

MOISTURE RESISTANCE OF PACKAGES FOR DRIED-EGG POWDER

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MOISTURE RESISTANCE OF PACKAGES FOR DRIED-EGG POWDER¹

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Introduction

The development of lower-moisture-content dried-egg powder has necessitated the improvement of its package in order to maintain its moisture content at or near its initial value. Egg powder is now being produced commercially with a moisture content of approximately 2 percent, compared to a value of 5 percent formerly considered acceptable. The drier powder is said to possess improved storage properties, in that it retains a higher degree of palatability over longer periods of time and under more adverse storage conditions than the other and thus is considered to be more suitable for export shipment.

As the drier powder has greater affinity for water, it requires a package more resistant to moisture vapor, in order to maintain its lower moisture content, than does powder having a higher initial moisture content.

To measure the resistance to moisture vapor of several packages proposed for egg powder of low moisture content, tests were made at the Forest Products Laboratory for the Dairy and Poultry Branch, Production and Marketing Administration, U. S. Department of Agriculture. Tests included storage of powder in unit packages and in shipping containers, rough-handled and not rough-handled, at high and at low temperatures, and at high humidities, for various periods of time up to 8 months. Parallel storage tests were made of unit packages containing silica gel. These packages were not rough-handled and were stored for 13 weeks at a high temperature and a high humidity.

¹This study was conducted in cooperation with the Dairy and Poultry Branch, Production and Marketing Administration.

²Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Materials Tested

Five-ounce Packages

Two kinds of 5-ounce egg-powder cartons of dimensions 2-3/4 by 2 by 4 inches, were used. Both kinds were regular flap-end cartons with full overlapping long flaps and with an extended glue flap with double glue seam, and were die-cut to provide a retuckable flap-closure device. The blanks for these cartons were similar in design to the blank illustrated for Carton Style No. 1 in U. S. Department of Agriculture, Food Distribution Administration, specification for dried-egg packages, Form FSC-1762.

Two kinds of carton stock were used as follows:

(a) 0.018- to 0.020-inch natural kraft-faced chipboard (0.005-inch minimum kraft facing) laminated to a 25-pound, basis weight (24 by 36 - 500 sheets), hydrated, greaseproof liner with an odor-free, nontoxic adhesive. The kraft facing was treated to prevent a penetration by the wax exterior coating exceeding 0.004 inch. Cartons made from this stock by a paper-products company are hereinafter referred to as A cartons.

(b) Substantially the same stock as described in (a), except that the facing appeared to be a colored semibleached kraft. Cartons made of this stock were currently used by the packaging plant where the experimental packages were filled and sealed. Hereinafter these cartons are referred to as B cartons.

The 5-ounce packages were either exteriorly coated with wax or overwrapped after filling and closing. The four kinds of wax used were as follows:

B wax - A specification wax currently used by the packaging company at the time its 5-ounce B packages were filled and closed.

C wax - A high-melting point blend of paraffin and microcrystalline wax.

D wax - A low-melting-point blend of paraffin and microcrystalline wax.

E wax - A blend of 50 percent paraffin and 50 percent microcrystalline wax with a melting point of 132° to 135° F. and an application temperature of 185° to 190° F.

Carton overwraps and case liners used in tests of 5-ounce packages were:

F - An aluminum-foil overwrap, consisting of 0.00035-inch aluminum foil glued to a 15-pound, basis weight, tissue, wax-laminated to an 8-pound, basis weight, tissue with an over-all thickness of approximately 0.00035 inch. The seal was obtained by heat with a wax coating on the tissue.

G - A metal-foil pouch overwrap, 6 by 9 inches, consisting of a 30-pound, basis weight, kraft sheet, laminated with an asphaltic compound to a 0.00055-inch composition lead foil that was in turn laminated with thermoplastic lacquer to T cellophane, to give a total thickness of approximately 0.0075-inch. The seal was obtained by heat with a coat of heat-seal lacquer applied to the cellophane.

H - A case liner for inner cartons containing seventy-two 5 ounce unit packages. This material consisted of a 30-pound, basis weight, kraft sheet, laminated with an asphaltic compound to 0.00035-inch aluminum foil, wax-laminated to an 8-pound, basis weight, tissue. A heat seal was obtained by use of a wax coating on the tissue. This material was also tested as a bag liner for 14-pound unit packages.

I - A 6- by 9-inch pouch overwrap, consisting of a 25-pound, basis weight, kraft sheet, laminated with a permanently plastic adhesive to U cellophane, which in turn was laminated to a 12-1/2-pound, basis weight, waxed sulphite, and was coated on the sulphite side with a 17-1/2-pound coating and dusted with starch. Seal was obtained by heating the wax coating. This material was also tested as a bag liner for 14-pound unit packages.

Fourteen-pound Unit Packages

A regular, slotted-style, B-flute, domestic, corrugated container, J, inside dimensions of 7-3/4 by 7-1/2 by 14-1/4 inches, was used for the 14-pound packages. This container was used with the following bag liners:

K - A single-ply, 0.0052-inch, creped, waxed, kraft bag liner, composed of a 45-pound kraft sheet with 35 percent by weight of wax added. This liner was closed by tying at top with cotton twine.

L - A double-bag liner, The interior bag was waxed, creped, kraft made from a 30-pound, basis weight, kraft sheet to which 15 percent by weight of wax was added. The waxed, creped, kraft exterior bag was made from a 35-pound, basis weight, kraft sheet with 60 percent by weight of wax added. The interior and exterior bags were closed separately with cotton twine.

H - The aluminum foil previously described for the 5-ounce, unit-package, case liner. The bag was closed by heat sealing.

I - The material previously described for the 5-ounce-package pouch over-wrap. The bag was closed by heat sealing.

Interior Cartons for Seventy-two
5-ounce Packages

A regular, slotted-style, B-flute, 200-pound-test, domestic, corrugated container, M, 13-1/4 by 11-3/4 by 12-5/8 inches, inside dimensions, was used for seventy-two 5-ounce, egg-powder packages. An inner lining tube and top and bottom pads of A-flute corrugated board were used. The containers were packed without case liners. Aluminum-foil case liner H was used for the 5-ounce-package case liner. The case liner was heat-sealed.

Shipping Containers for Two
72-ounce-package Cartons

A regular slotted-style, V3s-grade, solid-fiberboard container, N, 13-5/8 by 13-5/8 by 24-1/8 inches, inside dimensions, was used as a shipping container for two cartons each containing seventy-two 5-ounce unit packages of egg powder. The flaps of the containers were glued, and two flat metal bands were placed around the sides, top, and bottom, approximately 3 inches from each end.

Shipping Container for Four
14-pound Unit Packages

A regular slotted-style, V3c-grade, fiberboard container, O, 16-1/4 by 15 by 16 inches, inside dimensions, was used as a shipping container for four 14-pound unit packages of egg powder. The flaps of the container were glued, and two round wires were placed around the centers of the top, sides, and bottom and top, ends, and bottom at right angles.

Fiber Drums for 14 Pounds
of Egg Powder

A cylindrical, moisture-resistant fiber drum, P, was used as a unit container for 14 pounds of powder. The drum was a convolutely wound kraft container, 9 inches in diameter and 13 inches in height. The cover was of the partial-telescope friction type, and the cover joint was sealed with gummed kraft tape. This container, as manufactured, had an inner hard-finish kraft lining, supported by kraft asphalt-barrier board with an interior paraffin spray impregnation in bottom and cover.

Slack Barrels and Fiber Drums for Bulk Storage

Slack barrels, Q, were used that complied with requirements of War Food Administration, Office of Distribution, specification for slack barrels for dried eggs, Form FSC-1833-C. The barrels were tested with single and triple, waxed, creped, kraft barrel liners, tied at the top. The single barrel liner, R, was the specification liner in use at a dried-egg plant at the time the barrels were loaded. The triple barrel liner, S, supplied by a bag company, consisted of an inner bag made from a 35-pound, basis weight, kraft sheet with a minimum of 15 percent by weight of wax added, and of two outer bags each made from a 45-pound, basis weight, kraft sheet with a minimum of 60 percent by weight of wax added. The moisture-resistant fiber drum P was also tested for bulk egg-powder storage.

Egg Powder

The dried-egg powder used in the test was dried to a moisture content of less than 2 percent. The fiber drums and slack barrels were filled and sealed at the drying plant. Powder for the 5-ounce packages was transported in barrels using tripple-bag liners to the packaging plant using B cartons.

Silica Gel

The silica gel was contained in cotton bags in approximately 5-ounce quantities.

Test Procedure

Shelf Life of 5-ounce Packages

Shelf-life tests were made on eight different kinds of 5-ounce packages. The exteriors of packages tested were either coated with wax or the packages were overwrapped. The storage conditions for shelf-life tests are presented in table 1.

Five-ounce Packages in Shipping Container

Seventy-two 5-ounce packages in each of two inner cartons were tested in shipping containers to measure the resistance of the complete package to moisture-vapor entry and the effect of rough handling on this resistance. Five kinds of 5-ounce packages were placed in each inner container. The various inner cartons were loaded in accordance with a predetermined pattern that gave comparable exposure to each kind of 5-ounce package.

The five kinds of 5-ounce packages included in this test are listed in table 2. Four shipping containers were stored at each of the conditions and for the periods given in table 2. No case liners were used either in the inner cartons or in the shipping containers.

Inner Cartons with and without Case Liner in Shipping Container

Two inner cartons (table 3), each containing seventy-two 5-ounce packages, either with or without an aluminum-foil case liner H, were stored in a shipping container for each of the same combinations of time, temperature, and humidity as for the 5-ounce packages in shipping containers given in table 2. Some of these were rough-handled in the large drums before storage. The 5-ounce packages used in these tests were regular B packages with exteriors single-coated with B wax.

Fourteen-pound Packages in Shipping Containers

Four 14-pound packages of egg powder were tested in shipping containers to measure the resistance of the complete pack to moisture vapor (table 4). Each of the four 14-pound unit packages in the shipping containers had a different kind of bag liner, as described previously. Five shipping containers were stored for each of the same combinations of time, temperature, and humidity as for the 5-ounce package in shipping containers tested previously (table 2). None of the four 14-pound packages were rough-handled.

Fiber-drum Shipping Containers

The moisture-resistant, convolutely wound fiber drum P was tested for its moisture resistance. One drum was tested at each of the conditions and for each of the periods given in table 4.

Bulk Powder in Slack Barrels and Fiber Drums

Bulk powder was stored in slack barrels and fiber drums in a commercial warehouse under cold, moist, and dry, warm storage conditions. The containers and the two kinds of barrel liners, R and S, were used. Loading, storage, and sampling of the powder were under the direct supervision of the Poultry Branch. One egg-powder sample from each barrel was sent to the Forest Products Laboratory for moisture-content determination after storage at the conditions and for the periods given in table 5.

The powder in the fiber drum was sampled after 3 months of dry commercial storage.

Five-ounce Packages Filled with Silica Gel

Five-ounce packages identical to those used in the shelf-life test (table 1), except that they were loaded with about 5 ounces of silica gel, were stored at 80° F. and 80 percent relative humidity to measure the rate of moisture pick-up (table 6). Twenty of each kind of package were tested.

Package-loading Operation

Shipping containers carrying four 14-pound unit packages, fiber drums, and slack barrels were filled with egg powder at an egg-drying plant. The 14-pound-package bag liners and the slack-barrel liners were closed by representatives of their respective manufacturers. Shipping containers were loaded, closed, and strapped by the regular drying-plant crew.

Five-ounce unit B packages of egg powder were filled and closed by automatic machinery at the plant using these packages. Silica-gel packs were placed in the 5-ounce unit cartons manually, and the cartons were closed by machinery. All exterior wax-coating operations on 5-ounce packages were done automatically by the spray process. Overwraps were placed and sealed on 5-ounce packages manually by representatives of their manufacturers.

Cartons without liners for seventy-two 5-ounce regular B packages were loaded and closed mechanically. All others were loaded by hand and closed and sealed mechanically. Case liners were sealed by a representative of the manufacturer.

Shipping containers for two inner cartons, each containing seventy-two 5-ounce-packages, were loaded, closed, sealed, and strapped by hand.

Storage of Packages

After packing, all packages were trucked to the Forest Products Laboratory or to a cold storage plant, and were immediately placed in the prescribed storage atmospheres. Packages were stacked to give free access of air to all faces.

Sampling of Egg Powder

Samples of egg powder were taken at the loading plant as the packages were filled. These samples were for moisture-content determinations and palatability tests. The moisture-content samples were placed in weighing bottles or regular 5-ounce test packages and sent to the Forest Products Laboratory. Palatability samples were placed in regular sample bags and sent to the Chicago Laboratory of the Production and Marketing Administration.

At the end of the required storage period packages were removed from the storage rooms and opened for removal of moisture-content and palatability samples of the powder. Five-ounce shelf-life test packages were opened, the contents were thoroughly mixed, and a moisture-content sample of a few grams was taken. The remainder of the powder was placed in a No. 2 sanitary can that was closed in a sealing tool, or in a metal friction-cover can that was tightly closed. Powder stored in 5-ounce unit packages enclosed in inner cartons for comparison of five different kinds of unit packages was sampled by compositing the powder in the 12 packages of each kind and drawing representative moisture-content and palatability samples. The moisture-content samples were placed in a weighing bottle, the cover of which was tightly closed. The palatability samples were placed in No. 2 sanitary cans or friction-cover cans that were tightly closed. The cans were completely filled to exclude as much air as possible.

Powder stored in 5-ounce unit packages enclosed in inner cartons for comparison of the moisture resistance of unlined inner cartons to cartons having aluminum-foil case liners H, was sampled by compositing the powder in 10 of the seventy-two 5-ounce packages. Four corner packages and six packages from interior positions were used for sample purposes.

Powder in 14-pound packages was sampled by taking small quantities of powder from near each corner of the package (about 1 inch from adjacent sides), from points midway between the corners (about 1 inch from the sides), and from the center, with a wood auger. Samples were drawn from near the top, at the center, and near the bottom of the package at each of the sample points. The samples were combined and thoroughly mixed. Moisture-content and palatability samples were then packed as described in the previous paragraph. One pair of samples was taken for each 14-pound package.

Powder in 14-pound-capacity fiber drums was sampled by taking small quantities of powder from four equally spaced points around the circumference of the container (about 1 inch from the edge), and from the center, with a wood auger. Samples were drawn from near the top, at the center, and near the bottom of the container at each of the five sampling points. Samples for moisture-content determination and palatability tests were prepared as for the 14-pound packages.

Determination of Moisture
Content of Egg Powder

Moisture content of egg powder was determined by placing an accurately weighed, 2-gram portion of a well-boxed sample on a tared covered disk that had previously been dried at 105° to 107° C. and cooled in a desiccator. The cover was then loosened, and the disk was placed in a thermostatically controlled oven at 105° to 107° C. After 1-1/2 hours the cover was tightened, and the disk was transferred to a desiccator where it was cooled to room temperature. It was then weighed. The loss in weight (moisture content) was computed as a percentage of the weight of the powder after drying.

Palatability Tests

Palatability samples were sent to the Chicago Laboratory of the Poultry Branch, Production and Marketing Administration, where the tests were made. The results of these tests are not included in this report.

Moisture Pick-up of Packages
Filled with Silica Gel

The unit packages that were filled with about 5 ounces of silica gel were stored at 80° F. and 80 percent relative humidity. The packages were weighed when placed in storage and each week thereafter. The gain in weight (moisture pick-up) of the silica gel and of the package material was determined. The tests were continued for 13 weeks.

Rough Handling of 5-ounce
Unit Packages

The 5-ounce unit packages of egg powder schedules for shelf-life storage tests after rough handling were tumbled for 100 falls in the small revolving hexagonal box-testing drum prior to storage. The small 7-foot revolving hexagonal box-testing machine was used for the drum tests.

Baffles and guides on the six inner faces of the drum caused the box to slide, tumble, and fall as the drum revolved in a way simulating the condition of actual shipping and handling. The drum revolved at 1-5/6 revolutions per minute. A low conical projection represented the puncture hazard, and the effect was similar to that obtained by dropping one box cornerwise onto the face of another in careless handling. Tumbling of the box from one face of the drum to the next was counted as one fall, and six falls occurred with each complete revolution of the drum. As the test continued, a record was made of any damage as it occurred to the box and of the final failure, if any.

Rough Handling of Shipping Containers
for Two Cartons of Seventy-two 5-ounce
Unit Packages

The shipping containers carrying two inner cartons, each filled with seventy-two 5-ounce unit packages, and scheduled for rough handling before storage, were tumbled for 100 falls in the large revolving hexagonal box-testing drum. The construction and operation of this drum was similar to that of the small drum, except that it was 14 feet in diameter and revolved at a rate of one revolution per minute.

Results of Tests

Five-ounce Packages

Packed in inner carton and shipping container.--Tests of 5-ounce unit packages, packed in inner cartons without case liners and in a shipping container, showed that the package overwrapped with aluminum foil F was the most resistant to the entry of moisture vapor at both conditions of storage (80° F. and 80 percent relative humidity and 40° F. and 90 to 95 percent relative humidity). Average moisture-content values for powder stored in five kinds of 5-ounce packages are listed, in order of performance, in table 2.

Individual packages not overpacked.--In shelf-life tests of 5-ounce unit packages, the B package overwrapped with a metal foil G was found to be the most resistant. Average results for all kinds of packages tested are presented, in order of performance, in table 1. Rough handling had a detrimental effect on all kinds of packages. Cold storage, although at a high relative humidity, caused less increase in moisture content than 80° F. storage. The order of performance of the various kinds of packages was essentially the same regardless of the rough-handling treatment or storage conditions.

Individual 5-ounce packages filled with silica gel.--At the end of 13 weeks' storage at 80° F. and 80 percent relative humidity, identical values were obtained for the regular B package with aluminum-foil overwrap F and with the same package with a pouch overwrap made of metal foil G. These two packages offered the greatest resistance to moisture pick-up. Table 6 presents, in order of performance, the average gain in weight (moisture pick-up) of the various types of packages.

Case Liners

Inner cartons without case liners and with aluminum-foil case liners H, packed with seventy-two 5-ounce regular B packages and

overpacked, two in a shipping container, were stored at 80° F. and 80 percent relative humidity and 40° F. and 90 to 95 percent relative humidity. Some of the containers stored at 80° F. were rough-handled before storage. The average moisture-content values of the egg powder before and after storage for various periods are shown in table 3. The results show that the powder stored in the unlined cartons picked up moisture at several times the rate of the powder stored in the cartons with aluminum-foil case liners H. Cold storage was much less detrimental to the powder in cartons both with and without case liners. Rough handling adversely affected the performance of the package without case liners, but it had no effect on the packages with case liners.

Bag Liners and 14-pound Fiber Drums

Four 14-pound unit containers with different kinds of bag liners packed in shipping containers and in 14-pound fiber drums were stored at 80° F. and 80 percent relative humidity and at 40° F. and 90 to 95 percent relative humidity. Moisture-content determination of the powder in these containers indicated that an aluminum-foil bag liner H and a bag liner I were the most resistant to moisture entry. These were followed by the fiber drum. The average moisture-content values are shown in table 4.

Barrel Liners and Large Fiber Drums

Two kinds of barrel liners for slack barrels carrying about 175 pounds of powder and a fiber drum holding about 100 pounds of powder were stored in commercial storage. All three types of containers performed very efficiently for most periods. The humidities of the storage atmospheres were not determined. Results are shown in table 5.

Conclusions

From the data obtained in the Forest Products Laboratory tests, the following conclusions were made.

Five-ounce Unit Packages Overpacked in Inner Cartons and Shipping Containers

Unit packages overwrapped in aluminum foil F were the most resistant to the entry of moisture vapor of the five kinds of packages tested. All others except the regular B package with a single exterior

coat of wax were nearly as effective. The order of performance held, in general, for both storage conditions.

Five-ounce Unit Packages, Shelf Life

Unit packages with a pouch overwrap of metal foil G were the most resistant to moisture-vapor entry of the eight kinds of packs tested. They were closely followed in order of performance by A packages that had been given a double exterior coating of wax and that were overwrapped with aluminum foil F. The performances of the other kinds of packs were fairly well distributed.

The regular B package with a single exterior coat of B wax showed the greatest moisture-vapor entry. Only a slight variance in order of performance was noted between the two storage conditions or as a result of rough handling prior to storage.

Five-ounce Unit Packages Overpacked in Cartons with and without Case Liners

Use of a case liner H more than doubled the resistance to moisture-vapor entry. This held true under both storage conditions, as well as for storage after rough handling.

Individual 5-ounce Unit Packages Filled with Silica Gel

Packages overwrapped with aluminum foil F and packages with a pouch overwrap of metal foil G were almost identical in performance and offered the most resistance to moisture pick-up. Next in order of performance were packages using pouch overwraps made of bag liner I and aluminum-foil case liners H. The remaining kinds of packs were distributed as to order of performance, with the regular B package with single exterior coat of B wax showing the greatest moisture pick-up during the storage period.

Fourteen-pound Unit Packages with Bag Liners and 14-pound Fiber Drums

Bag liners I made of kraft cellophane sulphite lamination and aluminum foil H gave almost identical performance and showed the greatest resistance to moisture-vapor entry of the four bag liners tested. Next in order of performance was the moisture-resistant 14-pound fiber drum. The order of performance was the same under both storage conditions.

One-hundred-and-seventy-five-pound Slack
Barrels with Barrel Liners

A special three-ply, waxed, creped, kraft barrel liner tested in commercial bulk storage showed no distinct advantage over the currently used single-ply, waxed, creped, kraft barrel liner.

Table 1.--Average results of moisture-resistance storage test (shelf life) of 5-ounce packages of egg powder stored without rough handling and after 100 falls in the small drum at 80° F. and 80 percent relative humidity and without rough handling at 40° F. and 90 to 95 percent relative humidity for various periods

Kind of carton:	Moisture-resistance of treatment, exterior:	Average percentage of moisture content ¹ of egg powder after rough handling and storage indicated	0 mo.	1 mo.	2 mo.	3 mo.	6 mo.	1 mo.	2 mo.	6 mo.	2 mo.	4 mo.	8 mo.
overwrapped	No rough handling, storage at 100 falls in small drum, storage at 40° F.	No rough handling, storage at 80° F. and 80 percent relative humidity for:											
	rough handling, storage at 80° F. and 80 percent relative humidity for:	rough handling, storage at 80° F. and 80 percent relative humidity for:											
	storage:	storage:											
B	Metal-foil pouch overwrap G		2.5	2.8	3.2	3.4	3.7	5.8	9.4	11.6	2.2	2.6	3.2
A	Exterior double-coated with B wax		2.1	2.7	3.3	3.8	5.8	6.8	10.5	($\frac{2}{2}$)	2.5	3.1	5.3
B	Aluminum-foil overwrap F		2.5	3.3	4.0	5.7	7.3	8.1	11.7	($\frac{2}{2}$)	2.8	2.7	5.5
B	Exterior double-coated with E wax		2.5	3.5	5.1	5.4	9.6	7.3	12.4	($\frac{2}{2}$)	3.1	5.0	7.8

Table 1.--Average results of moisture-resistance storage test (shelf life) of 5-ounce packages of egg powder stored without rough handling and after 100 falls in the small drum at 80° F. and 80 percent relative humidity and without rough handling at 40° F. and 90 to 95 percent relative humidity for various periods (continued)

Kind of carton:	Moisture-resistance:	Average percentage of moisture content ¹ of egg powder after treatment, exterior:	rough handling and storage indicated	0 mo.	1 mo.	2 mo.	3 mo.	6 mo.	1 mo.	2 mo.	6 mo.	2 mo.	4 mo.	8 mo.
	No rough handling, stored in small drum at 40° F.		No rough handling, storage at 40° F.											
	rough handling, storage at 80° F. and 80 percent relative humidity		rough handling, storage at 80° F. and 80 percent relative humidity											
	rough handling, storage at 40° F. and 90 to 95 percent relative humidity		rough handling, storage at 40° F. and 90 to 95 percent relative humidity											
	overwrapped		overwrapped											
B	Exterior coated with D wax	2.5	3.9	4.8	5.3	9.9	10.3	13.9	(2)	3.0	3.8	6.3		
B	Exterior double-coated with B wax	2.5	4.1	4.7	6.5	11.2	10.1	13.9	(2)	4.7	6.2	12.4		
B	Exterior coated with C wax	2.5	4.8	6.3	8.3	12.5	10.3	13.2	(2)	4.6	6.6	15.8		
B	Exterior coated with B wax	2.8	8.5	11.0	12.9	16.9	10.8	17.3	(2)	9.9	15.4	23.1		

¹Based on weight of egg powder after drying.

²Powder was infested with mites and no moisture-content value was determined.

Table 2.--Average results of moisture-resistance storage tests of 5-ounce unit egg-powder packages packed in inner cartons and shipping containers stored at two conditions of temperature and humidity for various periods

Kind of 5-ounce package	Moisture-resistance : treatment of 5-ounce packages, exterior wax-coated or over-wrapped		Average percentage of moisture content ¹ of egg powder after the storage indicated								
	80° F. and 80 percent relative humidity for:	40° F. and 90 to 95 percent relative humidity for:	0 mo.	1 mo.	2 mo.	3 mo.	6 mo.	0 mo.	2 mo.	4 mo.	8 mo.
B	Aluminum foil over-wrap F	2.5	3.2	3.2	3.6	3.6	3.6	2.5	2.7	2.7	3.2
B	Exterior double-coated with wax E	2.5	3.0	2.9	3.4	4.9	2.5	2.8	2.6	3.4	
B	Exterior double-coated with wax B	2.5	3.2	3.0	3.3	5.3	2.5	2.9	3.1	4.1	
A	Exterior double-coated with wax B	2.1	3.1	3.2	3.9	5.9	2.1	2.8	2.8	3.9	
B	Exterior single-coated with wax B	2.8	5.1	5.5	8.1	10.0	2.8	4.4	5.5	8.2	

¹Based on weight of powder after drying.

Table 3.--Results of moisture-resistance storage tests of seventy-two 5-ounce B packages, with exteriors wax-coated, of egg powder, stored in inner cartons, with and without case liners, and overpacked in fiberboard shipping containers, two inner cartons to a container

Inner carton number	No rough handling, storage	Percentages of moisture content ¹ of egg powder after handling and storage indicated								
		No rough handling, storage at 80° F. and 80 percent relative humidity for:	100 falls in large drum, storage at 80° F. and 80 percent relative humidity for:	1 mo.	2 mo.	3 mo.	6 mo.	2 mo.	4 mo.	8 mo.
1	2.9	5.0	8.1	5.5	8.0	10.9	4.3	5.1	7.8	
2	2.9	4.4	9.8	5.3	7.4	11.2	3.6	5.8	9.2	
3	2.9	4.3	10.7	5.2	8.6	11.1	3.6	5.1	9.0	
4	2.9	4.4	9.0	5.5	6.6	13.1	3.9	4.9	7.6	
Inner Carton without Case Liner										
Inner Carton with Aluminum-foil Case Liner H										
1	2.9	2.5	2.9	2.9	3.6	4.2	2.7	2.6	3.0	
2	2.9	2.4	3.2	3.0	3.1	4.2	2.8	1.9	2.8	

¹Based on weight of egg powder after drying.

²Five-ounce packages without wax-coated exteriors; interior liner used.

³Stored 2-1/2 months.

Table 4.—Results of moisture-resistance storage tests of 14-pound unit
egg-powder cartons J with various kinds of bag liners,
packed in shipping containers O and of 14-pound fiber
drums F

Specimen number	Percentage of moisture content indicated	Storage at 80° F. and 80 per cent relative humidity for:	Storage at 40° F. and 90 to 95 percent relative humidity for:
		0 mo. : 1 mo. : 2 mo. : 3 mo. : 6 mo. : 2 mo. : 4 mo. : 8 mo.	
<u>Container O, Single Bag Liner J</u>			
1	1.9	1.8 : 10.3	9.9 : 15.1 : 6.5 : 9.9 : 14.5
2	1.9	8.2 : 11.8	10.4 : 11.4 : 3.6 : 7.9 : 14.5
3	1.9	8.5 : 9.9	10.5 : 12.1 : 3.6 : 8.7 : 13.5
4	1.9	7.9 : 9.6	10.5 : 12.8 : 7.1 : 8.2 : 15.3
5	1.9	7.7 : 9.1	10.4 : 12.7 : 4.4 : 8.9 : 14.3
<u>Container O, Double Bag Liner K</u>			
1	1.5	12.0 : 10.1	9.8 : 12.0 : 4.5 : 9.1 : 14.3
2	1.5	6.3 : 9.7	9.7 : 11.7 : 3.8 : 8.6 : 14.5
3	1.5	6.7 : 7.9	9.7 : 11.7 : 2.9 : 8.2 : 12.2
4	1.5	7.0 : 8.1	9.5 : 13.5 : 4.9 : 6.5 : 13.1
5	1.5	6.9 : 8.8	10.3 : 14.6 : 3.9 : 8.0 : 12.8

Table 4. Results of moisture-resistance storage tests of 14-pound unit egg-powder cartons J with various kinds of bag liners, packed in shipping containers O and of 14-pound fiber drums F (continued)

Specimen number	Percentage of moisture content ¹ of egg powder after storage indicated	
	No	Storage at 80° F. and 80 per-
	storage	cent relative humidity for:
		: relative humidity for:
	0 mo.	1 mo. : 2 mo. : 3 mo. : 6 mo. : 8 mo.

Container O, Aluminum-foil Bag Liner H

1	1.9	2.0	2.2	2.5	2.2	1.5	1.5	2.0
2	1.9	2.1	2.5	1.9	2.4	2.0	1.8	2.2
3	1.9	1.9	2.6	2.6	3.1	2.5	1.6	2.0
4	1.9	1.9	1.9	2.6	2.2	2.2	1.6	1.9
5	1.9	2.6	2.1	1.8	3.4	1.9	1.7	2.1

Container O, Bag Liner I

1	1.9	2.7	2.2	1.9	2.4	2.0	2.2	2.1
2	1.9	.....	2.1	2.3	3.9	3.2	1.5	1.7
3	1.9	1.9	2.6	2.2	2.4	1.9	1.5	1.8
4	1.9	2.6	2.2	1.9	2.5	1.9	1.6	1.7
5	1.9	2.3	2.5	2.0	2.3	1.9	2.6	1.8

Fiber Drum L

1	1.6	2.8	4.5	2.3	2.7
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¹ Based on weight of egg powder after drying.

Table 5.—Results of moisture-resistance storage tests
of 175 pounds of egg powder stored in slack
barrels Q with two kinds of liners and of
100 pounds stored in fiber drums P

Type of package	Percentage of moisture content ¹ of egg powder after storage indicated							
	Commercial dry (warm) storage				Commercial cold storage			
	0 mo.	1 mo.	3 mo.	0 mo.	1 mo.	3 mo.	7 mo.	
Slack barrel Q with barrel liner R	1.8	1.7	2.2	1.8	2.2	2.1	2.6	2.0
Slack barrel Q with barrel liner S	1.8	2.3	2.2	1.8	1.7	1.9	.....
Fiber drum P	.....	.....	1.6	.....	.....	.....	.....

¹Based on weight of egg powder after drying.

²Sample bottle broken.

Table 6.---Average accumulated weight gain of 5-ounce powdered-egg packages filled with silica gel and given various treatments for moisture resistance after storage at 80° F. and 80 percent relative humidity

Type of package	Moisture-resistance treatment	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	10 weeks	11 weeks	12 weeks	13 weeks
B	Aluminum foil overwrap F	0.27	0.52	0.98	1.08	1.42	1.49	1.79	1.89	2.27	2.57	2.31	3.05	3.44
B	Metal foil pouch overwrap G	.34	.72	.95	1.05	1.42	1.74	2.04	2.25	2.23	2.86	3.07	3.27	3.44
A	Exterior double-coated with B wax	.47	.71	1.27	1.68	1.94	2.35	2.62	3.05	3.37	3.86	4.18	4.47	4.85
B	Pouch overwrap bag liner I	.58	1.65	1.58	1.99	2.54	2.32	3.17	3.45	3.83	4.32	4.10	4.81	5.38
B	Exterior double-coated with E wax	.64	.81	1.57	1.98	2.40	2.91	3.71	3.86	4.20	4.83	5.28	5.60	6.35

Table 6.---Average accumulated weight gain of 5-ounce powdered-egg packages filled with silica gel and given various treatments for moisture resistance after storage at 80° F. and 80 percent relative humidity (continued)

Type of pack- age	Moisture- resistance:	Gain in grams after storage for:												
		1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks	7 weeks	8 weeks	9 weeks	10 weeks	11 weeks	12 weeks	13 weeks
B	Exterior :double- :coated :with B wax:	0.35	1.00	1.66	1.93	2.63	3.03	3.43	4.12	4.54	5.13	5.80	6.25	6.81
B	Pouch :overwrap :case liner: :H	.66	1.37	1.88	2.28	2.87	3.61	3.99	4.53	4.93	5.76	6.20	6.73	7.42
B	Exterior :coated :with C wax:	.92	1.78	2.92	3.68	4.57	5.38	6.21	6.90	7.75	8.95	9.59	10.47	11.96
B	Exterior :coated :with D wax:	1.14	1.98	3.29	4.08	5.11	5.92	6.82	7.78	8.76	9.77	10.09	11.43	12.31
B	Exterior :coated :with B wax:	1.95	3.77	6.33	7.95	9.86	11.66	13.30	15.02	16.84	18.73	19.81	21.92	23.43