

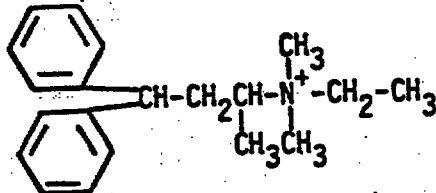
Description

Field of the invention

The present invention relates to a novel complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol, and a process for the preparation thereof. The invention also relates to novel pharmaceutical compositions containing such a complex of carrageenan and active ingredient, a process for the preparation thereof and to the use of the complexes in medicine.

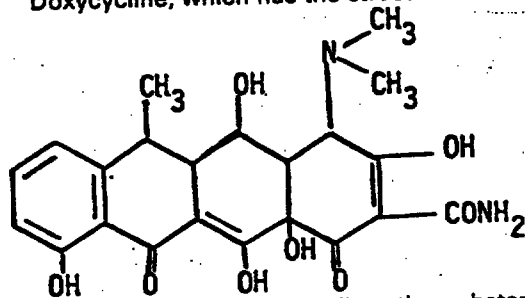
Background of the invention

Emepronium, which has the structural formula



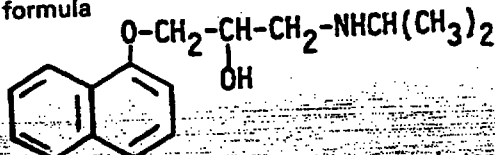
is a known therapeutically active substance which mainly is used in the form of its bromide. Its preparation is described e.g. in Chemical Abstracts 48, 729 a (1954). It is used as an anticholinergic and antispasmodic agent, mainly in the treatment of ailments related to the bladder function in man, for example incontinence, urinary frequency, irritable bladder, nervous bladder, and neurogenic bladder.

Doxycycline, which has the structural formula



is also a known therapeutically active substance. It is mainly used in the form of its hydrochloride. It is used as an antibiologically active agent in the treatment of bacterial infections.

Also propranolol, which has the structural formula



is a known therapeutically active substance. It is mainly used in the form of its hydrochloride. It is used as a betareceptor blocking agent.

The customary mode of administration of emepronium is by the oral route, mostly in the form of tablets which contain emepronium in the form of its bromide together with usual inert tableting aids such as swelling agents. Patients

taking emepronium bromide tablets are advised to swallow them with water. However, since patients suffering from bladder ailments at the same time often are advised to reduce their intake of fluid, there is a risk that the tablets are swallowed with too little water. The tablet may then, when disintegrating during its passage through the oesophagus, stick to the mucosa in the oesophagus whereby high local concentrations of emepronium bromide are created. Emepronium bromide has irritating effect on the mucosa, and such high local concentrations may cause severe irritation and ulceration in the oesophagus. Such effects have been described i.a. by Bennett, Oesophageal ulceration due to emepronium bromide, Lancet 1977, 1, 810. There is also risk for mouth ulcers caused by emepronium bromide.

A further problem with emepronium bromide is that it tastes very bitter. Liquid dose formulations are therefore accepted by the patients only with difficulty.

Also doxycycline and propranolol are mostly administered orally in the form of tablets containing doxycycline hydrochloride and propranolol hydrochloride. Also such tablets tend very easily to stick to the mucosa in the oesophagus giving the same type of irritation and ulceration as tablets containing emepronium bromide. See B. Carlborg et al., Oesophageal strictures induced by oral drug therapy, Läkartidningen 75, 46094611, 1978.

Prior art

Certain complexes containing sulfated hydrocolloids e.g. carrageenan as complex forming agents are disclosed in the literature. Reference is made to French patent 5227M, Journal of Pharmaceutical Sciences Vol. 50 No. 6, 483-486 (1961); Journal of Pharmaceutical Sciences Vol. 52 No. 2, 192-197 (1963); and Journal of Pharmaceutical Sciences Vol. 52 No. 10, 964-967 (1963).

Hydrocolloid - containing liquid carriers for a diagnostic or therapeutic agent are disclosed in the US patent 3 984 571. However, it cannot be inferred from these citations that the novel complexes of the present invention would exhibit the properties of binding the active substance sufficiently strong in aqueous solution at the pH prevailing in the oesophagus that only a minor amount - for emepronium less than 3% of the amount of emepronium in a given complex while the active substance is released very rapidly in the gastric juice, thus providing pharmacokinetic properties of the active substance which are quite comparable to the pharmacokinetic properties of the active substance in the presently used salt form.

Detailed description of the invention

The present invention provides a novel complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol. These complexes, which are stable and chemically and physically well defined entities, represent an improvement over the presently used emepronium bromide, doxycycline hydrochloride and propranolol hydrochloride as is summarized below.

The complex of carrageenan and emepronium may contain 10 - 70% by weight of emepronium, calculated as emepronium bromide.

The complex of carrageenan and doxycycline may contain 10 - 70% by weight of doxycycline, calculated as doxycycline hydrochloride.

The complex of carrageenan and emepronium is only sparingly soluble in water. Therefore, the main part of emepronium will be complex-bound and biologically inactive during the passage of a corresponding tablet through the oesophagus. This greatly reduces the risk for irritation and ulceration of the mucosa in the oesophagus.

In the gastro-intestinal fluids, on the other hand, emepronium is rapidly released from its complex with carrageenan.

Therefore, the biological availability of the active substance is practically equivalent to the biological availability of conventional tablets containing emepronium bromide.

The novel complex of carrageenan and emepronium contains a sufficient amount of emepronium to make the preparation of tablets of suitable size possible. This is important because emepronium is often prescribed in large doses.

The complex also has suitable properties to admit its use in the preparation of tablets.

The complex of doxycycline and carrageenan, and of propranolol and carrageenan, have properties which are very much the same as outlined above for the emepronium-carrageenan complex. Thus, the carrageenan complexes of doxycycline and propranolol are only sparingly soluble in water. Therefore, the main part of the active substance will be complex-bound and biologically inactive during the passage of a corresponding tablet through the oesophagus. This greatly reduces the risk for irritation and ulceration of the mucosa in the oesophagus.

In the gastro-intestinal fluids, on the other hand, the active substance is rapidly released from its complex with carrageenan. Therefore, the biological availability also of doxycycline and of propranolol will be practically equivalent to the biological availability of conventional tablets containing doxycycline hydrochloride and propranolol hydrochloride.

The novel complex of carrageenan and doxycycline and propranolol, respectively, contains a sufficient amount of active substance to make the preparation of tablets of suitable size possible. The complex also has suitable properties to admit its use in the preparation of tablets.

The carrageenan-emepronium complex has a taste wherein the bad taste of emepronium is greatly reduced. The complex can therefore be used in aqueous oral preparations.

The nature of the carrageenan used to form the complexes of the invention is not any critical factor in the invention. The following specification and examples will, however, deal with complexes with a specific carrageenan, available under the trade name Aubygum x 2, which now will be identified.

Aubygum x 2 is manufactured by CECA SA, France. Carrageenan is a hydrocolloid cell constituent of certain red seaweeds belonging to the Gigartinaceae family. The name carrageenan covers a range of sulphated polysaccharides which are composed of galactose residues.

Aubygum x 2 exists mainly as the sodium salt. It is a linear polysaccharide of sulphated galactose and 3,6 - anhydrogalactose residues and exists in two principal fractions known as kappa and lambda amounting to about 50-80% and about 20-50%, respectively. The molecular weight is in the range 100,000 - 1,000,000.

IR Spectrum (KBr disc):

Group Moiety	Band at wavenumber (cm ⁻¹)
-O-H	3700-3000
aliphatic C-H	3000-2800
water	1640
S=O	1300-1200
C-O	1100-1000
C-O (anhydrogalactose)	920
S-O-C	850

Presence of galactose and 3,6-anhydrogalactose: Apart from IR the presence of galactose and 3,6-anhydrogalactose can be established by thin-layer chromatography.

Appearance: White powder, odourless and tasteless.

Viscosity: 100-200 mPaS at 25°C and not less than 5 mPaS at 75°C

using a Brookfield viscometer



pH 1%, by weight aqueous solution, 20° C):
7-9.5

Optical rotation:

$$\left[\alpha \right]_D^{21} = 67.8^\circ \quad (c=0.1718, H_2O)$$

Particle size: 98% through 250 μ m sieve

Moisture content: Not more than 12%, by weight determined according to Karl Fischer.

Aubygum x 2 is a stable substance.

In clinical use the complexes of carrageenan and emepronium, doxycycline and propranolol, respectively, will normally be administered orally in the form of a pharmaceutical preparation which contains the active component optionally in combination with a pharmaceutically acceptable carrier. The carrier may be in the form of a solid, semisolid or liquid diluent, or a capsule. These pharmaceutical preparations are a further object of the invention. The complex may also be used without carrier material. Usually the amount of the complex is between 5 and 99% by weight of the preparation, for example between 25 and 80% by weight in preparations for oral administration.

In the preparation of pharmaceutical preparations containing the complex in the form of dosage units for oral administration, the complex may be mixed with a solid, pulverulent carrier, such as lactose, saccharose, sorbitol, mannitol, a starch such as potato starch, corn starch, or amylopectin, or cellulose, and may also include a lubricant such as magnesium stearate, calcium stearate or polyethyleneglycol waxes. The mixture is then pressed into tablets. If coated tablets are desired, a core prepared as described above may be coated with a concentrated sugar solution which may contain gum arabic, starch, talc, titanium dioxide or alternatively with alacquer dissolved in volatile organic solvents or mixtures of solvents. To this coating various dyes may be added in order to distinguish tablets with different active compounds or with different amounts of the active compound present.

Soft gelatin capsules may be prepared which capsules contain a mixture of the complex and vegetable oil. Hard gelatin capsules may contain granules of the complex in combination with a solid, pulverulent carrier as lactose, saccharose, sorbitol, mannitol, potato starch, corn starch, amylopectin, or cellulose.

Liquid preparations for oral administration may be prepared in the form of syrups or suspensions, e.g. suspensions containing from 0.2% to 20% by weight of the complex, the remainder comprising for example sugar and a mixture of ethanol,

water, glycerol and propylene glycol.

The dosage at which the complex is administered may vary within a wide range and will depend on various factors such as for example the individual requirements of each patient and the manner of administration. The dosages will be in the same ranges as ordinarily used for emepronium, doxycycline and propranolol. Thus, in general, oral dosages of emepronium will be in the range from 100 to 1600 mg/day; oral dosages of doxycycline will be in the range from 100 to 400 mg/day; and oral dosages of propranolol will be from 50 to 500 mg/day.

The following examples will illustrate the preparation of the complexes of the invention.

Example 1

50 g emepronium bromide was dissolved in 800 g distilled water. 50 g carrageenan (Aubygum x 2) was added during stirring at room temperature. The mixture was stirred for 30 minutes and was thereafter allowed to stand for 2 hours. The mixture was decanted and the sediment suspended in 400 g distilled water. The mixture obtained was thereafter filtered through a cellulose filter under pressure. The humid filter cake was granulated through a sieve with 1.7 mm aperture size and was dried in an oven. The dry and sintered granulate obtained was ground to powder form.

Example 2

70 g emepronium bromide was dissolved in 800 g distilled water. 50 g carrageenan (Aubygum x 2) was added during stirring at +30° C. The mixture was centrifugated at 4000 rpm. The solid residue was suspended in 200 g distilled water, whereafter the process was repeated. Hereafter the product obtained was granulated and dried as described in example 1.

Example 3

50 g emepronium bromide was dissolved in 200 g distilled water. 50 g carrageenan (Aubygum x 2) was dissolved in 3.5 kg water at +30° C. The two solutions were separately filtered through deep filters. Thereafter the solutions were mixed and were stirred for 2 hours at +30° C. The mixture obtained was allowed to stand for 2 hours. The mixture was thereafter decanted and the sediment suspended in 400 g distilled water. The mixture obtained was filtered through cellulose filter under pressure. The filter cake thus obtained was granulated through a sieve, with 1.7 mm aperture size dried and ground to powder form.

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Example 4

10 g doxycycline hydrochloride was dissolved in 100 ml distilled water. 6.4 g carrageenan (Aubygum x 2) was added during stirring at room temperature. The slurry was stirred for 30 minutes and thereafter filtered through a cellulose filter under pressure. The filter cake was dispersed in 50 ml distilled water and the slurry was filtered as before. The humid filter cake was allowed to dry over night at +37°C.

The obtained powder was milled to a particle size below 63 µm. The powder was analyzed spectrophotometrically after dissolution in an aqueous acidic sodium chloride solution and contained 1.34 mmole doxycycline per gram.

Example 5

10 g propranolol hydrochloride was dissolved in 100 ml distilled water. 9 g carrageenan (Aubygum x 2) was added during stirring at room temperature. The slurry was stirred for 30 minutes and thereafter filtered through a cellulose filter under pressure. The filter cake was dispersed in 500 ml distilled water and the slurry was filtered as before. The humid filter cake was granulated through a sieve with 1.7 mm aperture size and allowed to dry over night at +37°C.

The obtained powder was milled to a particle size below 200 µm. The powder was analyzed spectrophotometrically after dissolution in an aqueous sodium chloride solution and contained 1.69 mmole propranolol per gram.

As is illustrated in the above examples, the complexes of the invention are prepared by reacting a carrageenan or a salt thereof, with a solution of emepronium, doxycycline or propranolol, or a salt thereof, followed by isolation of the complex formed. Emepronium is suitably used as its bromide. Doxycycline and propranolol are suitably used as their hydrochlorides.

The emepronium-carrageenan complex can be prepared by choosing the relative amounts of carrageenan and emepronium so that the final complex will contain from 10 to 70% by weight of emepronium, expressed as emepronium bromide. Suitably the amount of emepronium bromide in the complex is from 50 to 70% by weight. The same ranges for the content of active substance apply also for doxycycline and propranolol.

Examples of usable salts of carrageenan that can be used are sodium salt and potassium salt.

The emepronium-carrageenan complex, herein also denoted emepronium carrageenate, obtained in examples 1-3 has the following characterizing data

Table 1. Association characteristics of the binding of emepronium

to Aubygum x 2

Sample	Sodium content ¹⁾ mmol/g on dry basis	Sulphate content ²⁾ mmol/g on dry basis	Emepronium content ³⁾ mmol/g on dry basis
Emepronium carrageenate	0.8	1.8 ⁴⁾	1.7

1) Determined by atomic absorption spectrophotometry after dissolution of the samples in hydrochloric acid, 0.5 M.

2) Determined gravimetrically as BaSO₄.

3) Determined by extraction with bromothymolblue after dissolution in hydrochloric acid.

4) Corresponding to 3.5 mmol/g based on Aubygum x 2.

IR spectra (KBr disc): The IR spectrum is given in Tables 2 and 3.

Table 2. Bands originating from Aubygum x 2

Group moiety	Band at wavenumber (cm ⁻¹)
-O-H	3700-3000
aliphatic C-H	3000-2800
water	1640
S=O	1300-1200
C-O	1100-1000
C-U (anhydrogalactose)	920
S-O-C	850

Table 3

Additional bands originating from

Group moiety	Band at wavenumber (cm ⁻¹)
aromatic	3100-3000
aromatic ring	(1600) 1490
-CH ₃	1450

Appearance: A white to yellowish and odourless powder.

Dissociation characteristics in NaCl and HCl: The exchange of emeprom-

nium by sodium as well as hydrogen ions was studied. Physiological conditions were used, i.e. 0.9% by weight (0.15 mol/l) sodium chloride and 0.15 mol/l hydrochloric acid at 37°C. Different volumes of these solutions were tested. The experiments were performed in the following way: 170 ± 1 mg of emepromium carrageenate were shaken for 2 hours at 37°C with 10.00 to 100.00 ml of the sodium chloride and hydrochloric acid solutions. After centrifugation and filtration through 0.2 µm filter the total content of emepromium in solution (expressed as exchanged emepromium) was determined. The results were that the dissolving effects of sodium and hydrogen ions were the same and that at least 50 ml were needed for complete dissolution of the sample.

It was calculated that the ratios [Na⁺]/(emepromium) and [H⁺]/(emepromium) must be ≤ 30 for complete dissolution of emepromium carrageenate.

Solubility in water: The following procedure has been used: 340 mg

of the sample was shaken for 2 hours with 20.00 ml of deionized and distilled water. After filtration through 0.2 µm filter the solubility has been determined gravimetrically and by photometric determination of emepromium. The results are given in Table 4.

Table 4

Solvent	ml of solvent	Amount of sample mg	Temp °C	Solubility mg/ml gravimetr.	Solubility mg/ml photometr.
water	20	340	25	0.5	-
"	50	170	21	0.07	0.03
"	50	170	37	0.2	0.08

The gravimetric results being higher than the photometric results, indicate that a minor amount of polysaccharide (probably as complex with emepromium) goes into solution. It is seen that the solubility in water of the complex is very low.

Melting point: 210-230°C (Mettler FP5)

Optical rotation:

$$[\alpha]_D^{21} = +40^{\circ} (C=0.325, 0.9 \% \text{ by weight NaCl})$$

Total content of emepromium: 54-64 % by weight (expressed as emepromium

bromide).

Water-soluble emepromium: ≤ 3 % by weight of total content of emepromium expressed as emepromium bromide.

The following examples will illustrate the composition of pharmaceutical preparations containing the emepromium-carrageenate complex, the doxycycline-hydrocarrageenate complex, and the propranolol-hydrocarrageenate complex of the invention.

Examples 6 and 7

COMPOSITION OF THE EMEPRONIUM CARRAGEENATE TABLETS



Composition	Tablet Content (mg)		5
	100 mg DkA 109	200 mg DkA 110	
Granulated emepronium carra- geenate, < 200 μ	175	350	10
Magnesium stearate	4	8	15
Colloidal silicon dioxide	2	4	
Polyvinylpolypyrrolidone	21	42	20
<u>Average weight</u>	202 mg	405 mg	25

Example 8. Capsules

Emepronium carrageenate as prepared in Example 1 was filled in capsules, each capsule containing 350 mg granulated emepronium carrageenate.

Example 9. Capsules

Emepronium carrageenate as prepared in Example 1 was filled in capsules, each capsule containing 175 mg granulated emepronium carrageenate.

Example 10

Composition of doxycycline hydrocarrageenate tablets:

Ingredients	Content per tablet
Doxycyclinehydrocarrageenate	160 mg
Magnesium stearate	4 mg
Colloidal silicone dioxide	2 mg
Polyvinylpolypyrrolidone	20 mg
Microcrystalline cellulose (Avicel [®])	64 mg
Average tablet weight	250 mg

The tablets were produced by a direct compression technique.

Example 11. Capsules

Doxycycline hydrocarrageenate as prepared in Example 4 was filled in capsules together with customary excipients, each capsule containing 100 mg doxycycline.

Example 12

Composition of propranolol hydrocarrageenate tablets:

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Ingredients	Content per tablet	
Propranolol hydrocarrageenate	164 mg	5
Magnesium stearate	4 mg	10
Colloidal silicone dioxide	2 mg	
Polyvinylpyrrolidone	20 mg	15
Microcrystalline cellulose (Avicel®)	60 mg	
Average tablet weight	250 mg	20

The tablets were produced by a direct compression technique.

Example 13. Capsules

Propranolol hydrocarrageenate as prepared in Example 5 was filled in capsules together with customary excipients, each capsule containing 100 mg propranolol.

Biological tests

An in vivo comparative study on the oesophagus-irritating effect in dogs was made using 0.2 g tablets of emepronium carrageenate and 0.2 g tablets of Cetiprin®, a commercially available emepronium bromide product. A further in vivo comparative study in cats was made using uncoated doxycycline hydrocarrageenate tablets, corresponding to 0.1 g of doxycycline hydrochloride, and coated doxycycline hydrochloride 0.1 g tablets. The latter tablets are commercially available Vibramycin® tablets.

The experimental method is essentially as described by Carlborg and Densert, Eur. surg. Res. 12, 1980, 270-282.

MATERIAL AND METHODS

A. Test of emepronium carrageenate tablets

Test tablets

Emepronium carrageenate tablets corresponding to 0.2 g emepronium bromide, uncoated and film coated with Eudragit E® (acrylic polymer) respectively, and Cetiprin® 0.2 g tablets film coated with Klucel® LF (hydroxypropyl cellulose) were tested in the present study.

The emepronium carrageenate tablets were prepared as illustrated in Examples 6 and 7.

The composition of the emepronium carrageenate tablets are essentially as given in Examples 6 and 7. The Cetiprin® tablets were as commercially available.

Animals

Three male and three female Beagle dogs were used for the study. The body weights of the animals ranged from 10.3 to 14.4 kg. Two animals were examined per test tablet.

Experimental procedure

Dogs fasted overnight, were anaesthetized with pentobarbital intravenously at an induction dose of 30 mg/kg body weight. The animals were placed on their right side and kept under intravenous anaesthesia throughout the experiment. Before the administration of the drug the oesophagus was inspected by use of an endoscope to make sure that the mucous membrane was normal. Endotracheal intubation was also performed.

A thread was tied firmly round the tablet to be tested. The thread was wound around a polyethylene catheter and was then together with the catheter inserted into a feeding tube with the tablet tied at the end. Thereafter the tube was introduced into the oesophagus to a specified length. The tablet was deposited by slow withdrawal of the tube with the thread attached to the catheter passing through. The upper end of the thread was sutured to the angle of the lips. The upper end of the catheter was attached to an infusion pump. During the first hour of emepronium carrageenate tablet exposure, tap water (2-5 ml/h) was instilled into the oesophagus close to the tablet. The tablet was placed at the beginning of the distal third of the oesophagus. The deposition of the Cetiprin® tablets was made in the same way but without insertion of a catheter for installation of water. The exposure time varied from 4.8 to 8 hours.

All animals were sacrificed at the end of the exposure period by means of overdosing pentobarbital. After sacrifice the oesophagus was dissected free and the external aspect was

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inspected. Thereafter the oesophagus was opened *in situ*. The site of the tablet was ascertained and the disintegration of the tablets as well as the dissolution/disruption of the film coat were recorded.

The following criteria were used for the assessment of the degree of disintegration of the tablets:

- + the external part of the tablet is moist
- ++ the tablet is moist, swollen and/or soft but withstands gentle pressure
- +++ the tablet is dissolved, fallen apart or softened to an extent not to withstand gentle pressure.

The following criteria were used for the assessment of the degree of dissolution/disruption of the film coat:

- cracked
- partly dissolved/removed
- almost completely dissolved/removed
- - completely dissolved/removed.

The oesophagus then was dissected free of adnexal tissue and spread on a cotton cloth. If necessary the oesophageal mucosa was gently rinsed with a few ml of physiological saline in order to verify if the tablet material was removable from the mucosal surface or if it stuck to the surface. In many cases the macroscopical appearance of the oesophagus at the site of the tablet as well as the tablet proper was recorded by photography. Thereafter the oesophagus was spread on a blotting paper on which appropriate markings were done as to the macroscopical characteristics of the oesophagus. Fixation was done in 10% buffered neutral formalin for 18-48 hours. Paraffin sections were prepared from at least two regions of the oesophagus accordingly: the oesophagus at the site of the tablet and a portion proximal to the site of the tablet. The paraffin sections, 4-5 microns thick were stained.

B. Test of doxycycline hydrocarrageenate tablets

Test tablets

The tablets tested were uncoated doxycycline hydrocarrageenate tablets prepared according to Example 10, corresponding to 0.1 g of doxycycline hydrochloride, and coated doxycycline hydrochloride 0.1 g tablets, commercially available Vibramycin tablets.

Animals

Eight female cats were used for the study. The body weight of the animals ranged from 2.0 to 2.8 kg.

Experimental procedure

The experimental procedure is as described above for the test on dogs. The exposure time for the tablets was 8 hours.

RESULTS AND COMMENTS

The disintegration of the emepronium carrageenate tablet corresponding to 0.2 g emepronium bromide, uncoated or coated, was complete after a deposition time of 4.8-6 hours.

Morphologically i.e. macroscopically and histopathologically, no oesophago-irritant effect was observed with the emepronium carrageenate 0.2 g tablets.

Cetiprin® 0.2 g coated tablets deposited for 6-8 hours in the oesophagus were comparably disintegrated although no accelerated disintegration of the tablet was applied.

Cetiprin® 0.2 g tablets produced a distinct oesophago-irritant effect in dogs exposed for 6 or 8 hours. After 6 hours the intensity of the changes was slight but after 8 hours were more pronounced. The changes consisted on one hand in a macroscopically visible oedema of the oesophageal wall and on the other hand in degenerative changes in the epithelial layer. The latter changes had a regional appearance and were seen as oedema with the spreading apart of epithelial cells in the dog that was exposed for 6 hours. In the dog that was exposed for 8 hours the oesophageal lesions in principle were of the same character but were more advanced with swelling and necrosis of epithelial cells.

The disintegration at 8 hours of the uncoated doxycycline hydrocarrageenate tablets corresponding to 0.1 g of doxycycline hydrochloride was + (+) or ++ (i.e. the tablet is moist, swollen and/or soft but withstands gentle pressure) in three of the four cats tested and +++ (i.e. the tablet is dissolved/fallen apart or softened to an extent not to withstand gentle pressure) in one cat.

The coated doxycycline hydrochloride (Vibramycin®) 0.1 g tablets were completely disintegrated at 8 hours and scored +++ in all the four cats tested.

The morphological investigation, which comprised macroscopic and histopathological examination of exposed oesophagi, did not reveal any pathological changes in the oesophageal mucosa or wall of cats after an exposure time of 8 hours with uncoated doxycycline carrageenate tablets corresponding to 0.1 g of doxycycline hydrochloride.

Consistent changes were found in all the cats after 8 hours of exposure with doxycycline hydrochloride (Vibramycin®) 0.1 g tablets. Macroscopically, the oesophagus was yellowish discoloured and slightly rigid and thin at the site of the tablet. The histopathological findings consisted in pronounced degenerative changes in

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the basal portion of the mucosa, slight oedema in the propria and focal necrosis of muscularis mucosae.

CONCLUSION

No local oesophageal-irritant effect of emepronium carrageenate tablets corresponding to 0.2 g emepronium bromide could be revealed using an *in vivo* dog model providing rapid and complete disintegration of the tablets.

No oesophageal-irritant effect of doxycycline hydrocarrageenate tablets corresponding to 0.1 g of doxycycline hydrochloride could be revealed using an *in vivo* cat model in which sufficient disintegration of tablets was achieved. With doxycycline hydrochloride (Vibramycin®) 0.1 g tablets, tested under identical conditions, severe morphological changes were observed in the oesophagus. Hence the conclusion is drawn that the new formulation of doxycycline, doxycycline carrageenate, offers significantly improved protection against oesophagorritation as compared with the commercially available tablet.

Bioavailability

A bioavailability study of 0.2 g tablets of emepronium carrageenate and 0.2 g Cetiprin® tablets containing emepronium bromide was carried out on 9 healthy volunteers. It was found that the emepronium carrageenate 0.2 g tablets gave the same serum peak time as the commercially available 0.2 g Cetiprin® tablets and that emepronium from the emepronium carrageenate tablets was absorbed essentially to the same extent as judged by serum concentration and urinary excretion data. The two formulations were considered bioequivalent.

Dissolution rate of doxycycline hydrocarrageenate

The dissolution rate according to USP XX in chloride buffer, pH 1.2 at +37°C of doxycycline hydrocarrageenate was compared to the dissolution rate of doxycycline hydrochloride, using the same procedure. The result was that the dissolution rate of the active substance was virtually undistinguishable between the two preparations. This result indicates that the doxycycline hydrocarrageenate complex of the invention releases the active substance in the gastric juice at the same rate as the commercially available preparations containing doxycycline hydrochloride.

Claims

1. A complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol.
2. A complex of carrageenan and emepronium.
3. A complex of carrageenan and doxycycline.
4. A complex of carrageenan and propranolol.
5. A complex according to claims 1-4 in solid form.
6. A complex according to claims 1-5 in dried form.
7. A complex according to claims 1, 2, 5 and 6 containing 10-70% by weight of emepronium, calculated as emepronium bromide.
8. A complex according to claims 1, 3, 5 and 6 containing 10-70% by weight of doxycycline, calculated as doxycycline hydrochloride.
9. A process for the preparation of a complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol by reacting carrageenan, or a salt thereof, with emepronium, doxycycline, or propranolol, or a salt thereof in solution.
10. A process for the preparation of a complex of emepronium, by reacting carrageenan, or a salt thereof, and emepronium, or a salt thereof in solution to the formation of a carrageenan-emepronium complex.
11. A process for the preparation of a complex of doxycycline, by reacting carrageenan, or a salt thereof, and doxycycline, or a salt thereof in solution to the formation of a carrageenan-doxycycline complex.
12. A process according to claims 9, 10 or 11, wherein the complex formed is isolated and dried.
13. A pharmaceutical preparation comprising a complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol as active ingredient.
14. A pharmaceutical preparation comprising a complex of carrageenan and emepronium as active ingredient.
15. A pharmaceutical preparation comprising a complex of carrageenan and doxycycline as active ingredient.
16. A pharmaceutical preparation according to claims 13, 14 or 15 in a form intended for oral administration.
17. A pharmaceutical preparation according to claims 13-15 in dosage unit form.
18. A pharmaceutical preparation according to claim 17 in tablet or capsule form.
19. A pharmaceutical preparation according to claims 13-17 in the form of an aqueous liquid preparation.
20. A pharmaceutical preparation according to claim 19 in the form of an aqueous suspension.
21. A complex of carrageenan and emepronium according to any of claims 1, 2, 5, 6 or 7 for use as an anticholinergic and antispasmodic agent in man.
22. A complex of carrageenan and doxycycline according to any of claims 1, 3, 5, 6 or 8 for use as an antibiotic agent in man.

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the basal portion of the mucosa, slight oedema in the propria and focal necrosis of muscularis mucosae.

CONCLUSION

No local oesophageal-irritant effect of emepronium carrageenate tablets corresponding to 0.2 g emepronium bromide could be revealed using an *in vivo* dog model providing rapid and complete disintegration of the tablets.

No oesophageal-irritant effect of doxycycline hydrocarrageenate tablets corresponding to 0.1 g of doxycycline hydrochloride could be revealed using an *in vivo* cat model in which sufficient disintegration of tablets was achieved. With doxycycline hydrochloride (Vibramycin®) 0.1 g tablets, tested under identical conditions, severe morphological changes were observed in the oesophagus. Hence the conclusion is drawn that the new formulation of doxycycline, doxycycline carrageenate, offers significantly improved protection against oesophag irritation as compared with the commercially available tablet.

Bioavailability

A bioavailability study of 0.2 g tablets of emepronium carrageenate and 0.2 g Cetiprin® tablets containing emepronium bromide was carried out on 9 healthy volunteers. It was found that the emepronium carrageenate 0.2 g tablets gave the same serum peak time as the commercially available 0.2 g Cetiprin® tablets and that emepronium from the emepronium carrageenate tablets was absorbed essentially to the same extent as judged by serum concentration and urinary excretion data. The two formulations were considered bioequivalent.

Dissolution rate of doxycycline hydrocarrageenate

The dissolution rate according to USP XX in chloride buffer, pH 1.2 at +37°C of doxycycline hydrocarrageenate was compared to the dissolution rate of doxycycline hydrochloride, using the same procedure. The result was that the dissolution rate of the active substance was virtually undistinguishable between the two preparations. This result indicates that the doxycycline hydrocarrageenate complex of the invention releases the active substance in the gastric juice at the same rate as the commercially available preparations containing doxycycline hydrochloride.

Claims

1. A complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol.

2. A complex of carrageenan and emepronium.

3. A complex of carrageenan and doxycycline.

4. A complex of carrageenan and propranolol.

5. A complex according to claims 1-4 in solid form.

6. A complex according to claims 1-5 in dried form.

7. A complex according to claims 1, 2, 5 and 6 containing 10-70% by weight of emepronium, calculated as emepronium bromide.

8. A complex according to claims 1, 3, 5 and 6 containing 10-70% by weight of doxycycline, calculated as doxycycline hydrochloride.

9. A process for the preparation of a complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol by reacting carrageenan, or a salt thereof, with emepronium, doxycycline, or propranolol, or a salt thereof in solution.

10. A process for the preparation of a complex of emepronium, by reacting carrageenan, or a salt thereof, and emepronium, or a salt thereof in solution to the formation of a carrageenan-emepronium complex.

11. A process for the preparation of a complex of doxycycline, by reacting carrageenan, or a salt thereof, and doxycycline, or a salt thereof in solution to the formation of a carrageenan-doxycycline complex.

12. A process according to claims 9, 10 or 11, wherein the complex formed is isolated and dried.

13. A pharmaceutical preparation comprising a complex of carrageenan and a member of the group consisting of emepronium, doxycycline and propranolol as active ingredient.

14. A pharmaceutical preparation comprising a complex of carrageenan and emepronium as active ingredient.

15. A pharmaceutical preparation comprising a complex of carrageenan and doxycycline as active ingredient.

16. A pharmaceutical preparation according to claims 13, 14 or 15 in a form intended for oral administration.

17. A pharmaceutical preparation according to claims 13-15 in dosage unit form.

18. A pharmaceutical preparation according to claim 17 in tablet or capsule form.

19. A pharmaceutical preparation according to claims 13-17 in the form of an aqueous liquid preparation.

20. A pharmaceutical preparation according to claim 19 in the form of an aqueous suspension.

21. A complex of carrageenan and emepronium according to any of claims 1, 2, 5, 6 or 7 for use as an anticholinergic and antispasmodic agent in man.

22. A complex of carrageenan and doxycycline according to any of claims 1, 3, 5, 6 or 8 for use as an antibiotic agent in man.



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23. The use of carrageenan as complexing agent for emepronium.

24. The use of carrageenan as complexing agent for doxycycline.

25. The use of carrageenan as complexing agent for propranolol.

Patentansprüche

1. Komplex von Carrageenan und einer Verbindung aus der Gruppe Emepronium, Doxycyclin und Propranolol.

2. Komplex von Carrageenan und Emepronium.

3. Komplex von Carrageenan und Doxycyclin.

4. Komplex von Carrageenan und Propranolol.

5. Komplex nach den Ansprüchen 1 bis 4 in fester Form.

6. Komplex nach den Ansprüchen 1 bis 5 in getrockneter Form.

7. Komplex nach den Ansprüchen 1, 2, 5 und 6 mit einem Gehalt von 10 bis 70 Gewichts-% Emepronium, berechnet als Emeproniumbromid.

8. Komplex nach den Ansprüchen 1, 3, 5 und 6 mit einem Gehalt von 10 bis 70 Gewichts-% Doxycyclin, berechnet als Doxycyclinhydrochlorid.

9. Verfahren zur Herstellung eines Komplexes von Carrageenan und einer Verbindung aus der Gruppe Emepronium, Doxycyclin und Propranolol durch Umsetzung von Carrageenan oder eines Salzes desselben mit Emepronium, Doxycyclin oder Propranolol oder eines Salzes derselben in Lösung.

10. Verfahren zur Herstellung eines Komplexes von Emepronium durch Umsetzung von Carrageenan oder eines Salzes desselben mit Emepronium oder einem Salz desselben in Lösung unter Bildung eines Carrageenan-Emepronium-Komplexes.

11. Verfahren zur Herstellung eines Komplexes von Doxycyclin durch Umsetzung von Carrageenan oder eines Salzes desselben mit Doxycyclin oder einem Salz desselben in Lösung unter Bildung eines Carrageenan-Doxycyclin-Komplexes.

12. Verfahren nach den Ansprüchen 9, 10 oder 11, bei den, der gebildete Komplex isoliert und getrocknet wird.

13. Präparat, das als Wirkstoff einen Komplex von Carrageenan und einer Verbindung aus der Gruppe Emepronium, Doxycyclin und Propranolol enthält.

14. Pharmazeutisches Präparat, das als Wirkstoff einen Komplex von Carrageenan und Emepronium enthält.

15. Pharmazeutisches Präparat, das als Wirkstoff einen Komplex von Carrageenan und Doxycyclin enthält.

16. Pharmazeutisches Präparat nach den Ansprüchen 13, 14 oder 15 in einer für orale Verabreichung bestimmten Form.

17. Pharmazeutisches Präparat nach den Ansprüchen 13 bis 15 in der Form einer Dosierungseinheit.

18. Pharmazeutisches Präparat nach Anspruch 17 in Tablettenoder Kapselform.

19. Pharmazeutisches Präparat nach den Ansprüchen 13 bis 17 in der Form eines wäßrigen flüssigen Präparates.

20. Pharmazeutisches Präparat nach Anspruch 19 in der Form einer wäßrigen Suspension.

21. Komplex von Carrageenan und Emepronium nach einem der Ansprüche 1, 2, 5, 6 oder 7 zur Verwendung als anticholinergisches und spasmolytisches Mittel für Menschen.

22. Komplex von Carrageenan und Doxycyclin nach einem der Ansprüche 1, 3, 5, 6 oder 8 zur Verwendung als antibiotisches Mittel für Menschen.

23. Verwendung von Carrageenan als komplexbildendes Mittel für Emepronium.

24. Verwendung von Carrageenan als komplexbildendes Mittel für Doxycyclin.

25. Verwendung von Carrageenan als komplexbildendes Mittel für Propranolol.

Revendications

1. Un complexe de carraghénine et d'un élément du groupe constitué par l'émépronium, la doxycycline et le propranolol.

2. Un complexe de carraghénine et d'émépronium.

3. Un complexe de carraghénine et de doxycycline.

4. Un complexe de carraghénine et de propranolol.

5. Un complexe selon les revendications 1-4, sous forme solide.

6. Un complexe selon les revendications 1 à 5 sous forme séchée.

7. Un complexe selon les revendications 1, 2, 5 et 6, renfermant de 10 à 70% en poids d'émépronium, calculé sous la forme de bromure d'émépronium.

8. Un complexe selon les revendications 1, 3, 5 et 6, renfermant de 10 à 70% en poids de doxycycline, calculé sous forme de chlorhydrate de doxycycline.

9. Un procédé pour la préparation d'un complexe de carraghénine et d'un élément du groupe constitué par l'émépronium, la doxycycline et le propranolol en faisant réagir la carraghénine ou un de ses sels, avec de l'émépronium, de la doxycycline ou du propranolol, ou bien un de leurs sels en solution.

10. Un procédé pour la préparation d'un complexe d'émépronium, en faisant réagir la carraghénine, ou un de ses sels, et l'émépronium, ou un de ses sels en solution pour la formation d'un complexe carraghénine-émépronium.

11. Un procédé pour la préparation d'un complexe de doxycycline, en faisant réagir la carraghénine, ou un de ses sels, et la doxycycline, ou un de ses sels en solution pour la formation d'un complexe carraghénine-



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doxycycline.

12. Un procédé selon l'une des revendications 9, 10 ou 11, dans lequel le complexe formé est isolé puis séché.

13. Une préparation pharmaceutique comportant un complexe de carraghénine et d'un élément du groupe constitué par l'émépronium, la doxycycline et le propranolol comme ingrédient actif.

14. Une préparation pharmaceutique comportant un complexe de carraghénine et d'émépronium comme ingrédient actif.

15. Une préparation pharmaceutique comportant un complexe de carraghénine et de doxycycline comme ingrédient actif.

16. Une préparation pharmaceutique selon les revendications 13, 14 ou 15 sous une forme destinée à l'administration orale.

17. Une préparation pharmaceutique selon les revendications 13 à 15 sous la forme de dosage unitaire.

18. Une préparation pharmaceutique selon la revendication 17 sous la forme de comprimé ou de capsule.

19. Une préparation pharmaceutique selon les revendications 13 à 17 sous la forme d'une préparation liquide aqueuse.

20. Une préparation pharmaceutique selon la revendication 19 sous la forme d'une suspension aqueuse.

21. Un complexe de carraghénine et d'émépronium selon 1, une quelconque des revendications 1, 2, 5, 6 ou 7, destiné à être utilisé en tant qu'agent anticholinergique et d'antispasmodique chez l'homme.

22. Un complexe de carraghénine et de doxycycline selon l'une quelconque des revendications 1, 3, 5, 6 ou 8, destiné à être utilisé en tant qu'agent antibiotique chez l'homme.

23. L'utilisation de carraghénine comme agent complexant pour l'émépronium.

24. L'utilisation de carraghénine comme agent complexant pour la doxycycline.

25. L'utilisation de carraghénine comme agent complexant pour le propranolol.

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