# THE USE OF ULTRA-VIOLET LIGHTS FOR THE CONTROL OF MOULD ON STORED CHEESE.

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**SUMMARY.**

**Ultra-violet lamps installed in a humid cheese storeroom reduced moulding of cheese without affecting its flavour.**

**Mould counts of the storeroom air were quickly reduced by the lamps. Cheese moulding was reduced to such an extent that whereas cheese showed slight moulding in 2-3 days before treatment, no cheese younger than 10 days showed any evidence of moulding after treatment.**

**The efficiency of the lamps is affected by storage temperature and by the amount of ozone liberated.**

## I. INTRODUCTION.

The use of ultra-violet lamps of certain types would appear to be a valuable aid in the control of cheese moulding. Sutton (1941) showed the harmful effect of such light on moulds from cheese but did not investigate its effect on actual cheese moulding. Godbertson (1951, 1952) investigated the effect of ultra-violet light on cheese and on cultures of yeasts and moulds occurring in cheese. He found considerable variation in resistance to irradiation by moulds, obtaining a high but incomplete kill. He also found that the development of microflora on cheese was reduced without the flavour of the cheese being affected. The work reported here was designed to provide information on the performance of ultra-violet light under commercial conditions.

The ultra-violet ray units used in the experiments operate on 240V AC and are of the cold cathode, low-pressure mercury-arc type, emitting radiations in the region of 2,537 Angstrom units, which is the wavelength of maximum germicidal effectiveness. The emission is through fused silica-quartz tubes with an ozone control provided by removable sleeves of special glass. Each tube has a current consumption of 25 watts.

## II. DESCRIPTION OF CHEESE STORE.

The cheese storeroom at a large factory on the Darling Downs was chosen as the site of the trial. This room measures 75 ft. by 30 ft. and has a concrete floor, concrete walls and a wooden ceiling 9 ft. 6 in. high. The cheese is stored on shelves reaching from floor to ceiling and arranged so that there are 22 access bays between the shelves. At one end of the room a space is set aside for packing and crating cheese. There are three insulated sliding doors.

Temperature control of the room is achieved by an air-circulation system in which the air within the room is drawn through trickling chilled water, after which it is forced back into the room through an air-duct. The air-duct flue runs down the centre of the room for its full length. Thus the temperature of the room depends on the air circulation system and the supply of chilled water.

For the following reasons, the air-circulation system is responsible for a considerable amount of moulding in the room:—

(1) The system embodies no filter other than the water, so mould spores can be spread to all parts of the room.

(2) The water itself can, and does, become heavily charged with mould.

(3) The cold water imparts a great deal of moisture vapour to the air, keeping it practically saturated.

In the past the air-ducts and fans have become from time to time so overgrown with mould filaments that the air-flow has been seriously impeded.

There is no doubt that the humidity of the room has been the major factor promoting the growth of mould.

## III. METHODS.

The experiment was run for a period of 18 months from March 1953. During the first six months detailed observations were made. Following this, the overall effects of ultra-violet light were observed for a year of commercial operation.

The value of the lamps in reducing moulding was assessed by progressively surveying the amount of moulding on cheese in store and determining mould counts in the storeroom air. Observations by both methods were made usually at 3-weekly intervals. However, on two occasions the interval between observations was a little longer.

During the first six months, shields were removed from the lamps progressively in order to increase the generation of ozone. Initially only five of the 23 lamps were left bare; later this number was increased to 12, and towards the end of the trial all were exposed to give maximum liberation of ozone.

## IV. RESULTS.

### (1) Mould Counts in Storeroom Air.

Fifteen poured plates of yeast and mould agar were exposed for 30 sec. at evenly spaced positions in the room. The mean mould counts are set out in Table 1 and are plotted in Fig. 1. It will be seen that the lamps were very effective in reducing quickly the counts of mould in the cheese store air. An increase in the amount of ozone did not, however, reduce the mould counts further.

TABLE 1.

MOULD COUNTS IN CHEESE-ROOM AIR.
(Mean Results from 15 Tests.)

| Time of Count. | Mean Mould Count per Plate. | |
|---|---|---|
| Pre-treatment | 66 | |
| 3 weeks after U.V. lights switched on | 18·7 | |
| 6 weeks after U.V. lights switched on | 9 | |
| 9 weeks after U.V. lights switched on | 9 | |
| 12 weeks after U.V. lights switched on | 31 | Cold water shut off. Air temperature increased |
| 15 weeks after U.V. lights switched on | 2 | |
| 18 weeks after U.V. lights switched on | 7 | |
| 22 weeks after U.V. lights switched on | 11·5 | |
| 26 weeks after U.V. lights switched on | 8 | |

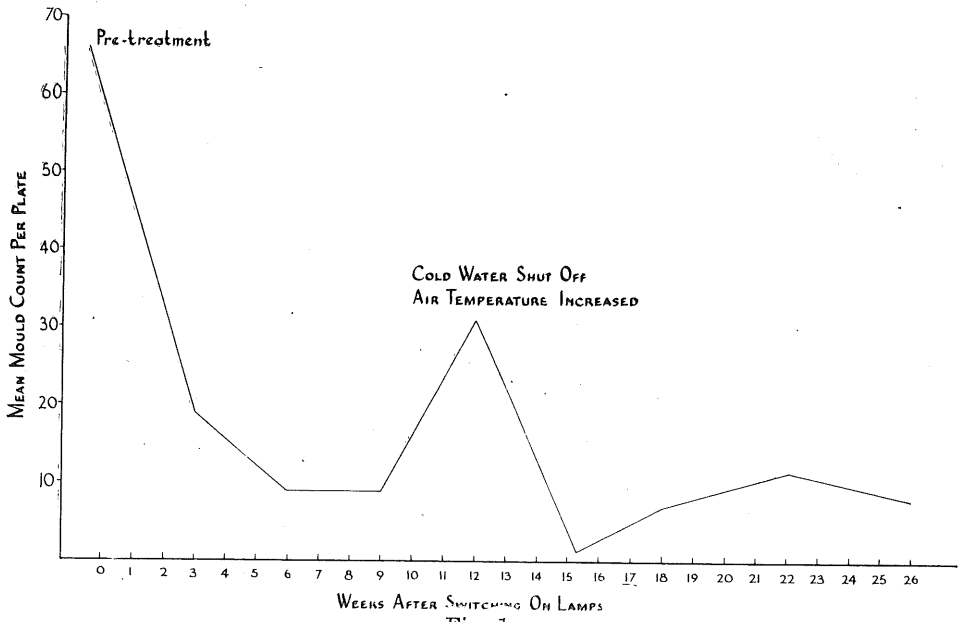


Fig. 1.

MOULD COUNTS IN STOREROOM AIR.

## (2) Moulding of Cheese.

An index of the extent of cheese moulding was obtained by examining every cheese held on the shelves on the day of inspection and classifying mould infestation as very slight, slight, moderate, or heavy. The results obtained are shown in Fig. 2 and are briefly summarised as follows:—

| Extent of Cheese Moulding. | Before Treatment. | After Treatment. |
|---|---|---|
| Very slight | Cheese 3 days old | Cheese 10 days old |
| Slight | Cheese 4 days old | Cheese 18 days old |
| Moderate | Cheese 5 days old | Cheese 28 days old |
| Heavy | Cheese 6 days old | Cheese 28 days old |

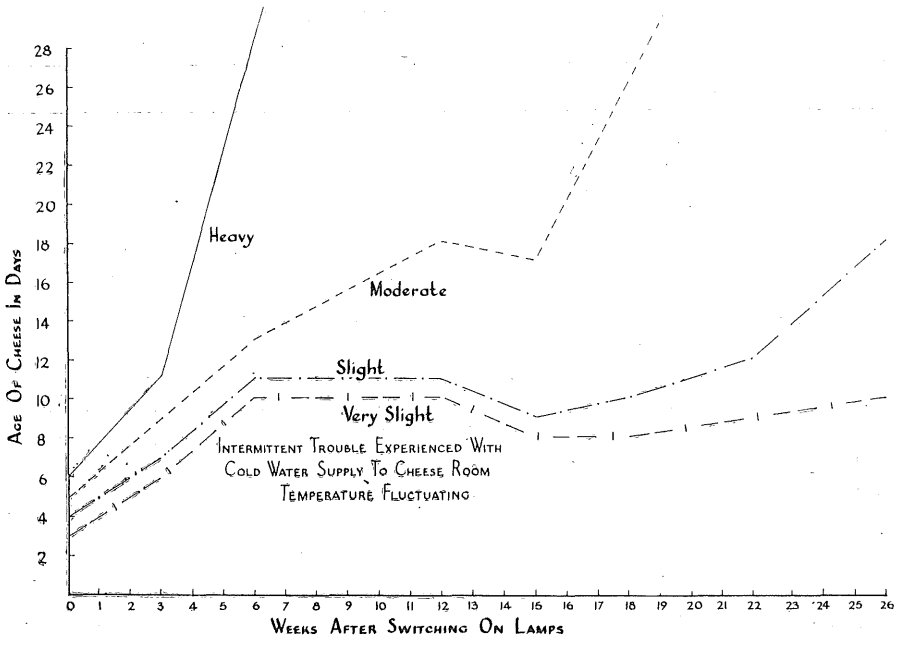


Fig. 2.

Degree of Moulding of Cheese.

No cheese under a month old showed heavy moulding after 6 weeks' treatment, while after 19 weeks' treatment no cheese under a month old showed even moderate moulding. In addition, the minimum age at which cheese showed slight and very slight moulding increased from 4 days and 3 days at the commencement of the trial to 18 days and 10 days respectively after 26 weeks' treatment.

### (3) Temperature and Humidity of Storage.

The daily temperature of the room recorded at 8 a.m. varied between 47 deg. and 52 deg. F., with relative humidity between 81 and saturation.

At one period after the trial had been in progress for six weeks, partial blockage of the cold water pipes caused faulty cooling of the room. The fluctuating temperatures observed during this period caused an increased development of moulds, which was reflected in both mould counts and moulding of cheese. These observations indicate that under the humid conditions experienced, the maximum storage temperature permitting satisfactory control of moulding by ultra-violet lamps is approximately 52 deg. F.

### (4) Ultra-Violet Radiation and Ozone.

The observations carried out show that both ultra-violet radiation and ozone liberation affected cheese moulding. This is borne out by the following points:—

(1) Moulding on cheese did not occur on the surface of the cheese constantly exposed to ultra-violet radiation. Mould developed on some surfaces protected from the ultra-violet rays.

(2) Some cheese on the shelves did not receive any ultra-violet rays, yet this cheese did not show much moulding unless it was tightly packed.

(3) Where cheese, particularly loaf cheese, was closely packed on the shelves so as to restrict air circulation between individual cheese, the extent of moulding increased greatly but only on surfaces between the cheese—not on the surfaces exposed to the light rays or to free air circulation.

(4) As the number of shields removed was increased throughout the trial, moulding was reduced. When all shields were removed, the odour of ozone was strongly noticeable in the room.

The increase in ozone liberation did not appreciably alter the counts of viable moulds in the cheese-room air.

It would appear that the conditions in the room were not conducive to a satisfactory build-up of ozone in the air—probably the water sprays removed large quantities of ozone as it was formed.

### (5) Handling of Cheese.

There are three aspects of cheese handling in store which are revealed as being important in cheese moulding and also played a part in the moulding noticed during the trials. These are—

(1) *The turning of the cheese.*—Where cheese was frequently turned, moulding was least. However, cheese almost always moulded somewhat on the ends regardless of the appearance of the sides.

(2) *Packing of shelves.*—The practice of packing loaf cheese four deep on shelves is not recommended. This invariably led to moulding of the cheese placed towards the centre of the shelves. With the cheese-room air almost saturated with moisture vapour, as was the case in the present trial, some moulding would appear to be inevitable.

(3) *Cleaning of shelves.*—Much moulding on the ends of cheese could be reduced by the frequent cleaning of shelves.

### (6) Effect of Lamps on Cheese.

Cheese stored for periods of up to eight months have shown no adverse effects due to either the ultra-violet radiation or ozone concentration. There was no evidence of oxidised flavour.

## ACKNOWLEDGEMENT.

The firm of Bunge (Aust.) Ltd. supplied and installed the ultra-violet lights in the experiment room.

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