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NOVEL SUGAR COATING COMPOSITION FOR APPLICATION TO COMPRESSED MEDICINAL TABLETS

The present invention relates to novel sugar coating compositions for application to compressed medicinal tablets, compressed tablets coated with the compositions and to methods of preparing the compositions and tablets. More particularly the invention relates to the sustained release of steroids from the novel coatings.

In the past three decades, substantial effort has gone into the identification of methods for controlling the rate of release of drug from pharmaceutical tablets. Excipients have been incorporated into tablet cores to control dissolution, and hence absorption, of drugs. Tablets and spheroids have been coated with polymers to provide slow, diffusion - controlled release or site-specific release of drugs.

Tablets and encapsulated spheroid dosage forms have also been prepared containing multiple drugs, either in admixture or as separate tablet layers or spheroids. The drugs are provided to perform multiple functions or to provide synergism. Such tablets are especially useful in those circumstances where conventional therapy dictates the use of more than one drug possessing different but compatible activities. For example, diuretic agents are frequently administered with antihypertensive agents, and progestational agents in conjunction with estrogens.

In accordance with this invention, there is provided a compressed, sugar-coated, pharmaceutical tablet containing two or more pharmacologically-active agents. The compressed tablet may contain excipients to provide rapid or slow release of the agents. The sugar coat contains a therapeutic amount of a hormonal steroid and a hormonal steroid release-controlling amount of microcrystalline cellulose. The medicinal agents present in the tablet core may include any such agent which is conventionally administered in conjunction with a hormonal steroid. The sugar-coated tablet may also be finished with color coatings and polished as is common in coated tablets.

The contents of the tablet core are quite independent from the sugar coating in the sense that the sugar coating and the hormonal steroid contained in it, are dissolved

before disintegration of the compressed tablet and dissolution of the component drug(s) takes place. Hence the components employed in formulation of the core tablet may include pharmaceutically-acceptable water-soluble and/or insoluble substances such as lactose, calcium phosphate, starch, calcium carbonate, dextrose, sorbitol, mannitol, microcrystalline cellulose, sucrose, polyvinylpyrrolidone, methylcellulose, carboxymethylcellulose, alginates, hydroxypropylcellulose, hydroxypropylmethyl-cellulose, ethylcellulose, croscarmellose sodium, sodium starch glycolate, magnesium stearate, stearic acid, polyethylene glycol, sodium lauryl sulfate, fumed silica, talc and the like.

The sugar coat containing the hormonal steroid also contains a steroid release rate-controlling amount of microcrystalline cellulose and, in certain circumstances, polyvinylpyrrolidone to aid in application of the sugar coat.

The tablet core is produced by compression of an admixture, which has preferably been granulated, of steroid compatible drug and other pharmaceutically-acceptable excipients. The tablet core may have an unplasticized or plasticized seal coat designed to modify the drug release characteristics of the drug(s) contained within the core, or to protect them against moisture and/or oxygen.

Detailed Description of the Invention

This invention provides an improved compressed tablet in which, in addition to a conventional internal tablet core containing one or more drugs that are pharmacologically compatable with the steroid in the external sugar coating, a sugar coating is present which comprises a hormonal steroid in an amount of about 0.1 to about 20 percent by weight of the sugar coating; microcrystalline cellulose in an amount from about 0.1 to about 3 percent by weight of the sugar coating; polyvinylpyrrolidone in from about 0 to about 5 percent by weight of the sugar coating; and sugar. On a unit dose basis, the tablet contains about 0.05 to about 50 milligrams, preferably about 0.1 to 30 milligrams, of hormonal steroid in the loaded sugar coating layer. If desired, an undercoat of inert filled sugar may be applied over a seal coat prior to the steroid loaded sugar coat layer. The inert filler-containing sub-layer sugar coating may be made up with sucrose containing about 7.5 to about 15 percent microcrystalline cellulose. The

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outer sugar coating may contain a coloring agent such as titanium dioxide or a primary, secondary or grayed tint as is customary in the tableting art. If desired, the coloring agent may be applied as a separate coating layer over the outer sugar layer. A final polish may complete the tablet.

The sugar used in production of the sugar coatings referred to throughout this specification is a sugar product, such as sucrose, derived from beet or cane sources or starch, saccharid or polysaccharid converted sources, which are considered suitable for tablet coating purposes. The currently preferred sugar is sucrose.

It has been discovered that the release of a hormonal steroid from the sugar coating can be controlled by limiting the quantity of microcrystalline cellulose to from about 0.1 to about 3 percent by weight of the sugar coating. This use of a small quantity of microcrystalline cellulose in the sugar coat is unlike the use of this excipient as a compression aid or to assist disintegration of a tablet core. In the latter case, the concentration of microcrystalline cellulose may rise to as high as 15 to 30 percent of weight.

Examples of hormonal steroids suitable for incorporation into the sugar coating formulations of this invention include, medroxyprogesterone acetate, levonorgestrel, gestodene, medrogestone, estradiol, estriol, ethinylestradiol, mestranol, estrone, dienestrol, hexestrol, diethylstilbestrol, progesterone, desogestrel, norgestimate, hydroxyprogesterone, norethindrone, norethindone acetate, norgestrel, megestrol acetate, methyltestosterone, ethylestrenol, methandienone, oxandrolone, trimegestone, and the like.

The amount of hormonal steroid to be included in the coating composition of the present invention is an amount of steroid which provides for the formulation of a predetermined unit dosage when applied to a tablet core.

To illustrate <u>in vitro</u> dissolution rate control of steroid in the absence and presence of microcrystalline cellulose, the following illustrative examples are presented, without limitation:

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EXAMPLE 1

A sugar coating consisting of the following solids was applied over a tablet core using either a non-perforated or perforated coating pan:

Sucrose, NF	87%
Polyvinylpyrrolidone	3%
Medroxyprogesterone Acetate, USP	10%

The rate of dissolution of the steroid was determined in accordance with <711> of USP XX, p.959 (1980), employing Apparatus 2, operating at 50 rpm by dissolving in 0.54% sodium lauryl sulfate in water at 37°C in six repeated trials (Method A). CV represents the coefficient of variation between these trials expressed as a percentage.

Time (min.)	Percent Steroid Released (CV%)
5	93 (5.2)
10	94 (5.3)
30	95 (5.3)
60	95 (5.4)
120	95 (5.4)

EXAMPLE 2

Tablets coated in the same manner with the same sugar coating as above were dissolved in 0.13% sodium lauryl sulfate in 0.1N HCl at 37°C using USP Apparatus 1 at 100 rpm, in six trials (method B). The results of this study were:

Time (min.)	Percent Steroid Released (CV%)
5	83 (6.0)
10	85 (5.8)
30	85 (6.2)
60	85 (6.1)
120	85 (6.2)

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EXAMPLE 3

Additional tablets coated in the same manner with the same sugar composition were subjected to a flow-through dissolution test procedure in 0.12% sodium lauryl sulfate in 0.1N HCl at 37°C using a SOTAX Dissotest Apparatus at 5.7 mL/min. flow rate (Method C). The results of three separate runs were as follows:

Time (min.)	Percent Steroid Released (CV%)
30	90.9 (2.9)
60	94.2 (3.0)
90	95.3 (2.9)
120	96.0 (3.0)
210	97.4 (3.0)
300	98.9 (3.6)

From these in vitro studies it is clear that medroxyprogesterone acetate, used here as a typical hormonal steroid, is released from the sugar coating extremely rapidly.

EXAMPLE 4

For comparison purposes, and to illustrate the unexpected properties of the sugar coatings of this invention, a sugar coating consisting of the following solids was applied over a tablet core:

Sucrose, NF	86.5%
Microcrystalline Cellulose	0.5%
PVP	3.0%
Medroxyprogesterone Acetate, USP	10.0%

Employing the microcrystalline cellulose - containing sugar coated tablets and following Method A, the following in vitro dissolution data were obtained from three runs:

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Time (min.)	Percent Steroid Released (CV%)
5	19.5 (49.5)
10	29.9 (32.8)
30	50.0 (23.0)
60	61.6 (19.5)
120	74.2 (19.2)

EXAMPLE 5

With additional microcrystalline cellulose - containing sugar coated tablets prepared in the same manner as above, following Method B in six runs, the following data were obtained:

Time (min.)	Percent Steroid Released (CV%)
5	2.3 (34.4)
10	8.2 (27.0)
30	17.9 (16.1)
60	26.5 (13.6)
120	32.7 (16.6)

EXAMPLE 6

And, following method C, with the tablets containing microcrystalline cellulose in the sugar coating, in three runs, the following data were obtained:

Time (min.)	Percent Steroid Released (CV%)
30	2.8 (34.4)
60	4.1 (24.8)
90	5.1 (22.3)
120	6.4 (22.3)
210	11.0 (19.4)
300	14.3 (11.0)

From these data it is apparent that a small amount of microcrystalline cellulose

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in the sugar coating (in this case 0.5% by weight of the sugar coating solids) has markedly retarded the release rate of hormonal steroid.

EXAMPLE 7

Sugar coated tablets were prepared in which the sugar coat contained 0.0%, 0.5% or 2% microcrystalline cellulose in combination with 3.0% polyvinyl pyrrolidone, 10.0% medroxyprogesterone acetate and sucrose. These tablets were fed to four beagle dogs under fasting conditions and the blood plasma levels of steroid were determined at 0, 0.5, 1, 1.5, 2, 3, 5, 8, 12, 16, and 24 hours. The resulting data were plotted, the area under the curve (AUC) calculated for a twenty four hour period and the time at which the maximum plasma concentration occurred was determined to be as follows:

Microcrystalline Cellulose %	AUC(0-24 Hrs) ngxhr/mL	tmax (Hr)	Cmax (ng/mL)
0.0	345	0.6	37.8
0.5	294	1.0	36.9
2.0	294	1.1	24.6

From these in vivo dog data, it is obvious that a marked change in bioavailability of a hormonal steroid occurs as the concentration of microcrystalline cellulose in the sugar coating increases from 0.0 to one containing 0.5 to 2.0% microcrystalline cellulose. Thus, the rate of release of hormonal steroid incorporated in a sugar coating may be controlled by incorporation of very small amounts of microcrystalline cellulose into sugar coating.

EXAMPLE 8

Sugar coated tablets were prepared in which the sugar coat contained 0.25%, 0.5% or 0.8% microcrystalline cellulose in combination with 0.5% polyvinyl pyrrolidone, 5.0% medroxyprogesterone acetate and sucrose. These tablets were subjected to an in vitro dissolution test employing the USP Disintegration Apparatus (USP XX, <201>, p958) (1980) with a 0.54% sodium lauryl sulfate dissolution

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medium at 37°C. The following test data were obtained:

Percentage Medroxyprogesterone Acetate Dissolved (CV%)

Time (Minutes)	0.25% Microcrystalline Cellulose	0.5% Microcrystalline Cellulose	0.8% Microcrystalline Cellulose
15	97.8 (5.2)	72.6 (9.5)	32.4 (15.2)
30	98.8 (5.3)	89.9 (6.3)	62.8 (8.2)
45	99.3 (5.2)	95.2 (5.6)	76.6 (6.9)
60	99.1 (5.2)	98.3 (5.7)	84.8 (6.6)
90	99.9 (5.3)	100.9 (6.0	94.4 (6.9)
120	100.3 (5.6)	102.4 (5.3)	98.0 (7.1)

These dosage forms were also evaluated in a human bioavailability study. The dosage forms were administered in a cross-over design to twelve healthy female subjects. Blood samples were collected at 0.5, 1, 1.5, 2, 2.5, 3, 4.5, 6, 8, and 12 hours and the plasma assayed for medroxyprogesterone acetate. The following data were obtained:

Microcrystalline Cellulose	AUC (0-12 h)	tmax (hr)	Cmax (ng/mL)
0.25%	26.0 ± 14.3*	2.9 ± 1.3	4.24 ± 3.0
0.5%	25.8 ± 10.5	3.2 ± 1.2	3.88 ± 1.87
0.8%	13.2 ± 4.0	3.9 ± 1.6	1.99 ± 0.73

*Mean values ± 1 Standard Deviation

From the in vitro dissolution and in vivo human bioavailability data, it is clear that the drug release characteristics and bioavailability of the hormonal steroid, are controlled by the concentration of microcrystalline cellulose in the sugar coating.

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EXAMPLE 9

A sugar coating containing 5 mg of medrogestone in a matrix of sucrose with 0.4% microcrystalline cellulose and 0.5% polyvinyl pyrrolidone was applied to a sealed and sugar-coated tablet core. The in vitro dissolution profile of this dosage form was compared to that of a rapidly-disintegrating compressed tablet containing 5 mg of medrogestone using the dissolution test described in <711> of USP XX, p. 959 (1980) employing Apparatus 2 operating at 50 r.p.m., with 900 mL of 0.54% sodium lauryl sulfate at 37°C. The following data were obtained:

Mean Percentage Medrogestone Released (CV%)

Time (Minutes)	Conventional Rapidly Disintegrating Tablet	Sugar Coated Tablet Containing Medrogestone in Sugar Coat
15	95 (2.0)	6 (11.2)
30	95 (2.9)	11 (6.9)
45	97 (1.6)	15 (6.4)
60	97 (1.9)	18 (6.6)
120	98 (1.9)	25 (6.2)

The dramatic effect of reduced dissolution of medrogestone when the hormone is incorporated in a sugar coat containing 0.4% microcrystalline cellulose is clearly demonstrated.

One preferred embodiment of this invention is a compressed tablet in which the tablet core contains a unit dose of an estrogenic compound or a mixture thereof in an amount of from about 0.1 to about 5.0 milligrams, or more preferably from about 0.3 to about 2.5 milligrams, in combination with standard excipient compression aids and fillers. Most desirably, the conjugated estrogens found in the tablet core comprises the naturally occurring conjugated estrogen product known as Premarin® . Over a sugar coat on the compressed tablet is applied an additional sugar coat containing about 1 to about 50 milligrams, and preferably about 1.5 to about 30 milligrams, of medroxyprogesterone acetate, a color coat, and finally, a polish coat.

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CLAIMS

1. A sugar coating composition for application to a compressed medicinal tablet comprising a sugar, a dose of a hormonal steroid and a steroid release rate controlling amount of microcrystalline cellulose.

2. A sugar coating composition according to claim 1 in which the sugar is sucrose.

3. A sugar coating composition according to claim 1 or claim 2 in which said hormonal steroid is medroxyprogesterone acetate, levonorgestrel, gestodene, medrogestone, estradiol, estriol, ethinylestradiol, mestranol, estrone, dienestrol, hexestrol, diethylstilbestrol, progesterone, desogestrel, norgestimate, hydroxyprogesterone, norethindrone, norethindone acetate, norgestrel, megestrol acetate, methyltestosterone, ethylestrenol, methandienone, oxandrolone or trimegestone.

4. A sugar coating composition according to any one of claims 1 to 3 comprising from about 0.1% to about 3% microcrystalline cellulose, by weight, of the sugar coating.

5. A sugar coating composition according to any one of claims 1 to 4 further comprising polyvinylpyrrolidone in an amount of from 0 to about 5% by weight of the sugar coating.

6. A sugar coating composition according to any one of claims 1 to 5 comprising a hormonal steroid in an amount of from about 0.1 to about 20% by weight of the sugar coating.

7. A compressed tablet comprising a tablet core and a coating according to any one of claims 1 to 6.

8. A compressed tablet according to claim 7 wherein the tablet core comprises a medicinal agent which is conventially administered in conjunction with a hormonal steroid.



9. A compressed tablet according to claim 8 wherein the tablet core comprises conjugated estrogens.

10. A compressed tablet according to claim 9 in which said tablet core contains from about 0.1 to about 5.0 milligrams of conjugated estrogens and said sugar coating contains from about 1.0 to about 50 milligrams of said hormonal steroid.

11. A compressed tablet of claim 9 in which said tablet core contains from about 0.3 to about 2.5 milligrams of conjugated estrogens and said sugar coating contains about 1.5 to about 30 milligrams of medroxyprogesterone acetate.

12. A method of preparing a coating composition comprising bringing into association a sugar, a hormonal steroid and a steroid release rate controlling amount of microcrystalline cellulose.

13. A method of preparing a tablet which comprises coating a tablet core with a coating composition as claimed in any one of Claims 1 to 6.

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