THE COATING OF COMPRESSED TABLETS.*

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The thought has come to the writer in the preparation of a paper on "The Coating of Compressed Tablets" that a very much larger paper could have been presented on how tablets should not be coated rather than on how they should be. On the market to-day we find a great many varieties of coating with regard to the colors presented, the materials used, the quality of these materials and the quality of the coating itself, all of which is indicative of the knowledge and skill of the manufacturer and his conception of what a fine coated tablet should be. A few general remarks at this time may be enlightening.

Coating work originally began with pills, and just as tablet manufacture itself sprang from the manufacture of pills so was the idea of coating tablets adopted. The first pills coated were unquestionably handled singly and the methods were very crude. Pills were picked up one at a time, either on the point of a needle or with a pair of tweezers, and dipped in a heavy solution of gelatin, or acacia, or a combination of both. Later experiments were made combining with these two agents syrups in varying amounts. The gelatin coating of pills developed rapidly to a place where as many as five hundred were picked up at a time, held in place on the end of small tubes by suction, one-half of the pills then being dipped in the gelatin solution, the process reversed and the other half dipped. All this work involved the selection of certain grades of gelatin, and the manufacture of certain densities of this solution, the heating problems being more or less complex, not only at the time of dipping but also in the subsequent drying of the pills which had been coated. The use of various colors in pill coating was tried out from time to time but at present the colors are practically limited to black, white and brown.

Pills, as we know, are manufactured from the plastic mass and contain more or less moisture, whereas tablets are manufactured from dry ingredients and do not or should not contain moisture. Sugar coating for that reason is not only best in handling tablets, but is preferable on account of a great freedom from temperature and humidity interference. The dipping of pills or tablets into a syrup solution would not give a smooth coating as the sugar would ultimately crystallize on the tablet. Coating basins were, therefore, necessary for this work. These should be spherical in shape, as any corners or edges would not allow the tablet to roll properly and would interfere with the entire method. These are, as all of us know, made of copper, the basin being surrounded by steam coils, and also being equipped with a hot and cold air blast. These basins are geared to a shaft in such a manner that they rotate in one regular direction. The speed of this rotation varies in accordance with the size of the basin, and the size and kind of coating work which is to be done. While the work done is regarded by many as sugar coating pure and simple, this idea is erroneous, as with the vast majority of tablets coated use is made of both acacia and gelatin. The building up of the first layers of coating is referred to as sub-coating, thus giving us three stages before finishing, namely, sub-coating, coating, and polishing. The sub-coating, of course, varies in accordance with the ingredients in the tablets. It will readily be seen that the coating of a tablet made almost entirely of heavy extracts would differ from one containing volatile ingre-

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dients such as chloral, camphor, caffeine, etc. The coating will also vary if the tablet be white originally, or if it be one of dark color.

The results desired in ninety-five percent of all coatings are confined to three purposes; first, and most practical, the protection of the ingredients in the tablet itself; second, the rendering of unpleasant-tasting ingredients tasteless; and third, the appearance. The last gives rise to the wide variety of colors and shades which are to be found in tablets to-day. These are without end, and must suit the whim of an enormous number of individuals who are anxious that their tablet differ from all others. There can, therefore, be no standard of color to which the manufacturer can adhere, especially when it comes to private formulas. Different size basins are used, from those eight inches in diameter up to sixty inches; this of course, to accommodate the large and small runs of tablets. As in other forms of pharmaceutical processes, it is vastly cheaper per thousand to coat half a million tablets in one operation than to coat twenty-five or fifty thousand. It will be found that aside from the small cost of additional coating material, the labor and time involved are the same.

The coating of tablets with the use of talcum was at one time popular. This was called "pearl coating" and followed the period when gilding and silvering of tablets was popular. It is a fact that at one time powdered gold and powdered silver were used for this purpose. Some coatings on the market to-day render a tablet absolutely insoluble, and therefore defeat the entire plan of medication; just as tablets must be made to disintegrate properly, just so must the coating layers on a tablet disintegrate readily in order that the medicinal ingredients present may be exposed. It is interesting to note that the best ingredient to make tablets disintegrate if incorporated in the coating will do the same work. Potato starch is the agent which excels all others for this purpose. Its use will cause the coating to rupture readily as soon as moisture is applied on account of the rapid swelling of the starch. Just as great care is exercised in tablet making to use as little foreign material in excipients and diluents as is possible, the careful manufacturer of to-day aims to give complete protection to the tablet with the thinnest coating possible. Clumsy heavy coating will be found on the tablets of manufacturers who have not perfected their processes. Have those present ever thought that the sugar coating of almonds by confectioners is done by exactly the same method and that the same apparatus is used as in the coating of tablets? Of course few difficulties are involved in the coating of such things as almonds, and a very ordinary workman is capable of handling this. Perfectly round pills are easier to coat than are the flatter tablets. A perfectly flat tablet is extremely difficult to coat, and is therefore never used. For this reason the punches used by manufacturers are separated into two classes, so far as oval tablets are concerned, one class being known as "Regular Cup," and those intended for future coating as "Deep Cup." A casual thinker must therefore arrive at the conclusion that with the "deep cup" tablets the manufacturer is trying to arrive at as nearly spherical a shape as is possible; this because these tablets will roll more uniformly in the coating basin, and are not nearly so inclined to stick. It must be remembered that every individual tablet, even though half a million are present, must roll independently of the other or it will not gather coating evenly and will show defects in the surface of the finished product.

Humidity is one of the greatest difficulties which has to be met. Moisture interferes very seriously with gelatin, acacia and sugar, and the coating of the same tablets on a dry or a very damp day would necessitate changes in manipulation. This accounts for the use of an air blast which produces dry air, and another in which air of a higher temperature is present. This means that the manufacturer can control the atmosphere in the basin in matters of both temperature and evaporation, for naturally when these coatings are put on in the form of solution the speed with which they evaporate must be controlled. The steam coils surrounding the outside of the basin of course control the temperature of the pan surface. Some tablets must be kept warm while they are being coated, as otherwise they would absorb too much moisture, while others if heated would allow the penetration of the coating solutions; these therefore require that the first surface be applied very rapidly in order to protect the ingredients.

There are some odd coatings used to-day in certain processes. Collodion and balsam tolu are used by some manufacturers on tablets containing ferrous iodide and phosphorus. This work is of necessity very slow. Keratin coating was first developed in Germany for the coating of pills which were not to be acted upon in the stomach, but which were intended to be dissolved in the intestinal fluid. The process was very slow and difficult. It is, as you know, a constituent of horny matter, and is obtained after the same has been freed of all fat present by treating with ether and then digesting the horny material in the form of shavings with a mixture of hydrochloric acid, pepsin and water for about thirty hours in order to remove all material which would be soluble in gastric juice. After proper washings with water the residue is treated with 5% ammonia water, using slight heat, until a complete solution results. This fluid is evaporated to dryness, and the alkaline solution is used on pills containing metallic sulphides, pancreatin, trypsin, etc. Acetic solutions of keratin have been used for coating such products as salicylic acid, arsenic, salts of mercury, creosote, tannin and such like. Tablets intended for this kind of coating first have to be made with some fatty excipient such as cacao butter, pure mutton tallow and either white or yellow wax in various combinations, and must contain no moisture. Salol has largely supplanted the use of keratin, as it also does not permit of the tablets being disintegrated until the intestine is reached. The majority of manufacturers apply the salol (after it has been melted) in about three different coatings. This presents considerable difficulty and the writer has found that the application of the salol mixture with alcohol has proved decidedly better, but can only be applied by a very skilful operator. This general discussion now brings us down to a definite set of processes which at this stage may be readily understood.

COATING PROCESSES.

Removal of Dust.—The first step in the coating of all tablets is the removal of edges. This is done by placing the tablets to be coated in a coating basin and allowing the same to revolve for five minutes. The tablets should then be thrown on a separator and the dust and particles resulting from these edges removed. If allowed to remain these cause rough particles to adhere to the tablets, which cannot be made smooth unless an extremely heavy coating of many layers be put on.

Chocolate Coating.—After removing the edges sufficient syrup and gelatin solution must be added to cover the tablets. This should be poured in slowly from a graduate

and the tablets should not be allowed to mass in the pan. If this is put on sufficiently slowly this may not occur, but if it does the operator must thrust his hand into the mass to prevent surging, and must stir the mass of tablets until they break up and roll free. The next step is the addition of about five dustings of No. 3 powder. This is done by alternate moistening with the syrup and gelatin solution and the dusting on of the powder. The tablets should be allowed to roll for between forty-five minutes and an hour between each dusting. Next, enough chocolate syrup should be applied to remove all dust. The tablets are then rolled for from ten to fifteen minutes. Three or four coats of heavy chocolate syrup are next applied, using the same care to prevent massing, the last two lots of chocolate syrup being diluted with water to one-half their density. This will bring the tablets to a smooth surface. These lots of syrups go on thirty minutes apart. Next enough plain chocolate syrup should be added to bring all tablets uniformly smooth. They are run in this condition for from three to four hours. They should then be put in the polisher with the lumps of polishing wax and run for thirty minutes. This will produce a tablet with the typical brown chocolate coloring, and a splendid polish, and will not have a rusty color.

Coating White Tablets White.—The next type of coating to consider will be the white. This process is more simple then the chocolate coating. After having removed the edges, successive treatments of gum and syrup solution, and coating powder No. 1 are applied. These go on one hour apart for five lots. Plain syrup is then added to settle the dust, and four lots of heavy white syrup are added thirty minutes apart. The tablets are then polished for thirty minutes. It must be noted that the above method is applicable only to white coating of white tablets such as quinine, acetanilide, salol, etc.

Colored Tablets.—In coloring tablets the process is identical except that before polishing plain syrup containing sufficient coloring to produce the desired shade is applied until sufficient color is obtained. The tablets are then polished.

Coating Dark Tablets White.—The coating of dark tablets: First remove all edges as in the preceding cases, then add solution with gum and coating powder No. 4. These should then be rolled for one hour. The next step is the treating four times of the tablets with solution of gum, and coating powder No. 2. These are applied one hour apart. Solution of gum, and one lot of coating powder No. 4, is the next treatment. The tablets are then rolled for one hour. Next is settled all dust with plain syrup. This takes from ten to fifteen minutes. Four lots of heavy white syrup are next applied thirty minutes apart. The tablets are then polished for thirty minutes. Or if color is desired, before polishing plain syrup with sufficient coloring to supply the desired shade is used on the tablet for from three to four hours.

Massing Tendency.—It must be remembered that in applying all solutions, whether of syrup or gum, or their combination, there is the tendency if these are applied too quickly for the tablets to mass and ride the side of the coating basin in solid mass, simply rising and sliding without any movement of the individual tablets. This will cause one tablet to pick the surface from the other with the ultimate result that one tablet will have an uneven projection and the other will be pitted on one side. As soon as this massing condition is noted the operator must thrust his hand into the mass and stir quickly until the individual tablets begin to roll. Large tablets, it will be observed, are not inclined to mass as quickly as do small, because

the small tablets naturally lie closer together. The slow application of the solutions will ofttimes prevent this, and it should be remembered that the various dusting powders applied should be added as nearly uniformly over the whole amount of tablets as is possible, and not simply thrown in one mass. If these precautions are observed a skilful operator may cut down the time of the preceding method by from twenty-five to forty percent. Remember that the rolling of the tablets in the basin after all is the reason for coatings being layered evenly, and the novice should not attempt to coat too rapidly.

Weather Conditions.—Circumstances which play a great part in the coating of tablets are the weather conditions. In humid weather it is not to be expected that syrup and gum will dry as quickly as in dry weather, and the same speed should consequently not be anticipated. Therefore, coating in summer is usually a more troublesome operation than during a winter season.

Drying.—The solutions to be added at the various stages which contain solid ingredients, such as the heavy chocolate syrup, the heavy white syrup, etc., should always be agitated before applying, in order that the solid ingredients contained may not be allowed to settle. Under circumstances where the tablets do not dry sufficiently fast it is extremely helpful to have an air blast which blows directly into the coating basin, thereby setting up a circulation of air, and more quickly removing the moisture. To be able to apply heated air from 120° to 140° F. from these air blasts as well as air at ordinary room temperature will increase the speed with which coating may be done, but should only be used by a skilful operator, as too quick drying will sometimes not allow sufficient roll in the basin to give a smooth tablet. It must be remembered that the perfect coated tablet is one having the thinnest possible coating yet presenting ample protection.

Moist Tablets.—Certain tablets which attract moisture should be dried thoroughly before placing in the coating basin, as too much moisture left in the tablet will affect the coating from the inside with ultimate fracture of the coating. In some cases where a number of vegetable extractives of damp or gummy nature are present it will be found most helpful to apply two or three treatments of 50% solution of gum arabic. This adheres quickly and is preferable to solutions of gelatin which in themselves add moisture to the tablets before they harden sufficiently for the following coating treatments. It must be remembered that all tablets containing volatile ingredients such as camphor, menthol, etc., must be coated quickly, as the rolling of such tablets around in the basin presents ideal exposure for the escape of these substances. The operator in time acquires an intuition which will give him a clue as to just what these peculiar tablets need to protect them in the early stages. Coatings such as those containing beeswax, etc., should not be used as in some cases they render the tablets insoluble and therefore worthless.

Potato Starch.—It will be noted that at some stage in the coating there is applied a powder which contains potato starch. This is necessary as the potato starch when exposed to moisture swells more rapidly than any other agent which can be used and ruptures the coating quickly thus allowing the tablet to disintegrate promptly. Before placing any tablets of this character on sale a fair practical test is to drop some in water at about body temperature and see how quickly the coating will leave the tablet. A point worth remembering is that no accurate colors can be built up except on a perfectly white sub-coating. This is why in the

case of all colored tablets they are coated up to a finished dull white condition before the color solutions are applied.

COATING SEVERAL SIZES OF TABLETS.

If different sizes of tablets are to be coated containing ingredients which are not incompatible, and these tablets are all to be coated the same color, or with a chocolate coating, they may all be placed in the same basin at the same time. We may thus have one-, three- and five-grain tablets which are to be coated. The coating process being identical they are all coated in the one operation, and then separated afterwards by the use of a separator.

Separating.—Separators are not screens in the ordinary sense but are made from sheets of metal having circular perforations. Thus when we place the mixed tablets on a separator, those which weigh only one grain may fall through; when these are removed the remaining tablets are placed on a separator which will permit the three-grain tablets to escape, but the five-grain to remain. This work is so precise and the separator so accurate that there is really no danger of admixture, and three or even four different sizes of tablets of different ingredients may be coated at the time expense of only one coating.

Odd Colors.—A great number of freak colors found in tablets on the market to-day render it necessary to have an operator who is far from color-blind, as very peculiar shades are ofttimes demanded. It is, therefore, wise for the operator to begin with a weak color solution, and build up his shade, as he may otherwise find he has gotten his color too intense from the start. There are to be obtained a vast variety of water-soluble colors which mix very readily in simple syrup solutions, but the operator will be frequently called upon to remember that yellow and blue make green, and that red and blue make purple, and red and black, brown, etc. Color charts such as those supplied by paint manufacturers often prove helpful in selecting and matching shades.

FORMULAS EMPLOYED IN TABLET COATING.

COATING POWDER NO. 1, WHITE.

	Pounds.	Ounces.	Gallons.
Powdered sugar, white	87	2	
Powdered acacia, best	12	14	

COATING POWDER NO. 2.

Calcium carbonate precipitated, white	87	8	
Potato starch, best	12	7	

COATING POWDER NO. 3 (CHOCOLATE).

Powdered chocolate, fat-free	14	8	
Powdered extract of licorice	2	1	
Potato starch	12	7	
Powdered sugar	71		

COATING POWDER NO. 4.

Powdered sugar	88		
Powdered starch	4	8	
Powdered acacia	6	8	

PLAIN SYRUP.

Granulated sugar	40		
Water			3

PLAIN CHOCOLATE SYRUP.

	Pounds.	Ounces.	Gallons.
Chocolate paste	11		
Plain syrup			10

HEAVY CHOCOLATE SYRUP.

Powdered cocoa	20		
Powdered sugar	100		
Plain syrup			10

HEAVY WHITE SYRUP.

Coating powder No. 2	20		
Powdered sugar	50		
Plain syrup			6

SYRUP WITH GELATIN.

Powdered acacia	1		
Best gelatin	1	3	
Granulated sugar	15		
Water			1.625

SOLUTION WITH GUM ACACIA.

Powdered acacia	2		
Granulated sugar	15		
Water			1

POLISHING WAX.

Carnauba wax	3		
Paraffin	2		
Beeswax	2		