THE USE OF DESICCATED EGGS IN THE HOME
PREPARATION OF FOODS

by

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PREPARATION OF FOODS

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THE USE OF DESICCATED EGGS IN THE HOME PREPARATION OF FOODS

Introduction.

A problem of the greatest importance which confronts us at the present time, is the production and distribution of an adequate food supply at a fair price. For this reason a study of conditions and practices in the egg trade is of interest and of economic importance. The conditions are of interest in that many of them are of recent development, and are practically unknown to the great majority of consumers; the subject is of economic importance since the egg, which has for so long been a stable article of food, is coming more and more rapidly to command a price somewhat out of proportion to its nutritive value, as will be shown later.

The price of eggs fluctuates very greatly throughout the year, being lowest in the season of greatest production, during the months of April, May and June. The recent development of cold storage of perishable food material has tended to equalize the price and to raise it to a somewhat higher level for the year as a whole. The effect of such storage upon the physical and chemical properties of eggs and upon their bacterial content has¹ been studied in some detail, and need not be discussed here.

A consideration of the cost of eggs in relation to their value as a food is striking, and has a practical bearing upon our

1.

U. S. Dept. of Agr. Bureau of Chem. Bul. 115.
H. W. Wiley, "A Preliminary Study of the Effects of Cold Storage on Eggs, Quail, and Chickens."

problem. For the United States as a whole, the lowest average price paid to the farmers for eggs on the first of each month (1915), was 16.6 cents per dozen - in April and June; the highest average price was 31.6 cents per dozen in January.¹ Adding to this 40% for the cost of distribution (a very conservative estimate - some authorities place it as high as 65% of the total cost to the consumer) the lowest average retail price of eggs would be 23.2 cents per dozen; the highest average retail price would be 44.2 cents per dozen. It will be readily seen that these figures are not placed too high. In small towns the price may frequently be less than 23 cents per dozen and will seldom reach the higher figure; but in cities the lower figure is infrequent, and a price of from 40 to 50 cents per dozen, or even more, is not at all unusual during the winter months. The following table shows the basis for our statement that eggs often command a price very much higher than their food value will warrant.²

Food	Quantity	Cost	Calories	Protein	Cost 100 Calories	Cost 5g. Protein
Eggs	1- $\frac{1}{2}$ doz.	.3750@	1440	121.5g	.0260	.0156
	2 lbs.	25/doz.				
		.4500@				
	30/doz.	1440	121.5g	.0312	.0190	
		.7500@	1440	121.5g	.0520	.0312
	50/doz.					
Milk	1 qt.					
	2 lbs.	.10	650	29.9	.0154	.0166
Meat	2 lbs.	.40@	1900	146.	.0210	.0138
Beef Hind		20/lb				
Quarter		.50@	1900	146.	.0263	.0172
		25/lb				

1.

Yearbook of the Dept. of Agr. 1915. p. 524

2.

Figures based on analysis given in Bul. 28. U.S. Dept. of Agr. Bureau of Chem.

It will be readily seen that at 25 cents per dozen eggs are not an expensive source of fuel; but that they are a comparatively cheap source of protein. At 50 cents per dozen, eggs are very expensive both from the standpoint of fuel and of protein. However, it is impossible to judge this food material too closely by the above standard since, because of their peculiar characteristics, they are so valuable in the preparation of a great variety of foods.

In the commercial handling of eggs, there is a tremendous loss due to decomposition and to wastage of the so-called "cracks". The former loss may be obviated to a great extent by more intelligent handling of the product on the farm. The need for better methods of production and distribution is emphasized by Maurer, who speaks of the "wagon loads of rotten eggs hauled from the establishments of egg dealers"; and by Pennington who points out the "necessity of lessening the number of eggs that become totally unfit for food each year". The extent of this loss may be emphasized by a consideration of the following figures. The value of the poultry and eggs produced in the United States exceeds \$620,000,000.00 a year, 60% of which represents the value of the eggs alone. In the marketing of these, 17% are lost, due to broken, dirty, heated, shrunken, rotten, and mouldy eggs. The 17% loss amounts to \$63,240,000.00 annually.

1.

Kansas State Agr. Bul. 180 p. 333.

O. Maurer, "Bacteriological Studies on Eggs."

2.

U. S. Dept. Agr. Bureau Chem. Bul. 51.

M.E. Pennington, "Chem. Study of Commercial Eggs in the Producing Districts of the Central West."

3.

U. S. Dept. of Agr. Bureau of Animal Industry Bul. 141

H. M. Lamon, C. L. Apperman, "Improvement of the Farm Egg."

Comparitively recently methods have been devised for the preservation of some of these eggs which would otherwise be a complete loss. The two methods least open to criticism are removal from the shell with subsequent freezing or desiccation. Freezing is used quite extensively, but the resulting product is bulky, difficult to ship, and impracticable for home use in which we are most interested. Desiccation yields a product which is easily handled, both commercially and in the home, and is the more satisfactory of the two processes. It seems hardly necessary to say that several of the above mentioned classes of eggs are unfit for human consumption, and that there is no sort of treatment which will render them desirable. However, 7 of the 17%¹ loss, as stated above, is due to broken and shrunken eggs. It is the broken eggs - commercially known as "checks" and "cracks", and the shrunken or "held" eggs for which desiccation is practicable. By the utilization of this 7%, there would be effected an annual saving of \$4,400,000.00. More intelligent methods of production and handling on the farm must be relied upon to do away with the greater part of the annual loss; and such improvement will in turn lessen the number of eggs deteriorating because of broken shells and "shrunken" (evaporated) contents. The Department of Agriculture through its Farmer's Bulletins, and the bulletins and circulars issued by the Bureaus of Chemistry and Animal Industry, is doing educational work along this line, but the improvement will necessarily be slow, and in the mean time as much of the product as possible should be used.

1.

U. S. Dept. of Agr. Bureau Animal Industry. Circ. 140, p 16.
M. M. Hastings, "Egg Trade of the U.S."

Preparation of Desiccated Eggs.

The commercial desiccation of eggs is described by¹ Stiles and Bates who made an extensive study of the process and product. They emphasize the importance of location of the factory within easy shipping distance of the centers of production, and in a place having good drainage, ventilation, and plenty of sunlight; in a word - a factory located and constructed so that there shall be as little chance as possible for deterioration of the raw material or contamination of the product. It is quite true that many of the individuals and firms dealing in eggs out of the shell have by no means measured up to this standard either as to factory, or as to quality of eggs used, and the unscrupulous have often made a practice of buying up small lots of bad eggs for little or nothing, and mixing these with better eggs from other sources, thus lowering the cost and increasing the output. This is possible of course, since the individual eggs are lost sight of in the dried or frozen product. Such possibilities of adulteration make necessary strict supervision of the classes of eggs used in egg breaking establishments. Supervision by health officials has been put into effect in many places, so that a satisfactory product may now be obtained. There has been much criticism of desiccated eggs on the ground of poor quality. The following quotation is an example. "It takes four dozen eggs to make one pound of dried egg,

1.

U. S. Dept. of Agr. Bureau Chem. Bul 158. p. 14-15
G. W. Stiles, C. Bates, "Bacteriological Study of Shell, Frozen, and Desiccated Eggs."

and as the product sells for 25 cents per pound when fresh eggs are bringing from 36 to 48 cents per dozen, one can readily draw his own conclusions as to the quality of dried eggs on the whole.¹ At the present time such a sweeping statement is unwarranted and gives a false impression, both as to quality and price - which we shall leave for later discussion.

2

According to Stiles and Bates, the egg breaking season is from April 1st to October 1st, the bulk of it being done in June and July. Eggs are, of course, very plentiful earlier in the season, but the excess supply at that time is, for the most part, put in cold storage since these eggs "hold up" better than the summer eggs. In a large establishment, the eggs received are graded by candling and put in the following classes: (1) "firsts" and "extras"; (2) "seconds", made up of undersized eggs, checks, and cracks; (3) "leakers", eggs whose shells and shell membranes have been broken allowing some of the contents to escape; (4) "dirties"; (5) "weak" eggs in which the albumen has become watery due to temperature changes and lack of care in handling; (6) "spots" and "rots" made up of all the discards.

The firsts and extras are put directly on the market, or selected for storage; many of the seconds are put on the market, the remainder of their class used for freezing or desiccating, and such

1.

N. Y. Med. Jour. Vol. 92. p. 1331

R.C. Rosenberger, "Study of Eggs Offered for Sale as Pure Food."

2.

U. S. Dept. of Agr. Bureau of Chem. Bul 158.

G. W. Stiles, C. Bates, "Bact. Study of Shell, Frozen, and Desiccated Eggs."

eggs are perfectly satisfactory for food. The leakers, which are as a rule badly contaminated with bacteria, and the spots and rots are unfit for food, and should be used only for manufacturing purposes.

After grading, the eggs are broken with a knife blade or on the sharp edge of a metal cup, and the contents put in vessels according to the grade of the egg. In the better classes of eggs used, the white and yolk may be separated and dried or frozen as white and yolk, but this is done rather infrequently since in many of the eggs used there is already a mixing of the two parts within the shell.

The egg meat thus obtained is mixed, strained through a colander, mixed again in a churn or other mechanical device, and is then ready for drying. Stiles and Bates describe four methods; the (1) instantaneous, (2) belt, (3) disk, and (4) tray or board method. The first two mentioned are most satisfactory. When the instantaneous method is used, the eggs are sprayed into a heated chamber at a temperature of about 160 degrees Fahrenheit (71 degrees Centigrade) where they are immediately reduced to a fine powder. From the sanitary point of view, the method is said to be highly satisfactory, though the temperature used may yield a slightly less soluble product than the belt method. In this latter process, the egg material is dried on an endless belt made of zinc or galvanized iron. The liquid egg is kept cold in vats, and is supplied to the belt by means of a mechanical feeding device. Several factors affect the rate of drying in this process; the temperature, of course, which is usually 140 degrees Fahrenheit (60 degrees Centigrade), the length of the belt, and the rate of its revolution. One layer of

egg, a thin film over the entire belt, is usually dried in one revolution. After drying several films in this way, the dried material is removed and placed in a "finisher" where it is further dried at 100 to 110 degrees Fahrenheit (37-40 degrees Centigrade) for two or three hours. The product obtained by this process is very satisfactory from the sanitary point of view, is fairly soluble, more so than the product described above, but by the use of the belt method it is not possible to get so dry a preparation, and when it is finished it contains from 3 to 4 per cent more moisture. There are many objections to the other two methods mentioned, and, since these methods are not extensively used, they need not be described here.

Healthfulness of Desiccated Eggs.

Dried eggs are frequently objected to on the grounds that their bacterial content is so great as to render them unfit for food. In some cases the proof of this statement depends upon results obtained after innoculating an animal with some of the solution.¹ The author of one article quoted above, says that the inoculation of guinea pigs with a solution made by treating a sample of desiccated egg with sterile, distilled water, resulted in death in a few hours, and he goes on to say that "one wholly unacquainted with bacteria and their products will readily see that a potent poison is contained in the eggs, and that they are absolutely unfit for food."

1.

N. Y. Med. Jour. Vol. 92. p. 1331

R. C. Rosenberger, "Study of Eggs Offered for Sale as Pure Food."

The best answer to such a statement is the fact that the injection method for determining the toxicity of a substance has long since been abandoned, because substances entirely harmless when taken by mouth, often prove fatal when put directly into the blood stream.

However, in discussing the healthfulness of commercial egg products, the bacterial content must be considered. According to the work reported by Stiles and Bates,¹ 6.8% of commercial desiccated eggs examined contained 1,000,000 or less organisms per gram; 52% contained 100,000,000 or more per gram. The statement of the authors is as follows; "these results show that more than one half of the samples of commercial dried egg products examined, which had entered interstate commerce for food purposes, corresponded bacteriologically to the grade of eggs designated as 'heavy spots' and 'rots'. It cannot be concluded from this, however, that such eggs were used in these products, as investigations now making by this bureau show that the ordinary handling of the product may introduce as many bacteria as though some rots and spots were actually included."

2

Maurer discusses in detail the bacterial content of

1.

U. S. Dept. of Agr. Bur. Chem. Bul 158. p. 34.

G. W. Stiles, C. Bates, "Bacteriological Study of Shell, Frozen, and Desiccated Eggs."

2.

Kansas Agr. Exp. Sta. Bul. 180. p. 345-59.

O. Maurer, "Bacteriological Studies on Eggs."

desiccated eggs in relation to their effect upon health, and his conclusions are of interest and value. He states that there is little or no danger to the consumer from poisonous decomposition products brought about by non specific (putrefactive) bacteria. Even though comparatively large numbers of such bacteria are present in the dried egg product, they do not indicate decomposition since they infected the egg meat most probably at the time of its removal from the shell (being present particularly in the fecal material on the shells of dirty eggs). After removal from the shell, the egg mixture is kept at a low temperature until the actual drying which is accomplished in about fifteen minutes, so that the conditions are most unfavorable for multiplication of the organisms, or decomposition of the product. It must also be borne in mind that the bacteria contained in the dried egg product are from three to four times as numerous as in the undried material, due, of course, to greater concentration of the former. The specific, pathogenic bacteria present in desiccated eggs seem at first highly objectionable; yet, when we consider that the product is used entirely for cooking and baking at temperatures high enough to kill the organisms, it appears that danger of infection is less than from shell eggs taken as soft-cooked, poached, or raw, which have not been subjected to temperatures high enough to destroy any bacteria present on the shells or in the eggs. To substantiate these statements, Maurer gives a table, quoted from Escherich and Pfandler, showing that *B. coli* cannot possibly survive the temperature to which the product is subjected during cooking or baking.

1.

Kans. Agr. Exp. Sta. Bul 180. p 353.

O. Maurer, "Bacteriological Studies on Eggs."

It would seem desirable to establish for dried egg products a numerical standard, above which the bacterial content could not go, if the material were to be sold for use as food. We have such a standard for milk which is satisfactory, but there are several factors which go to make it inapplicable in the case of dried eggs. These factors may be summarized as follows:

(a) Dried eggs prepared under strictly sanitary conditions during a rainy season will often exceed in bacterial content a product prepared under insanitary conditions in dry weather, since every rainy day increases markedly the number of dirty eggs received in the manufacturing establishment. (b) Dried eggs containing 10% added sugar show a marked decrease in bacterial content during storage, so that sugar might be added to conceal inferiority.¹ (c) The temperature at which the eggs are dried influences the bacterial content, so that if they are prepared by a subjection to a temperature not exceeding 110 degrees Fahrenheit (43.3 degrees Centigrade), the bacterial content is practically the same as in the undried material (except for greater concentration); while if a higher temperature is used in desiccating, the egg is more or less cooked, but the bacterial content is much lower since only the spores will have survived. The bacterial content may be reduced after desiccation by holding the product at a temperature of 60 to 70 degrees Centigrade for some time. Therefore, it would appear that the fixing of a

1.

U. S. Dept. of Agr. Bureau of Chem. Bul. 158. p. 36.
G. W. Stiles, C. Bates, "Bacteriological Study of Shell, Frozen, and Desiccated Eggs."

numerical standard would encourage the use of a high temperature for drying, or the practise of holding after drying at a higher temperature, both of which are objectionable on the grounds that the solubility of the product is decreased, making it less easily used in cooking. Finally Maurer points out¹ that such a standard is unnecessary since, as has been stated before, desiccated eggs are used entirely for cooking, and because they play no part in infant mortality, nor in the spread of epidemics.

Before leaving the discussion of the healthfulness of desiccated eggs, a word should be said concerning the vitamins contained, as well as growth promoting substances. Vitamins and growth producing substances are contained in the product since, according to McCollum and Davis,² 20% of desiccated egg added to 80% polished rice, when fed to rats gave "excellent growth with reproduction ----- This shows that the egg contains both the fat and water soluble accessories." This is what one would expect since eggs are rich in both of these so-called accessory dietary factors, and since the temperature at which the eggs are dried is not high enough to affect the easily destroyed water soluble substance.

1.

Kans. Agr. Exp. Sta. Bul. 180. p. 356.

O. Maurer, "Bacteriological Studies on Eggs."

2.

J. Biol. Chem. Vol. 23. p. 186.

McCollum and Davis, "Dietary Deficiencies of Rice."

However, it is convincing to have the above experimental evidence, and to know that the wholesale preparation of this food material does not destroy the vitamins and growth promoting substances, as does the commercial treatment of many of our other foods.

Cost of Dried Eggs.

The price of desiccated eggs is now about one dollar per pound (though it varies, of course, with the different manufacturers). However, one representative firm has stated that if there were a retail demand which would warrant a large output in retail form, the price could easily be lowered to from 75 to 80 cents per pound. In one pound of the dried material there are approximately 38 eggs, and at a price of one dollar per pound, the cost per dozen eggs is \$.3156. At a price of 80 cents per pound, the cost per dozen would be \$.2526.

From these figures, and a comparison with the table given above, it will readily be seen that even at the present price of one dollar per pound, desiccated eggs are a great improvement over the 40, 50, or 75 cent eggs of our winter city markets. If this price were lowered to 80 cents per pound, the product would be a comparatively inexpensive food within reach of the vast majority of consumers.

At the present time there is practically no retail demand for desiccated eggs, and consequently the product is difficult to obtain in retail trade. Since the producers of dried eggs dispose of all their output in large quantities, selling as they do to bakers and other extensive manufacturers of food, there has been no incentive for them to create a retail demand by a campaign

of advertisement, nor to put their product in containers suitable for the retail trade. If we are to control, or at least diminish, the prevalent waste of eggs, thus effecting a financial gain to both producer and consumer, the first step will be to create a retail demand for dried eggs. This can only be accomplished by the information, or education, of the housewives themselves, most of whom, we are safe in saying, do not know that there is such a thing as a dried egg product. The creation of such a demand would encourage, or indeed make necessary, a more extensive application of desiccation to many more eggs than are now used for food, and would therefore be, not an apparent saving by merely making a change in consumers, but would be a real saving effected by the preservation of a product otherwise useless.

The desiccated eggs used in this investigation are in a form suitable for retail trade, having been packed in one pound tin containers. However, it seems from the correspondence which we have had with the manufacturers that they are not especially favorable to retail distribution of their product. This is no doubt due to the fact that they can now dispose of the entire output of the factories in large quantities, and with the minimum of time and labor. If we can build up a large and insistent demand for dried eggs, thus making the extra time and labor sufficiently profitable, the producers will without doubt be willing to encourage, rather than to discourage, the greater use of desiccated eggs.

Practicability of Home Use.

There are several points which may be mentioned in favor of the home use of dried eggs. At any season of the year, the consumer may obtain a product of uniform quality. This is a result highly to be desired, and at present is far from the true situation. Every housekeeper knows the necessity of breaking each grocery egg into a separate vessel, and the large number of eggs wasted. The bad eggs are usually "made good" by the dealer from whom they were purchased, but at a loss of his time and money. As has been pointed out above, many of the eggs so lost are unfit for food when they leave the farm, but many more become unfit for food while in transit, and before retail distribution, and it is these eggs which might easily have been saved and made into a desirable product by desiccation.

The desiccated eggs in their tin containers require little storage room, and no particular care, except that they should be kept in as cool a place as possible since we have seen that the higher temperatures tend to lessen the solubility. On the other hand, the shell eggs are much more bulky and, during several months of the year, must be kept in an icebox. The question of the space occupied is of importance to city dwellers, many of whom have so little space for the storage of foods and are therefore forced to buy in such small quantities that their food bills are correspondingly increased.

The poor of cities, and of smaller communities as well, could use the dried eggs very advantageously as a substitute for the expensive meat products. The food problem of the poor is one of great importance and is daily becoming more acute, so that any suggestion that offers an aid to its solution has to be considered. If the poor, as well as more comfortably situated families, can secure desiccated eggs at from 75 to 80 cents per pound, and can be trained to use them in food preparation and also as a meat substitute, a step in advance will have been made, and a financial saving both to producer and consumer have been effected.

Statement of Problem.

The problem which we have attempted to solve in this investigation, presents two phases: (1) the determination of the composition of the commercial samples of desiccated eggs obtainable, with a view to ascertaining whether or not the product is prepared from eggs alone, and how much must be used to be equivalent to one egg; (2) the determination of the efficiency of these commercial products in the preparation of foods containing eggs, as well as the flavor and appearance of the foods so prepared.

Experimental Work.

Analysis of Desiccated Eggs.

The analytical problem consisted of the determination of the composition of three samples of commercial desiccated eggs, which were available in this work. The constituents determined in each product are (a) protein, (b) ash, (c) moisture, (d) fat.

The methods used are those of the Association of Official
Agricultural Chemists.¹ For protein, the nitrogen was determined
by a modification of the Kjeldahl method, using potassium sulphate,
and copper sulphate in the digestion. The nitrogen multiplied by
6.25 gives the protein. The moisture was determined by a tentative
method described in the Journal of the A. O. A. C.² It consists
of drying the sample, contained in fat extraction cones, in a
vacuum desiccator over sulphuric acid. The fat extraction cones
with the dried samples were then extracted with anhydrous ether for
18-20 hours, and the fat determined by difference. The ash was
determined by the official method, - in the case of most of the samples,
exhausting with water, after charring. The results are given in
the following tables.

1.
U. S. Dept. Of Agr. Bureau of Chem. Bul. 107.
"Official and Provisional Methods of Analysis."
2.
Journal of the A. O. A. C. August 15, 1916. p. 79-80.

Nitrogen Determination

		Wgt.of Sample	N grams	N %	Protein
Chinese Eggs	I.	.4447	.0361	8.12	average x 6.25
	II.	.6080	.0512	8.42	51.68% protein
	III.	.4035	flask cracked in		
	IV.	.3758	digestion		
Egg Powder	I.	.4533	.0317	7.23	
	II.	.4127	.0271	6.58	
	III.	.6726	.0452	6.72	
	IV.	.3355	.0236	7.05	average x 6.25
	V.	.4540	.0305	6.72	42.85% protein
	VI.	.2925	.0200	6.84	
Baker's Egg	I.	.5403	.0340	6.30	
	II.	.3675	.0247	6.56	average x 6.25
	III.	.3412	.0218	6.40	40.00% protein
	IV.	.3695	.0234	6.35	

Ash Determination

		Wgt.of Sample	Wgt.of Ash	Ash %	Average Ash
Chinese Eggs	I.	2.0655	.0661	3.20	
	II.	2.3287	.0716	3.07	average
	III.	1.5728	.0512	3.25	3.17%
	IV.	1.7747	.0592	3.27	
Egg Powder	I.	2.1337	.0638	2.99	
	II.	2.2520	.0718	3.14	average
	III.	2.1572	.0668	3.09	3.06%
	IV.	1.8996	.0576	3.03	

	Wgt.of Sample	Wgt.of Ash	Ash %	Average Ash
Baker's Egg	I. 2.1160	.0695	3.28	
	II. 2.9650	.0971	3.27	average
	III. 2.5590	.0820	3.20	3.25%
	IV. 2.2511	.0741	3.24	

Moisture Determination

	Wgt.of sample	Loss of wgt.	H ₂ O %	Average
Chinese Eggs	I. 2.3385	.2243	9.59	
	II. 2.7018	.2435	9.01	
	III. 2.3225	.2105	9.06	average
	IV. 2.4391	.2243	9.19	9.13%
	V. 2.4013	.2003	8.3	
	VI. 2.0789	.2010	9.67	
Egg Powder	I. 2.1240	.0825	3.88	
	II. 2.1205	.0842	3.97	
	III. 1.8520	.0737	3.97	average
	IV. 2.1369	.0824	3.85	3.93%
	V. 2.0729	.0813	3.92	
	VI. 1.8330	.0730	3.98	
Baker's Egg	I. 2.5555	.1956	7.65	
	II. 2.2222	.1752	7.88	
	III. 2.4778	.1994	8.04	average
	IV. 1.6408	.1228	7.48	7.64%
	V. 2.2412	.1678	7.48	
	VI. 2.1985	.1610	7.32	

Fat Determination

	Wgt.of Sample	Loss of wgt.	Fat %	Average
Chinese Eggs	I. 2.3385	.8518	36.42	
	II. 2.7018	.9888	36.59	
	III. 2.3225	.8593	36.99	average
	IV. 2.4391	.9090	37.26	36.92%
	V. 2.4013	.9038	37.64	
	VI. 2.0789	.7623	36.66	
Egg Powder	IV. 2.1369	.6811	31.87	
	V. 2.0729	.6827	32.88	average
	VI. 1.8330	.5788	31.57	32.10%
Baker's Egg	IV. 1.6408	.6726	40.99	
	V. 2.2412	.9173	40.92	average
	VI. 2.1985	.9163	41.67	41.16%

Due to an accident in the laboratory, it was impossible to determine the fat in samples I, II, and III of either the "Egg Powder" or the "Baker's Egg."

The above may be summarized in the following table.

	Protein % N x 6.25	Ash %	H ₂ O %	Fat %	Total %
Chinese Eggs	51.68	3.17	9.08	36.92	100.85
Egg Powder	42.85	3.06	3.93	32.10	81.94
Baker's Egg	40.00	3.25	7.64	41.16	92.05

From this table we are justified in concluding that the Chinese product (handled by Keith & Co., Boston) is the only one of the three commercial samples examined which is made entirely from eggs. The "Egg Powder" (prepared and distributed by Merrell-Soule Co., Syracuse, N. Y.) apparently contains almost 20% of added carbohydrate. In correspondence, this firm says that they use 10% of sugar in preparation of the eggs, and the package states that the product contains "added sugar". The "Baker's Egg" (prepared and distributed by the National Baker's Egg Co., Sioux City, Iowa) apparently contains over 8% of added carbohydrate, although the label on the container states that "Baker's Egg is guaranteed to be simply fresh eggs (dried)". There is, however, another possibility; namely, that some change has taken place in the protein, allowing some of the nitrogen to escape as ammonia. If this were true the protein, ash, moisture, and fat plus 10% of sugar would give a total of about 91% for the "Egg Powder", which agrees quite well with the total percentage determined for the "Baker's Egg". Then the differences between these total percentages and 100% would be accounted for by the changes which had taken place in the protein. In that case the determination of protein by difference would perhaps give better results. This is a possibility, yet it hardly seems reasonable to suppose that the protein has been changed enough to account for a discrepancy of 8.5 - 9%.

The analyses given above agree quite well with published
1 analyses of two commercial products in which the percentages were as follows:

1.

Maine State Bul. 75. p 89 - 112.

C. P. Woods, L. H. Merrill, "Analysis of Miscellaneous Food Materials."

	Prot. N x 6.25	Ash	H ₂ O	Fat	Total
Crystallized Egg	47.9	3.6	7.5	34.7	93.7
Egg Flake	45.2	3.5	6.8	38.5	94.0

In these analyses, as they were reported in the bulletin, the per cent of protein was given twice, first as N x 6.25, and second as protein "by difference". The possibility of the presence of added carbohydrate was apparently not considered since the authors state that "'Egg Flake' and 'Crystallized Egg' have a composition corresponding to dried eggs without a shell, and give every indication of being desiccated eggs." However, the addition of carbohydrate is a fairly common practice, so that when such results are obtained by analysis, it is a more or less certain indication of the presence of sugar. At least one is more justified in supposing that some sugar has been added, than in concluding that all the difference is due to incomplete determination of protein, due to changes which have taken place in it.

In order to verify the results obtained by the above analyses, qualitative tests were applied to the egg products to show the presence of carbohydrates. About five grams of each of the three samples were boiled with distilled water, filtered, and each filtrate divided into three parts, which were treated as follows: part I tested for starch by adding 2-3 drops of iodine in solution in potassium iodide; part II tested for reducing sugar, by adding to a few cc. of hot Benedict's solution, and then boiling; part III tested for sucrose by boiling with 3-4 drops of .2% hydrochloric acid, then adding to hot Benedict's solution and boiling. The samples were first boiled with distilled water in order to render soluble any starch which might

have been present, and to coagulate the proteins, thus removing any glyco-proteins, which might give a positive test for reducing sugar. The results of these tests are given below.

	Starch	Reducing Sugar	Sucrose
Chinese Eggs	not present	not present	not present
	not present	" "	present
Egg Powder	present		
	not present	present	present
Baker's Egg	present		(probably)

The carbohydrate added to the "Egg Powder" seems to be all sucrose; a reducing sugar, as well as sucrose has apparently been used in the preparation of "Baker's Egg." These positive tests for sugar give further support to the statement that the discrepancy of 8.5 - 9% is due to carbohydrate rather than to protein. As a further check on the analyses reported above, it would be well to determine the sugar, quantitatively, as well as qualitatively.

The effect of added sugar on the bacterial content of desiccated eggs has been mentioned above, and it will be recalled that it acts as an antiseptic, decreasing the number of bacteria present, so that it may be used to conceal inferiority. In addition to this, it will be noted that the products containing the added sugar have a smaller per cent of moisture, so that the keeping qualities may be thus increased, although this is doubtful since the Chinese dried egg product seems to keep equally well with its higher moisture content. The addition of sugar in the preparation of dried eggs has another advantage, to the manufacturer at least, since it must materially cheapen his product. However,

in case a retail demand were created, and many dried eggs sold to individual consumers, as well as to large food manufacturers, this decrease in cost of preparation would no doubt be accompanied by a decrease in the price asked of the consumer.

In calculating the amount of dried egg which is the equivalent of one fresh egg, it seems best to base it on the protein content, since many of the purposes for which eggs are used depend in large measure upon the protein. According to Atwater and ¹Bryant, the average protein content of fresh eggs is 13.4%.

Taking the average weight of one egg, without the shell, as 50g., we will have in one fresh egg 6.7 g. protein. The protein content of the three commercial samples as given above is: Chinese eggs, 51.68%; "Egg Powder" 42.85%; "Baker's Egg" 40.00%. Therefore, to get 6.7g of protein, one must use 13 g. of Chinese dried eggs, 16.1 g. of the "Egg Powder, and 16.7 g. of "Baker's Egg". However, in cooking with these products, excellent results were obtained when a smaller quantity was used than that stated above. In diminishing the amount used we are lowering the food value slightly, but this would make very little real difference unless the preparation, such as an omelette for instance, were being used as a meat substitute. It might be well to mention in this connection the fact that fresh eggs vary greatly in size and weight. Atwater and Bryant give the maximum protein content as 15.6%, the minimum as 10%, and therefore the substitution of the desiccated for fresh eggs cannot be very exact.

1.

U. S. Dept. Agr. Bur. of Chem. Bul. 128.
"Chemical Composition of American Food Materials."

Application of these Products in Cooking.

The problem here to be solved is a most practical one, and upon its satisfactory solution depends the value of the entire investigation. We have attempted to determine the extent to which dried eggs may be substituted for fresh ones, in the preparation of typical foods; and also the attractiveness and palatability of the foods so prepared.

In using desiccated eggs in the home, a little more foresight is required, since the eggs are not ready for immediate use as are the fresh ones. The required amount of dried egg should be put in a suitable vessel with three tablespoons of water to each egg used, and the whole allowed to stand, covered, with or without stirring, for from one half to three quarters of an hour. If the mixture is stirred or beaten up with a fork at intervals, it will be found to go into solution more quickly. The egg product should not be allowed to stand any longer than is necessary for solution, nor in a warm place, since both of these factors will influence the bacterial growth. The solution thus obtained resembles a whole egg removed from the shell, with both yolk and white beaten up together, and may be used as such. The method for using "Egg Powder" differs a little from the one described above, since it is in a much more finely divided condition, due to the added sugar, and the correspondingly lower moisture content. The amount of this required is rubbed until smooth and free from all lumps with about one half the necessary water, after which the rest of the water is added. The directions given on the container say that for beating, the required amount of powder

may be put on top of the necessary water, heated to a temperature which is comfortable for the hand to bear, and the whole beaten up quickly with any sort of egg beater. When this method is used, the solution is obtained easily and rapidly, but it was not found to give any added lightness or fluffiness to the finished food product.

In this connection, a brief discussion of egg cookery will be of advantage in pointing out the extensive substitution which may be made by the desiccated for fresh eggs.

Eggs may be cooked alone or with the addition of milk, or cream sauce, and served as a substitute for meat. The objects in view in cooking are to coagulate the protein and to develop the flavor, and the particular methods by which these objects are accomplished with shell eggs, and which are equally well adapted to dried eggs, are scrambling and cooking as omelette.

Eggs are used frequently as a means of thickening, and their use here depends upon the coagulation of the protein. The mixtures thickened are usually custards, either of the "soft" or "hard" type. In preparing the soft custards, the egg is added to the milk and sugar, and the whole cooked in a double boiler, and stirred while it is being cooked. This stirring serves to break up the protein coagulum, as it is being formed so that the resulting custard is of a soft and even consistency throughout. In preparing the "hard" type of custard, the egg is added to the milk, a smaller proportion of the latter being used than in the

above, and the mixture baked until "set". The protein coagulum is not interfered with here, so that the custard is firm throughout.

In batters and doughs, eggs are used so that the cells of the product will be sufficiently rigid when the mixture is cooked, or baked. This rigidity is made possible by the coagulation of the protein. Furthermore, the eggs are used as a means of incorporating and holding in air, and other gases, which give lightness to the finished product.

Eggs are used in salad dressings of two types; those which have a custard basis, and those in which the egg emulsifies the oil. The dressing with custard basis depends upon the same principles as those given above for custards. The oil dressing depends upon the emulsification of the oil by the egg, and this emulsifying power of the egg seems to be dependent upon fineness of division, and completeness of solution.

With these points in mind, we may more easily and fully discuss the use of dried eggs in the preparation of foods.

Scrambled Eggs - Omelettes.

Chinese dried eggs, "Baker's Egg", and "Egg Powder" were used in the preparation of "scrambled" eggs. The material was first brought into solution as described above, then cooked in a hot frying pan just as one would proceed in "scrambling" ordinary shell eggs. The mixture thickens up just as do fresh eggs, and looks very appetizing. The taste is slightly different, although it is not at all disagreeable. The "Powdered Egg" was not satisfactory prepared in this way, since the large amount of added

sugar gave it an undesirable sweet taste.

The Chinese and "Baker's" dried eggs were made into omelettes; first a plain omelette in which it is not necessary to separate the white from the yolk, and to which milk may be added 1 T to each egg¹; second omelettes with a cream sauce basis (one fourth cup of white sauce being used to each egg). The omelettes made were light, not at all tough, and of attractive appearance, since they brown as well as those made with fresh eggs. As was noted above, there is a slightly different taste, which is not objectionable, and the product so prepared is satisfactory in every way.

Custards.

The dried egg products were used in making custards. First, a series of the boiled or soft custards was prepared, the amount of materials used being the standard proportions -- the equivalent of one egg to three quarters cup of milk and two tablespoons of sugar. After combining the hot milk and the egg solution, it was necessary to strain the mixture, but this is usually the case when fresh eggs are used, and in the dried egg custard there was very little more of the insoluble matter than in the custard made with fresh eggs. The series of custards consisted of one made with a fresh egg, and three others made respectively of the Chinese product, "Egg Powder", and "Baker's Egg". The four custards were of uniform consistency and appearance, except that those made from the desiccated eggs tended to be of a lighter color than that made from the fresh spring egg, with its intensely yellow yolk.

1.

1 T - One tablespoon

Four custards of the "hard" or baked type were prepared, using the equivalent of one egg to two thirds cup of milk and two T of sugar. Those made from the desiccated eggs were of as good consistency and fully as attractive in appearance as the one made with a fresh egg.

However, there is a marked difference in the taste of the fresh and the dried egg custards. The latter are characterized by a peculiar taste, which may best be described as an "after taste", and which is very apparent when the fresh and dried egg custards are eaten side by side and the tastes compared. When one has once learned to recognize this "dried egg taste", it is practically impossible to overlook it in the custards where the flavor of the egg is brought out so delicately. However, some individuals in tasting and comparing the custards, could distinguish a difference in taste but preferred that made from the Chinese dried eggs to the one made with fresh eggs. This "after taste" is perhaps more noticeable in the case of the "Egg Powder" than in either of the other commercial products used.

In using the "Egg Powder" for the preparation of custards, the amount of sugar added may be decreased by one fourth, and the high per cent of sugar present in the egg product will make up for this reduction of the usual amount, and yield a custard which is sweet enough.

Muffins and Popovers.

Muffins were made using each of the three commercial desiccated egg preparations. The following standard proportions

were used;	The muffins in which the dried egg was
2 c. flour	substituted for the fresh were satisfactory
2 T. sugar	in every respect, and it was impossible to
2 T. fat	distinguish between the dried and fresh egg
1 c. milk or water	products.
4. tsp. B. P.	
salt.	

It was supposed that popovers, containing as they do a larger amount of eggs, might be less satisfactory than the muffins. Therefore popovers were made from the Chinese eggs, the "Baker's Egg" and the "Egg Powder" according to the following recipe:

2 eggs	The popovers so prepared were very light,
1 c. flour	and of good texture and flavor. Here again
1 c. milk (scant)	it is not possible to distinguish between
1 T. melted fat	those made with fresh and dried eggs.
salt.	

The use of desiccated eggs in muffins and popovers, suggests its further use in other batters and soft doughs. It would, no doubt, give excellent results in waffles and batter cakes, and for French toast and similar mixtures.

Cakes.

Four "butter cakes", or cakes in which fat of some kind is used, were made, taking proportions of material as follows:

3 c. flour	5 tsp. B. P.	The four cakes were mixed as
1 c. water	flavoring	nearly alike as possible, using
$\frac{1}{2}$ c. fat		the short method of combining.
$1\frac{1}{2}$ c. sugar		The only difference was in the eggs used; one
3 eggs		cake was made from a fresh egg - the other three

were made using the three dried egg products. After baking, the cakes were all light, of good texture and appearance, and all were of equally good flavor. Those made from the dried eggs were fully as satisfactory as that made from the fresh egg, it was, in fact, impossible to distinguish between them, either by texture or taste.

If one is using the "Egg Powder" in cake making, it was found to be quite convenient, and to give excellent results, to sift the required amount of the powder with the flour and other dry ingredients. The water in which the egg product would otherwise have been dissolved, is added to the other liquid used in the cake. This same method of using the "Egg Powder" may also be used in mixing muffins and popovers.

It may be of interest to state that corn oil was used in these cakes. It is very satisfactory, easy to use, and at present is a very cheap fat.

It is, of course, a more difficult matter to make good sponge cakes using the dried eggs in place of the fresh. The typical sponge cake depends upon the air incorporated in the egg white for its rising in baking and for its lightness when done. Since the desiccated eggs used in this work consist of both yolk and white dried together, it is not possible to incorporate the air in the usual manner, and we must therefore depend upon some other rising agent. The principle used in the cheap sponge cakes may be applied here; that is, substituting for part of the eggs by adding baking powder which will act as the rising agent, and by adding

water to replace the liquid which the egg would supply.

Sponge cakes were made from fresh eggs, and from each of the three samples of desiccated eggs, using the following proportions:

4 eggs	One half teaspoon of baking powder is the substitute for the air which would be incorporated in each egg white.
1 c. flour	The sponge cakes made with these proportions, using the dried eggs and adding baking powder, were fairly good though the appearance and texture were not quite so desirable as that of the fresh egg sponge cake.
1 c. sugar	
2 T. lemon juice	
2 tsp. B. P.	

The "Egg Powder" was used in making cream puff shells.

The proportions of ingredients were as follows:

1 c. H ₂ O	The usual method of combining was used, and the product when finished compared favorably in every way with that made from fresh eggs. It was impossible to distinguish between the two.
$\frac{1}{2}$ c. fat	
$1\frac{1}{4}$ c. flour	
$5\frac{1}{2}$ eggs	

Salad Dressing

Cooked salad dressings were made, using the ordinary ingredients, and substituting dried for fresh eggs. The dressings so made were satisfactory in every way. It is impossible to detect by the taste, or in any other way, the substitution of the fresh eggs.

Several attempts were made to prepare good oil dressings with the dried egg products, but each attempt was unsuccessful. It seemed at first that the egg had not been allowed enough ^{time} to become sufficiently soluble and finely divided, since it could be seen in small particles

suspended in the mayonnaise. The dressing did not thicken as it should, nor was the oil emulsified permanently since it separated out as soon as it was allowed to stand. After soaking the required amount of egg for two hours, beating frequently, an oil dressing was prepared, but with the same results as before. No further attempt to prepare a satisfactory oil dressing was made since, as has been pointed out above, the bacterial content of the desiccated egg is so great as to render a food prepared with it unsafe for use, without previous cooking.

From the results as given above, we conclude that desiccated eggs may be used very satisfactorily for scrambled eggs and omelettes, and with these as a basis, for many dishes and combinations which will take the place of meat in the diet. The product is open to criticism when used in custards, because of the peculiar flavor imparted to the mixture; however, it may be used here with fairly good results. The dried eggs used in batters and doughs gave the very best of results, and the foods of this class prepared with the commercial products were highly desirable in every way. The cooked salad dressings were also very good when made with dried eggs. In this work we have merely prepared a few typical foods, which are intended to suggest the extensive substitution which may be made of the desiccated for fresh eggs.

Summary of Conclusions.

1. Satisfactory egg products may now be obtained.
2. According to the references quoted above, the bacterial content is not such as to prove detrimental to health when used in cooked foods.
3. Their use even at the present price will effect a considerable saving throughout a large part of the year. If the price can be lowered, dried eggs will become comparatively a cheap source of both fuel and protein.
4. The composition as determined by analysis shows that the commercial products examined are prepared from eggs; one without the addition of carbohydrate, the other two with added sugar. The percentage of composition of the three samples varies as follows: protein 40.60, 42.85, 51.68; ash 3.25, 3.06, 3.17; moisture 7.64, 3.93, 9.08; fat 41.15, 32.10, 36.92. Those samples in which the protein and moisture are low are the ones to which carbohydrate has been added, and the one which is very low in moisture content is the one in which the largest amount of sugar has been used.
5. The desiccated eggs may be used with highly satisfactory results in the preparation of practically all typical foods in which eggs are used.

Approved: -
Louise Stanley.
May 14, 1918.

I wish to take this opportunity to thank Miss Louise Stanley for her criticism and encouragement throughout the course of this work.

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