute lower grades of flours for their established grades. This of course can be done to a certain degree; it was very much overdone by some millers, but it is readily detected by the baker and of course there is nothing to do on the part of the miller but to make it good."

GENERAL CONCLUSIONS.

1. Has any one a right to treat a product like flour which forms the basis of our food products by a chemical process unbeknown to the consuming public?
2. Bleaching is not an improved milling process, but is the introduction of chemical agents for the purpose of treating the flour which is analagous to the bleaching of fruit and other food products.
3. There is employed in this process of bleaching a chemical agent physiologically very active.
4. The bleaching agent is nitrous oxide.
5. Nitrous oxide remains in the flour after bleaching.
6. Nitrous oxide or the salts resulting therefrom remains in the bread produced from flour so bleached.
7. The quality of the gluten is injured by bleaching.
8. It is recognized that ozone is not a bleaching agent which can be used for flour bleaching.
9. Bleaching permits of using low grade flours in place of patents.
10. Low grade flours produced from well cleaned wheat can be successfully bleached to resemble high grades or patents.

IS FLOUR HARMED BY BLEACHING?

Yes, in TWO ways.

1. Valuable vitamins are destroyed by the bleach chemical. When cattle are fed grain without these vitamins, they show no harmful effects until they suddenly drop dead. (See "Science" Vol. 104, No. 2701, p. 312.) (Copy on request.)

Note that heart disease is the LEADING CAUSE OF DEATH in this country. IS IT THE BLEACHED FLOUR WE EAT? Heart disease is rare in China where bleached flour is also rare.

2. Bleached flour is so poisonous to dogs that they get "running fits" from eating white bread, a common disease known to all veterinarians. Heretofore considered as due to the wheat proteins, the disease has recently been proven to be DUE EXCLUSIVELY TO BLEACH CHEMICALS IN THE FLOUR. (This was reported in "Nature", June, 1947 in the article "Agenized Flour.")

3. Bleached white flour was declared unfit for human food by the Federal Western District Court of Missouri in 1910 and subsequently wound up in a maze of legal technicalities that was finally settled in 1919. Although the Supreme Court demanded a new trial due to a legal slip in the original proceedings, it clearly outlined the scope and intent of the Pure Food Law. (Sup. Ct. Rpts. Oct. 1913, book 58 Law Ed. pp. 658-663.)

The enforcement of this decree, according to Dr. Harvey W. Wiley, (First Chief of U.S. Food & Drug Administration) was halted through the political influence of the flour millers, and no notice of violations has since been made by the inspectors of the U.S. Food & Drug Administration. (See Dr. Wiley's book, "The History of a Crime Against the Pure Food Law", at your public library, published by himself, 1929, pages 383-389.)

"Thus the very law which the Supreme Court has said was enacted chiefly to protect the public health has been turned into a measure to threaten public health and to defraud the purchaser of flour." (Dr. Wiley, p. 391.)

(Comment by Lee Foundation for Nutritional Research-- January, 1951.)

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