EFFECT OF DEHYDRATION UPON THE BACTERIAL FLORA OF EGGS[1]

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INTRODUCTION

The commercial dehydration of broken-out eggs has been developed to minimize the losses incident to shipment and storage where long distances and long periods of time are involved. The reduction in volume and weight alone is significant, but the reduction in the demands on cold-storage facilities and the need for expensive and elaborate packing methods is still more important. Dehydration has made possible the development of large egg-handling establishments in China, which at present supply most of the dried egg used by the baking industry in the United States.

Sound fresh eggs subjected to one of the controlled drying processes make a very desirable dried product. The practices involved in the breaking and mixing of large quantities of commercial eggs, however, introduce so many opportunities for spoilage and contamination that a bacterial examination of the number and character of the bacteria, and a study of the opportunities for the growth of the microorganisms, seem desirable. Bacterial findings must be correlated with the odor, taste, or other evidence of soundness or spoilage in the manufactured product, and with the same properties in the raw materials.

Sources of contamination during dehydration are the hands of the operator, the apparatus, dirt from the air or from the surface of the shell, and the fragments of shell unavoidably left in the product.[3] Perhaps the principal source is the occasional single egg which contains large numbers of bacteria but has not developed physical evidence of spoilage by odor or taste. Such eggs have been found and reported in the investigations of Jenkins and Hendrickson.[4] Also, many eggs which have been damaged in handling become contaminated with microorganisms in considerable numbers before evidence of decomposition is noticeable. Therefore, a mixed product selected as sound by physical examination may at times contain a large number of bacteria per cubic centimeter. It seems fair to assume that a great many bacteria may be introduced without there having been negligence or gross carelessness in the preparation of the original mix.

With such initial bacterial contamination, enormous numbers of bacteria will develop in a comparatively short time, if the mix is

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[3] PENNINGTON, M. E., JENKINSON, M. K., STOCKING, W. A., ROSS, S. H., ST. JOHN, E. Q., HENDRICKSON, N., AND HICKS, W. B. A STUDY OF THE PREPARATION OF FROZEN AND DRIED EGGS IN THE PRODUCING SECTION. U. S. Dept. Agr. Bul. 224, 99 p., illus. 1916.

[4] JENKINS, M. K., and HENDRICKSON, N. ACCURACY IN COMMERCIAL GRADING OF OPENED EGGS. U. S. Dept. Agr. Bul. 391, 27 p., illus. 1918.

held at a temperature other than that of effective refrigeration. An efficient egg-drying process, therefore, must provide for the immediate chilling or freezing of the broken-out product or for its prompt dehydration.

In the course of dehydration the products are subjected to contact with heated air, which removes, partially at least, the volatile constituents. This removes or changes the odors characteristic of the fresh sound product and reduces or destroys the odors in low-grade eggs incident to spoilage, which would readily be recognized in the liquid egg. The odor of commercially dried eggs, therefore, may be expected to differ sufficiently from that of the fresh product to require careful examination by experienced analysts.

The odor, appearance, and taste of dehydrated egg differ so markedly from those of fresh liquid egg that extensive experience is necessary to coordinate the two kinds of egg.

In planning a bacteriological examination of dehydrated eggs, all of these factors must be taken into consideration. Theoretically, the number of living bacteria in the finished product depends on the number and kind of bacteria in the liquid product, the temperature to which the product is subjected, and the length of time at which that temperature is maintained. Furthermore, in view of the fact that most of the dried eggs used in this country are imported, the effect of the time and conditions of storage upon the bacterial count becomes important, if that count is to be used as an index of quality.

It is believed that the air is an unimportant source of contamination under proper conditions in the factory. This is certainly true of the processes studied in this investigation. Likewise, the amount of contamination from utensils is insignificant, if they are clean and dry. If the utensils are wet or improperly cleaned, however, the product will have more organisms in the portions in contact with such contamination. From the bacteriological standpoint, the moisture content of the dried product, and the evenness of the drying, are the factors which must be closely watched if a desirable and uniform product is to be obtained.

Two dehydration processes for eggs—the spray and vacuum-drum—were studied by the Bureau of Chemistry, United States Department of Agriculture, in the summers of 1922 and 1923. In both of these processes liquid egg was dried to a powder of low moisture content in a short time. Bacterial action during this short drying period was considered negligible. The content of living organisms in the egg powder represents the effect of the temperature, time of exposure at that temperature, and degree of the concentration of the product upon whatever organisms were initially present.

SPRAY PROCESS

GENERAL PROCEDURE

In the spray process, the first method studied, the egg was exposed to a temperature of about 75° C. for 18 to 25 minutes. Briefly, this process consisted in forcing liquid egg, under great pressure, through a fine spray apparatus, into a collecting chamber in which dehydration was accomplished by exposure to a large volume of heated air. The egg particles remained exposed on the floor of the heated chamber for the period of the "run," approximately 20 minutes.

GRADES OF EGGS USED

Two grades of eggs—good (commercial firsts) and inedible—were used. The inedible grade contained white rots, spots, and other types. In view of the fact that the eggs were broken under supervision at the breaking table, it was not thought necessary to candle the good eggs. The inedible eggs were candled and separated into the various classes. Each grade was broken out at the breaking table under the writer's supervision. The liquid egg was thoroughly mixed, and was dried immediately. From the drier, the powder was placed on trays and cooled, and then placed in friction-top cans which were finally sealed with paraffin.

EXPERIMENTS NOS. 1, 2, AND 3

WHOLE EGG.—The eggs used (30-dozen cases for each experiment) were purchased on the open market as first grade eggs. In order to have as uniform a product as possible, the following restrictions were made: All eggs which had a doubtful appearance after being broken out were discarded. If the eggs were "off" in color or odor, they were not used. The few green whites found were discarded, as were eggs in which the yolks were reddened, but not showing development of the embryo. Eggs in any way questionable were discarded.

EXPERIMENTS NOS. 4, 5, 6, AND 7

YOLK.—The quality of the eggs and the grading at the breaking table were the same as those in Experiments Nos. 1, 2, and 3. The yolks were separated carefully from the whites. The yolks from six cases were used in each experiment.

EXPERIMENTS NOS. 8 AND 9

YOLK.—In Experiment No. 8 the yolks of sound eggs, after being mixed, were allowed to stand at the temperature of the breaking room (about 25° C.), for approximately 15 hours before drying, and for approximately 24 hours in Experiment No. 9. Six cases were used in each experiment.

EXPERIMENTS NOS. 10 AND 11

HEATED WHOLE EGG.—Commercial firsts were placed in the sun. The course of their deterioration was followed by candling. The whites were very thin when broken out at the table. Black rots, white rots, and spot eggs were not used. Three cases were used in each experiment.

EXPERIMENT NO. 12

YOLK.—The treatment, grading, and quality of the eggs were the same as those in Experiments Nos. 10 and 11. The yolk membranes were firm, so that no difficulty was encountered in separating. Six cases were used.

EXPERIMENT NO. 13

WHOLE EGG.—The eggs in this and the following experiments were candled. This experiment was made on 28 dozen doubtful eggs and 48 dozen spots. The eggs which were graded as doubtful by the candler had weak yolks and watery whites, and there were some white rots.[5] All eggs were used except black rots.

[5] JENKINS, M. K., and HENDRICKSON, N. Op. cit., found that white rots were passed occasionally by candlers.

EXPERIMENT NO. 14

WHOLE EGG.—The egg used consisted of six dozen blood rings, 55 dozen addled eggs, and 15 dozen spots. In the blood rings there were no definitely marked embryos. The addled eggs contained white rots and green whites. All black rots were discarded.

EXPERIMENT NO. 15

WHOLE EGG.—In this experiment 54 dozen addled eggs and 24 dozen mixed rots, but no black rots, were used.

BACTERIOLOGICAL EXAMINATION

Samples of the liquid product were taken for bacteriological examination just before it was taken to the drier. They were collected in sterile glass jars, and placed in the sharp freezer and kept frozen until examined. Samples of the dried product were taken after it was cool, and again just before it was placed in the tin containers.

The odors of the liquid and dried egg were compared carefully. There was no difficulty in determining the quality of the liquid egg, but some volatile material was lost during the drying process, which made grading more difficult in the dried products. The dried product prepared from good eggs could be differentiated very easily from that prepared from rotten eggs. The number of bacteria in the liquid and dried egg is shown in Table I.

TABLE I.—*Number of bacteria in liquid and dried egg (spray process)*

Sample No. [a]	Type	Quality	Total bacteria on nutrient agar at—		Colon group	BCP lactose agar [b] 37° C. for 2 days	
			37° C. for 2 days	20° C. for 4 days		Total	Acid
1L	Whole	Good	75,000	65,000	100	147,000	8
1D	do	do	450	400	0	500	0
2L	do	do	225,000	225,000	0	380,000	0
2D	do	do	1,700	3,300	0	2,200	900
3L	do	do	7,500	8,000	100	23,000	4,000
3D	do	do	350	350	0	900	600
4L	Yolk	do	530,000	550,000	100,000	630,000	300,000
4D	do	do	550	550	0	700	40
5L	do	do	78,000	80,000	1,000	97,000	1,000
5D	do	do	320	550	0	800	50
6L	do	do	21,000	5,500	0	24,000	1,000
6D	do	do	115	500	0	100	40
7L	do	do	190,000	220,000	100	330,000	0
7D	do	do	1,460	170	10	1,400	0
8L	do	Good, held [c]	350,000	370,000	10,000	600,000	0
8D	do	do	370	285	10	380	60
9L	do	do [d]	650,000	475,000	100,000	3,000,000	1,600,000
9D	do	do	9,100	5,150	10	8,400	0
10L	Whole	Heated	1,700,000	820,000	100,000	2,700,000	300,000
10D	do	do	4,900	1,220	0	6,400	300
11L	do	do	1,600,000	1,050,000	1,000,000	4,400,000	300,000
11D	do	do	1,350	330	10	1,070	0
12L	Yolk	do	500,000	635,000	100,000	1,160,000	500,000
12D	do	do	2,950	650	10	3,500	0
13L	Whole	Doubtful, spots	23,500,000	17,500,000	1,000,000	28,000,000	6,000,000
13D	do	do	58,000	320,000	10	350,000	350,000
14L	do	Blood rings, addled spots.	106,000,000	94,000,000	10,000,000	109,000,000	160,000,000
15L	do	Addled, mixed rots	187,000,000	149,000,000	10,000,000	178,000,000	10,800,000
15D	do	do	410,000	740,000	0	680,000	120,000

[a] L designates the liquid product; D designates the dried product.
[b] Brom cresol purple lactose agar.
[c] Held 15 hours at 25° C.
[d] Held 24 hours at 25° C.

All counts were made on the gram basis of the liquid product. For the liquid egg, the sample was weighed in a glass-stoppered flask, on an analytical balance, to the nearest one-hundredth of a gram, and nine times that weight of physiological salt solution (considering that 1 c. c. is equal to 1 gm.) was added. This was called the 1 : 10 dilution. Sterile glass beads were added to help break up the egg. In the analyses of the dried product, salt solution was added to give approximately the same percentage of total solids as in the 1 : 10 dilution of the liquid product. This was taken as the 1:10 dilution of the dried product. By this procedure the counts of the dry product were comparable with those of the liquid product.

There was some difficulty in obtaining solutions of the dried product. Apparently the powder did not go completely into solution, but was broken up very finely to form a suspension, so that the product could be regarded as in solution only when no large undissolved particles were present.

The results in Table I show that there is a big reduction in the total number of viable bacteria, and in some cases a complete loss of the colon-aerogenes group, during the drying process.

In addition to the total bacteria counted, a large number of organisms were isolated from the spray-process samples. Some of these organisms of general types, as those of the colon group and a few of the aerobic spore-formers, were identified, but most of them could not be identified absolutely. Organisms of the colon type were predominant in the liquid product, and organisms of the aerogenes type were predominant in the dried products. This change in the types might be explained either by a difference in the heat resistance of the two types, or by a greater sensitiveness of the colon type to the change in pressure involved in the spray process. Further experiments have not been carried out to prove which of the two hypotheses is correct.

VACUUM-DRUM PROCESS

GENERAL PROCEDURE

Experiments in drying eggs by the vacuum-drum method were undertaken in the summer of 1923. Chemical and bacteriological analyses were made on the liquid and dried products, and the odor before and after drying was noted. The plan of the work was similar to that followed in the spray process.

The eggs were broken and dried as in the spray process, and mixed by hand with a perforated disk. Two cases were broken each day. The first case was dried approximately 2 hours after breaking. The second was held in an ice box, and dried approximately 5 hours after breaking. The temperature of the drum was usually about 90° C., but a few of the samples were dried at 88°, and a few at 93°. The exposure was 15 to 20 seconds.

GRADES OF EGGS USED

A few eggs of each grade were candled before the experiments were started. Inspection of the eggs at the breaking table, however, was taken as the best way of ascertaining the quality. Three grades were used—commercial firsts, heated, rots and spots. In general, the commercial firsts proved to be of very good quality. A few showed a little heat. The heated eggs were uniformly of

poorer quality than the first grade. Many of the eggs showed a thinning of the white, and some of the whites were slightly opaque. The rots and spots were classified at the breaking table. Grading was done at the breaking table. Table II gives the results of grading for the eggs used in all the experiments except Nos. 14 and 15. In Experiment No. 14 the numbers and types of eggs determined at the breaking table were 2 black rots, 28 white rots, 2 red rots, 1 moldy, 185 mixed rots, 20 sour, 26 blood rings, and 81 spots. Experiment No. 15 showed 11 red rots, 29 white rots, 187 mixed rots, 24 sour, 13 blood rings, and 88 spots.

One 30-dozen case of eggs was used in each experiment on whole eggs, and two cases in each experiment on whites and yolks.

BACTERIOLOGICAL EXAMINATION

The bacteriological samples were taken at the time of drying in the case of the liquid product and immediately after the drying in the case of the dried product. The method of analysis was the same as that in the experiment with the spray-process dried egg.

Results of the bacteriological examination are shown in Table II.

TABLE II.—*Number of bacteria in liquid and dried eggs (vacuum-drum process)*

Sample No.[a]	Type	Quality	Total bacteria on nutrient agar at—		Colon group	BCP lactose agar[b] 37° C. for 2 days	
			37° C. for 2 days	20° C. for 4 days		Total	Acid
1L	Whole	Good	54,000	137,000	10,000		
1D	do	do	45,000	67,000	10		
2L	White	do	2,600	2,850	1,000		
2D	do	do	40	60	0		
3L	do	do	166,000	189,000	10,000	111,000	53,000
3D	do	do	18,000	21,000	1,000	18,000	8,300
4L	Yolk	do	2,950	1,600	100		
4D	do	do	1,800	900	100		
5L	do	do	248,000	235,000	10,000	210,000	10,000
5D	do	do	22,000	30,000	0	19,000	61,000
6L	White	Good, held[c]	207,000,000	166,000,000	10,000		
6D	do	do	30,000	40,000	10		
7L	do	do[c]	4,400,000	4,900,000	1,000,000	5,400,000	100,000
7D	do	do	210,000	100,000	10	260,000	9,000
8L	Yolk	do[c]	600,000,000	600,000,000	100,000		
8D	do	do	1,800,000	900,000	1,000		
9L	do	do[d]	1,010,000,000	850,000,000	100,000,000	640,000,000	280,000,000
9D	do	do	22,400,000	35,000,000	10,000	16,000,000	12,000,000
10L	Whole	Heated	15,400,000	15,400,000	100,000	13,300,000	290,000
10D	do	do	760,000	6,400,000	10	750,000	670,000
11L	do	do	7,500,000	7,600,000	1,000,000	6,900,000	800,000
11D	do	do	120,000	180,000	0	200,000	100,000
12L	White	do	4,500,000	1,500,000	100,000	6,500,000	600,000
12D	do	do	1,010,000	1,620,000	10,000	740,000	40,000
13L	Yolk	do	10,000,000	17,000,000	1,000,000	4,200,000	3,100,000
13D	do	do	140,000	260,000	10,000	50,000	40,000
14L	Whole	Rots	164,000,000	170,000,000	10,000,000	100,000,000	33,000,000
14D	do	do	2,400,000	3,100,000	10,000	1,200,000	600,000
15L	do	do	108,000,000	150,000,000	10,000,000	104,000,000	25,000,000
15D	do	do	120,000	170,000	100	150,000	100,000

[a] L designates the liquid product; D designates the dried product.
[b] Brom cresol purple lactose agar.
[c] Held 24 hours before drying.
[d] Held 30 hours before drying.

The eggs dried by the vacuum process showed a smaller percentage decrease in the total count than the eggs dried by the spray process. This is explained by the fact that the vacuum process was less effective in killing the nonsporulating organisms.

RESULTS OF BACTERIOLOGICAL EXAMINATION

The heat applied to eggs by both processes killed a certain percentage of the organisms. This percentage increased as the total number increased, and varied with the type of organism. In most of the experiments the decrease in the numbers of the colon group was very large; the decrease in the numbers of the total lactose fermenters, as determined by the plate method, was decidedly smaller. A comparison of the counts on eggs dried by both methods showed that the vacuum-drum process is not as efficient as the spray process in killing bacteria.

The odor of the dried product was much less pronounced than that of the liquid product. Furthermore, the odor was stronger while the product was warm from the drier than after it had been cooled. Counts of the viable bacteria furnish little basis for estimating the quality of such products, especially where the details of their histories are not known.

EFFECT OF STORAGE

In order to determine the effect of temperature and time on the bacterial count, samples of the various grades of dried egg made by the spray process were stored for long periods.

The samples were placed in glass-stoppered salt-mouth bottles, sealed with paraffin, and held at 20° C., at room temperature (approximately 25°) and at 37°. By sealing with paraffin, the factor of variable humidity was eliminated. Total counts on plain agar incubated at 20° and 37°, total counts and the number of acid formers on brom cresol purple lactose agar, and counts of the colon group, were made at the beginning, at the end of 3 months, and at the end of 10 months. The results are shown in Tables III, IV, and V.

TABLE III.—*Effect of storage on bacterial counts of dehydrated eggs*

[Samples held in sealed bottles at approximately 25° C. and examined at the dates indicated] [a]

Sample No.	Type	Quality	Bacteria on plain agar held at—		Colon group	Bacteria on BCP agar [b] held at 20° C. for 4 days	
			20° C. for 4 days	37° C. for 2 days		Total	Acid
	June 20, 1922 (start):						
1	Whole	Good	350	350	0	900	600
2	Yolk	do	550	550	0	700	40
3	Whole	Heated	4,900	1,220	0	6,400	300
4	Yolk	do	2,950	650	10	3,500	0
5	Whole	Rotten	58,000	320,000	10	350,000	350,000
6	Do	do	410,000	740,000	0	680,000	120,000
	October 31, 1922:						
1	Whole	Good	230	145	0	200	0
2	Yolk	do	350	135	0	470	0
3	Whole	Heated	1,900	300	0	2,400	0
4	Yolk	do	2,800	95	0	1,900	0
5	Whole	Rotten	55,000	47,000	0	51,000	0
6	Do	do	145,000	101,000	0	87,000	0
	May 7, 1923 (37° C. for 2 days):						
1	Whole	Good	320	260	0	170	50
2	Yolk	do	335	170	0	290	40
3	Whole	Heated	930	210	0	210	30
4	Yolk	do	1,250	135	0	120	10
5	Whole	Rotten	36,000	26,000	0	29,000	27,000
6	Do	do	30,000	20,000	0	23,000	15,000

[a] The samples used in this experiment were dried by the spray process.
[b] Brown cresol purple lactose agar.

TABLE IV.—*Effect of storage on bacterial counts of dehydrated eggs*

[Samples held in sealed bottles at 20° C., and examined at the dates indicated] [a]

Sample No.	Type	Quality	Bacteria on plain agar held at—		Colon group	Bacteria on BCP [b] agar held at 20° C. for 4 days	
			20° C. for 4 days	37° C. for 2 days		Total	Acid
	July 11, 1922 (start):						
1	Whole	Good	350	175	0	370	30
2	Yolk	do	550	235	0	530	50
3	Whole	Heated	2,900	225	100	3,400	900
4	Yolk	do	1,025	75	0	1,130	0
5	Whole	Rotten	250,000	177,000	0	280,000	170,000
6	Do	do	235,000	385,000	0	970,000	200,000
	October 30, 1922:						
1	Whole	Good	355	240	0	280	0
2	Yolk	do	530	325	0	470	0
3	Whole	Heated	4,250	480	0	3,200	0
4	Yolk	do	9,350	175	0	2,300	0
5	Whole	Rotten	95,000	93,000	0	86,000	0
6	Do	do	430,000	350,000	0	235,000	0
	May 7, 1923 (37° C. for 2 days):						
1	Whole	Good	300	235	0	210	30
2	Yolk	do	490	245	0	150	0
3	Whole	Heated	1,400	700	0	440	220
4	Yolk	do	780	100	0	40	0
5	Whole	Rotten	41,000	42,000	0	32,000	11,000
6	Do	do	146,000	118,000	0	108,000	78,000

[a] The samples used in this experiment were dried by the spray process.
[b] Brom cresol purple lactose agar.

TABLE V.—*Effect of storage on bacterial counts of dehydrated eggs*

[Samples held in sealed bottles at 37° C., and examined at the dates indicated] [a]

Sample No.	Type	Quality	Bacteria on plain agar held at—		Colon group	Bacteria on BCP [b] agar held at 20° C. for 4 days	
			20° C. for 4 days	37° C. for 2 days		Total	Acid
	July 11, 1922 (start):						
1	Whole	Good	350	175	0	370	30
2	Yolk	do	550	235	0	530	50
3	Whole	Heated	2,900	225	100	3,400	900
4	Yolk	do	1,025	75	0	1,130	0
5	Whole	Rotten	250,000	177,000	0	280,000	170,000
6	Do	do	235,000	385,000	0	970,000	200,000
	October 31, 1922:						
1	Whole	Good	235	215	0	190	0
2	Yolk	do	610	230	0	470	0
3	Whole	Heated	2,300	130	0	1,600	0
4	Yolk	do	540	65	0	430	0
5	Whole	Rotten	7,500	7,500	0	6,000	0
6	Do	do	81,000	86,000	0	70,000	0
	May 7, 1923 (37° C. for 2 days):						
1	Whole	Good	300	115	0	80	20
2	Yolk	do	530	100	0	150	0
3	Whole	Heated	335	35	0	60	30
4	Yolk	do	130	20	0	0	0
5	Whole	Rotten	600	1,250	0	700	0
6	Do	do	1,350	1,300	0	1,400	300

[a] The samples used in this experiment were dried by the spray process.
[b] Brom cresol purple lactose agar.

The results reported in Tables III, IV, and V show that the number of viable organisms generally decreases as a result of storage. The extent of this decrease was studied in relation to the quality of the egg, the length of time in storage, and the temperature of storage. Good egg shows a much smaller decrease than poor material. Egg stored at a high temperature, or for a long time, loses a larger percentage of viable organisms than egg stored at a lower temperature or for a shorter time.

There was no visible deterioration in the product, but a distinct odor suggesting rancidity developed in all samples. This odor was most pronounced in the product made from low-grade eggs and held at the highest temperature.

The total colony count of the product made from good eggs remained practically stationary over a period of 10 months. The reason for this result is evident when the type of surviving organism is considered. The greater number of organisms which survived the heating process were spore formers. Furthermore, the spores did not germinate during the storage period, probably because the water content was too low, but they did not die during that period. Consequently, the count was an enumeration of the viable spores at each examination. In the samples of breaking stock having a high total count, however, many more of the nonsporulating organisms survived the heating process. These samples, therefore, showed a reduction in the total bacterial count, as these forms died during storage.

The effect of storage on the specific counts was marked. Samples which showed organisms of the colon group at the time of drying did not show them at the end of three months. All these results on the colon group were based on 1 c. c. of the 1:10 dilution. The same results were obtained with the acid formers. These also were absent in 1 c. c. of the 1:10 dilutions at the end of three months. At the end of 10 months, counts of the acid formers were made on plates held at 37° C. instead of 20°. Evidently the change in the temperature of incubation was all that was necessary for a different group of lactose fermenters to develop. These figures, therefore, lose any comparative significance with the preceding determination.

CONCLUSIONS

The count of viable bacteria in freshly prepared dehydrated egg varies, in general, with the quality of the raw product and the method of dehydration. The counts in the product prepared from whole eggs by the spray process varied from 350 in the good egg to 1,160,000 in the spots. In the product prepared by the vacuum-drum process from whole egg the counts varied from 45,000 in the good egg to 2,400,000 in the rots. In general, the yolk showed a higher number than the whites from the same whole egg.

The plate count of spray-process dehydrated egg held in storage depends on the initial count, the length of time in storage, and the temperature of storage. An initial count of 350 in good egg decreased to 300 in 10 months when held at 37° C. and at 20°, while a count of 235,000 in rotten eggs decreased to 1,350 when held at 37°. In one sample of the rotten eggs held at 20° the count increased from

235,000 to 430,000 in three months. A second sample showed a decrease from 250,000 to 95,000 at the end of three months and a further decrease to 41,000 at the end of 10 months.

The odor which is characteristic of poor-quality eggs is lost to some extent during the dehydration process.

An odor similar to rancidity develops in egg powder held at the various temperatures. This odor was most pronounced in rotten eggs held at 37° C.