

THE PASTEURIZATION OF MOZZARELLA CHEESE*

A. E. ABRAHAMSON, *Chief Wholesale Division*
EDWIN LUDEWIG, *Director, Bureau of Food and Drugs, and*

PAUL CORASH, *Chief, Division of Milk and Milk Products Inspection*
N. Y. C. Dept. of Health

This article describes mozzarella cheese, its method of manufacture and the difficulties that confront the Department of Health of the City of New York in causing industry to comply with regulations of the Sanitary Code requiring mozzarella cheese to be made from pasteurized milk.

Mozzarella cheese is a variety of cheese formerly limited in distribution to the Italian segment of our population. It was used mainly for cooking. However, some of it is consumed in an uncooked state. This cheese has recently attained such a popularity that its acceptance is extending to other population groups. The leading producers of mozzarella cheese estimate that there are about 30 firms of significant size producing this cheese in New York City. There are more than 150 distributors, and from 40,000 to 50,000 pounds of mozzarella cheese are manufactured daily.

In New York State in 1949 about 30 percent of Italian cheese curd was made from raw milk, most of which was used for mozzarella cheese. Italian cheese such as Ricotta during that year was made in the main from pasteurized milk.

DESCRIPTION

Our problem in 1948 related to mozzarella cheese, the curd of which is made generally from partially skimmed milk of a grade used for manufacturing purposes containing 1, 2, or 3 percent milkfat. This milk is heated to about 86°F and set with rennet usually for about 30 minutes. The curd is cut and stirred. It is separated from the whey when the latter flows freely. The curd is packed in a large cloth, cooled, and later shipped, packed in ice to plants in this city.

In the city manufacturing plant the curd is stored until regarded as workable or ripe. Small samples of each lot are tested daily for ripeness. This is accomplished by

*Read before New York Conference of Health Officers and Food and Drug Officials March 13, 1952.

hand working the cheese in hot water of about 130°F until it becomes stringy. When samples work easily the batch is regarded as ripe enough for working.

Working consists of placing about 30 lbs. of curd in a large basin. Hot water of about 180°F is poured into the basin. The mass of curd is broken up with a wooden paddle and submerged in the hot water. This water is then poured off and more hot water is poured over the mass. Working with the paddle continues until the somewhat granular texture of the curd becomes smooth and stringy. The curd then is kneaded by hand into a pear-shaped mass or molded into other shaped pieces weighing about a pound. This work is done rapidly to avoid the loss of butterfat while the curd is in contact with the hot water. The molded cheese is cooled in a brine solution and kept under refrigeration until sold. This hot water process has in very few instances been sufficient as a form of heat treatment to assure pasteurization and to inactivate the phosphatase enzyme.

PUBLIC HEALTH PROBLEM

Food and milk regulatory work is replete with a record of the successful development of procedures, methods, and equipment which have prevented disease and improved nutrition. Until recently, the public health significance of milk technology was not recognized as important in the field of cheese manufacture. Cheese manufacture through the ages has resulted in the formulation of processes and periods of aging which yielded a relatively safe product. However, during World War II in 1943-1944, shortcuts in normal processing were practiced with the result that certain safeguards provided by adequate aging were relaxed, and a number of typhoid outbreaks were reported.

Following the four outbreaks of typhoid in the United States^{1, 2} and Canada^{3, 4} from the consumption of green cheddar cheese, the



Mr. A. E. Abrahamson was born in New York City. Soon after graduation from Columbia University School of Pharmacy, he entered the service of the Department of Health of the City of New York in 1927.

His training includes study in the field of environmental sanitation and food technology at New York University and Massachusetts Institute of Technology respectively.

At present he is Chief of the Wholesale Division of the Bureau of Food and Drugs, American Public Health Association representative to the Bakery Industry Sanitation Standards Committee, and Instructor of Food Sanitation, Food Trades Vocational High School.

Departments of Health of the State and City of New York provided in their sanitary codes that cheddar and similar types of cheese be made of pasteurized milk or be heat treated equivalent to pasteurization or be aged for a period of 60 days at a temperature not lower than 35°F. The Board of Health of the City of New York extended these provisions to embrace all soft cheese including mozzarella.

The studies of some workers seem to indicate this aging period is too liberal. There is ample evidence in the literature of dairy science and public health to show that *Brucella abortus* is viable and may be recovered after six months in cheese made from cow milk positive for *Brucella abortus*.⁵

Federal standards and definitions for cheddar cheese, washed curd, and colby cheese which became effective April 9, 1941, makes the use of pasteurized milk permis-

sive. H
definitic
tage ch
which l
1945, p
be mad

Durir
ing the
pasteuri
readily
tion fro
ment
granted
availabl

Ched
difficult
both in
and the
erly age
were o
and stuc
regulato

Ricott
ian vari
next rec
teurizati
segment
which n

also saw
improver
is pasteu
ing and
Therefor
cheese re
soft chee
unpasteu
pressure
form to t

ment wa
little cor
uct was s
part of t
without c

In Dec
made am
mozzarell
All the
proved vi
tion requ
held with

on Februa
ment of F
to point c
cheese sho
ized milk
subjected
equival
Spokesmer
tained tha
the charac

The make
also conte
ing of th
water is us
ment equip

sive. However, the standards and definitions for cream cheese, cottage cheese, and Neufchatel cheese which became effective March 23, 1945, prescribe that these cheeses be made from pasteurized milk.

During and immediately following the years of World War II pasteurizing equipment was not readily available, and an exemption from the immediate enforcement of these provisions was granted until equipment became available.

Cheddar cheese presented many difficult technological problems both in the use of pasteurized milk and the means of identifying properly aged cheese. These difficulties were overcome by collaboration and study by industry groups with regulatory agents and experts.

Ricotta cheese which is an Italian variety of cottage cheese was next required to conform to pasteurization regulations. Soon the segment of the cheese industry which manufactures ricotta cheese also saw the advantages in quality improvement by using milk which is pasteurized to destroy gas forming and other spoilage bacteria. Therefore, in 1948, mozzarella cheese remained the only un-aged soft cheese which was made from unpasteurized milk. Until then pressure on the industry to conform to the pasteurization requirement was not great because so little comparatively of this product was sold and then only a small part of the output was consumed without cooking.

THE STUDY

In December 1948 a survey was made among some 30 wholesale mozzarella cheese manufacturers. All the samples of this product proved violative of the pasteurization requirement. A meeting was held with the principal producers on February 2, 1949, at the Department of Health of New York City to point out that the curd for this cheese should be made of pasteurized milk or that the cheese be subjected to a heat treatment equivalent to pasteurization. Spokesmen for the industry maintained that pasteurization destroys the characteristics of the cheese. The makers of mozzarella cheese also contended that in the working of the curd extremely hot water is used which is a heat treatment equivalent of pasteurization.

Members of our Department felt that mozzarella cheese could be made from milk pasteurized in the conventional manner. The industry was advised to experiment and develop a suitable method of pasteurization. It was also suggested among other things that small amounts of calcium chloride be added to the milk before pasteurization. One producer who participated in this latter experiment claimed poor results. This experiment was observed by a member of our country milk staff, who confirmed this finding.

On May 11, 1949, a case of undulant fever was reported in New York City. Epidemiological investigation revealed no history of consumption of raw milk, contact with animal hides, or recent meals out of the city. It was disclosed that mozzarella cheese was eaten frequently by the patient. Following this the Department of Health decided to press for compliance with pasteurizing requirements in the manufacture of mozzarella. The industry claimed their use of hot water for processing the curd was the equivalent of pasteurization. This was not substantiated by the results of the following study.

since a failure to solve the matter adequately is likely to result in a prohibition against the manufacture and sale of the cheese."

A new industry conference was held on October 18, 1949. The industry then submitted it was willing to heat milk by flashing to about 130°F. This they maintained would destroy pathogens.

Following this the Department of Health declared to the industry that its policy would be nothing short of the pasteurization requirements, for two reasons: (1) that previous experimental work on cheddar and other cheese supported the soundness of pasteurization; and (2) that an adequate control test such as the phosphatase test was not available to detect failure to use other methods of heat treatment, such as flash heating. The conference concluded with an order that all mozzarella cheese sold in the City of New York must be pasteurized after February 1, 1950, in accordance with the requirement. This date would allow plants ample time to install pasteurizing equipment.

The industry sought the aid of Dr. J. C. Marquardt, Assistant Director Milk Control, N. Y. State

TABLE I

Sample	Phosphatase activity	pH	Filth detected	Standard plate count Colonies per gram
1 a	500 units	5.6	none	1,000,000,000
b	500 "	5.7	"	270,000,000
2 a	500 "	5.9	"	600,000,000
b	500 "	5.6	"	205,000,000
3 a	500 "	5.6	"	1,180,000,000
b	20 "	5.7	"	180,000,000
4 a	500 "	5.6	"	180,000,000
b	50 "	5.8	"	110,000,000
5 a	500 "	5.9	"	2,420,000,000
b	50 "	5.8	"	38,000,000
6 a	500 "	5.8	"	540,000,000
b	250 "	5.6	"	640,000,000

a—represents raw curd

b—represents mozzarella cheese

The Department urged upon the New York State Department of Agriculture and Markets in a communication "that a concentrated attack upon the problem must be made if a proper solution is to be found.—The project is an important one not only from the standpoint of public health but it is highly important to mozzarella cheese manufacturers and to dairymen whose milk goes into the production of this type of cheese,

Department of Agriculture and Markets and then Professor H. T. Gilman at Cornell University.

Dr. Marquardt succeeded in establishing a pilot plant where he observed the pasteurization of the milk used to manufacture mozzarella curd. This curd was then made into mozzarella cheese. It was noted then that numerous difficulties presented themselves requiring a change in manufacturing technique. But it was observed that a better flavored product resulted when pasteurized milk was

s born
grad-
versity
ed the
Health
927.
in the
on and
s Uni-
stitute

of the
Bureau
n Pub-
esenta-
Sanita-
and In-
Food
ool.

the State
vided in
cheddar
eese be
lk or be
pasteur-
period of
not lower
of Health
extended
ce all soft
lla.

workers
ng period
mple evi-
dairy sci-
to show
iable and
six months
cow milk
us.⁵

id defini-
e, washed
which be-
41, makes
ilk permis-

used. On December 5, 1949, we were advised by one producer that he was ready to market a pasteurized product. Dr. Marquardt on January 18, 1950, reported the making of good mozzarella from pasteurized milk and that he was ready to work with other companies. On February 10, 1950, Dr. Marquardt reported continued satisfactory results and that the cheese flavor was improved. Pasteurization was at 161°F for 20 seconds.

The country milk inspectors of the Department of Health were asked to survey country plants producing mozzarella curd. The reports revealed that most of the plants were poor in sanitary development and lacked suitable controls for proper milk heating. Reports were received from various sources including plant personnel alleging that only the dirtiest milk produces curd with the most desirable stringiness, characteristic of mozzarella cheese.

The industry seemed to be floundering from lack of organization among the various producers, and lack of research facilities. The threat of extinction by the Department of Health order prompted the principal producers to seek more time from this Department.

Notwithstanding the fact that a producer now was able to manufacture a legal mozzarella cheese, the other producers still sought an extension of time from the Department. Another meeting was arranged for April 19, 1950. At this time notice was served on the industry that the use of pasteurized milk for mozzarella curd was possible. The regulation was to be enforced.

Soon other producers were shipping mozzarella curd made of pasteurized milk. The smaller local manufacturers had trouble working it. As a result they changed their source of supply to the unpasteurized curd producers.

On July 10, 1950, it was learned that a new mozzarella cheese starter known as DK starter was developed by Professors A. C. Dahlberg and Frank V. Kosikowsky of Cornell University which produced mozzarella curd with the proper properties from pasteurized milk. This starter containing *S. faecales* organism of known characteristics⁶ permitted pasteurized milk curd to

ripen as well as raw milk curd. The flavor and yield were good and the Pizza pies made with this pasteurized cheese were judged excellent. The industry was immediately apprised of this situation.

A period followed in which those who made curd from unpasteurized milk began to take advantage of those who sold acceptable curd and a break-down suddenly appeared. Those who had pasteurized curd complained of loss of customers and notified the Department of Health of their intention to discontinue to pasteurize unless the others do.

ENFORCEMENT

In order to launch our enforcement program we required a means by which to test for proper pasteurization in the field. Our chemical laboratory on March 11, 1950, reported they had developed a field phosphatase test for this product. A staff of inspectors was trained to use this test and a survey of all wholesale mozzarella cheese manufacturers was made. Any lot of cheese produced which was phosphatase positive by field test resulted in an embargo of the curd and cheese. Following laboratory confirmation of a positive phosphatase the owner of the curd and cheese was given the alternative of pasteurizing, or aging a most perishable cheese for 60 days at 35°F. Needless to say, such cheese and curd were voluntarily destroyed.

Complaints continued to pour in that the pasteurization requirement would ruin a substantial business. The industry maintained the new curd had to be worked differently and that the dealers were refusing to accept this condition. Following this, reports were received of spoilage of curd which failed to ripen properly, but embargoes continued and then a few prosecutions were instituted. Court action against one of the larger producers was instituted September 7, 1950.

RESULTS

On October 9, 1950, the principal producers met with members of our Department and agreed to pasteurize mozzarella cheese.

Members of the country staff advised cheese plant operators concerning the installation of pasteurizing equipment (usually short time), and saw to it that the appar-

atus was properly adjusted and capable of doing a satisfactory job of pasteurizing.

During 1950, up to October 10, only 26 of 121 samples had been phosphatase negative. The situation changed suddenly thereafter. All wholesale manufacturers were sampled in 1951. There were 5 samples positive for phosphatase of 127 samples taken. The Department of Health by this evidence had made a substantial advance to obtain compliance.

Beginning August 11, 1950, a survey of all retail manufacturers of mozzarella cheese was concurrently carried out. Numerous phosphatase positive samples were obtained. Each dealer was called in and warned against a recurrence of the use of unpasteurized curd, and a follow-up was made at the establishment of the wholesale supplier of the curd.

A resampling project in 1951 revealed that this phase of the problem was also successfully completed. (4 positive for phosphatase of 95 samples taken.)

A program of enforcement of labeling provisions followed. The mozzarella cheese was required by regulation to be pasteurized and so labeled. This phase was successfully concluded early in 1951.

The country plants which were earlier reported insanitary were ordered to correct plant conditions. Failure to conform to this order would result in embargo of the curd on arrival in the city. No difficulty was experienced. These plants are much improved as a result of this project.

CONCLUSION

A project of great proportions was undertaken when it was decided that mozzarella cheese should be made of pasteurized milk or should be heated so that the product would be subjected to a treatment equivalent to pasteurization. This was especially difficult since a change in the technology of the manufacture of cheese was necessary in an old industry which is steeped in tradition. We were advised at the time by the industry that the requirement could not be carried out and that good mozzarella cheese could not be made from pasteurized milk.

The concensus of the industry now, although grudgingly admit-

Continued on Page 38

The a
the dair
of the
State an
weighed
sponsibi
and to
of the n
censing
of Health
supervisi
Departm
where tl
sumed.
tive resu
requirem
ments of
the inspe
The maj
itan are
ease, cal
efforts e
teurizing
safeguar
contamin

The
consta
ods a
superv
tions o
for pa
after d
supplie
work a
kitchen
and ol
card.
farm t
the ir
water,
house.
tation,
tion bi
and ge
farm. I
enviro
dairy f
mendoi

Ther
shorter
proven
of our
elimina
other c
tion of

*Prese
INTERNA
AND FOC
polis, M:

MOZZARELLA CHEESE

(Continued from Page 24)

ted, is that pasteurized milk makes better mozzarella cheese. The flavor is better and what is more important, the quality can be maintained more uniformly. Thus the consumer is protected and the producer is satisfied. This is also satisfying as a public health accomplishment to those who participated in bringing it about.

We acknowledge with thanks the help of Mr. Elias Kushel, Chief of the Retail Division, and Mr. Andrew Pensa, Chief Chemist, and their staffs. We acknowledge also the help of Dr. J. C. Marquardt, N. Y. State Department of Agriculture and Markets, Professor H. L. Gilman and Professor Frank Kosikowsky, Cornell University.

REFERENCES

1. Typhoid Epidemic in Indiana Due to Eating Green Cheese Made From Unpasteurized Milk, *Public Health Reports*, 59-16.
2. Meyer, K. F. Cheese-borne Epidemics, *Calif. and Western Medicine*, 61, 137-139 (1944).
3. Gauthier, Jacques; and Foley, A. R., Cheese-borne Epidemic of Typhoid Fever, *Canadian J. Pub. Health*, 34, 543-556 (1943).
4. Menzies, D. R. Outbreak in Alberta Traceable to Infected Cheddar Cheese. *Ibid.* 35, 431-432 (1934).
5. Gilman, H. L., Dahlberg, A. C., and Marquardt, J. C. The Occurrence and Survival of *Brucella abortus* in Cheddar and Limburger Cheese. *J. Dairy Sc.*, 29, 71-85 (1946).
6. Correspondence with Prof. Frank V. Kosikowsky, Cornell University.

FEEDING IN LOGGING CAMPS

(Continued from Page 31)

washed in the main by three compartment sinks—pre-soak, washing in detergent, and sanitizing in water not less than 170°F for 2 minutes. This procedure produces low bacterial count dishes for both china and plastic. The use of plastic is increasing as far as plates, soup bowls, and bread and butters are concerned. Preference by practical personnel for plastic is due to ease of washing, light weight, and good drying qualities. Plastic dishes taken from 170°F water dry rapidly and tables can be reset immediately. Plastic cups are not in common use due to staining and

difficulty of cleaning, harsh abrasives soon penetrate the plastic surface, and the resultant cups are difficult to sanitize. However, due to durability and light weight, plastic has almost completely replaced vitreous china on river drives.

(f) The type of heating has a definite bearing on the sanitation of the kitchen. It may be surprising to learn that camps far removed from railroads and in the heart of the woodlands can still cook cheaper with propane gas than wood. The use of propane is increasing and as a result the general cleanliness of the kitchen has improved; no longer do cooks have to handle dirty wood and then return to baking duties where propane is installed.

(g) No discussion on camp cook-

ery would be complete without a word on fly control. Flies are kept to a minimum during the summer by spraying the dining hall and kitchen twice during the summer. Because these camps are located so far from towns or cities there have been no difficulties from DDT resistant strains of flies. Where campsite areas are sprayed it is seldom that a fly even gains access to a kitchen. Fly control is further aided by the strict regulation of garbage removal after each meal and storing in covered receptacles until buried.

In summing it up—the personnel required to oversee the feeding of men in logging camps are well qualified sanitation officers with a background and knowledge of the processing, storage, transportation, and preparation of food.

REPORT OF THE COMMITTEE ON FOOD EQUIPMENT*

Another year has passed and although your Committee on Food Equipment has made some progress which we hope will benefit sanitarians and assist the industry to supply the public with better quality food, we did not accomplish as much as we had desired. Under existing conditions, it was not possible to hold a single committee meeting during the year. We believe that far more rapid progress could be made if some means could be worked out to defray the expenses of the members to attend several meetings annually. Many governmental agencies have curtailed travel expenses for non-official activities. The food industries have awakened to the need for improvement in sanitation and are on the march to satisfy this need. They are looking to sanitarians and particularly our Association for assistance and guidance.

COOPERATION WITH THE NATIONAL SANITATION FOUNDATION

We appreciate the opportunity to continue to cooperate with the National Sanitation Foundation through its Joint Committee on Food Equipment Standards.

Standard No. 1—Soda Fountain and Luncheonette Equipment,

which was released in July, 1952, has been given wide distribution and has had an appreciative general acceptance.

Standard No. 2—Food Service Equipment, was approved prior to our last Annual Conference but was not released until October 1952. The Foundation, through the Executive Director of its Testing Laboratory, has provided the means and personnel for examining and testing equipment to ascertain whether it complies with the standard and whether or not it is eligible to carry the copyrighted "N.S. F." seal. Soda fountain, luncheonette, and food service equipment is now on the market bearing the Foundation seal of compliance with the standard. There have been instances where the Director of the Testing Laboratory has referred back to the Joint Committee items of the standard for clarification and interpretation.

We realize that these standards are not perfect and will have to be changed and improved as knowledge and experience is gained by the sanitarians and by the designers and fabricators of the equipment. Your Committee and the National Sanitation Foundation will welcome your suggestions for improving the standards. If you believe that any equipment or a specific feature thereof, bearing the seal of accept-

*Presented at the 40th Annual Meeting INTERNATIONAL ASSOCIATION OF MILK AND FOOD SANITARIANS, INC., East Lansing, Michigan, Sept. 1, 1953.

ance.
ratio
ly yo
tion.
ards
made
fence
and v
tion c
your
tunity
Aft
Stanc
washi
and p
as we
as yet
seal c
dishw
many
made
this st
We w
ing m
guara
ways
machi
functi
operat
not be
should
to pro
In
stated
more t
ten on
cal ar
two st
ceptan
they n
mons i
Found
tensive
but the
all inte
tained
tion, ar
ing tha
Journal
ogy. If
tical it
each st
all of c
means.
Howe
step, th
sider th
time the
the Fou
by this
our Ass
these st
ed with
able at
sound a
fore, rec