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(54) Titre : COMPOSITIONS PHARMACEUTIQUES CONTENANT DU MELOXICAM
(54) Title: PHARMACEUTICAL COMPOSITIONS COMPRISING MELOXICAM

(57) Abrégé/Abstract:
Disclosed herein are compositions comprising an NSAID such as meloxicam in combination with cyclodextrin and/or a carbonate or a bicarbonate. These compositions may be orally administered, for example, to improve the bioavailability or pharmacokinetics of the NSAID for the treatment of conditions such as pain.

Abstract

Disclosed herein are compositions comprising an NSAID such as meloxicam in combination with cyclodextrin and/or a carbonate or a bicarbonate. These compositions may be orally administered, for example, to improve the bioavailability or pharmacokinetics of the NSAID for the treatment of conditions such as pain.

PHARMACEUTICAL COMPOSITIONS COMPRISING MELOXICAM

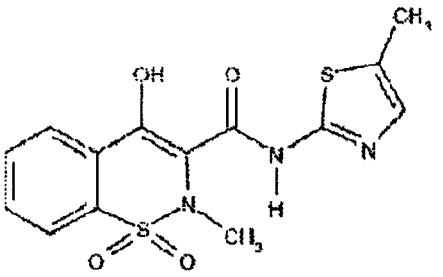
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CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a division of CA 2,976,272 filed April 11, 2016 and claims priority from United States Provisional Patent Application No. 62/259,993, filed November 25, 2015.

BACKGROUND

[0002] Meloxicam, which has the structure:



is a nonsteroidal anti-inflammatory (NSAID) drug that exhibits anti-inflammatory, analgesic, and antipyretic activities. The meloxicam mechanism of action may be related to prostaglandin synthetase (cyclo-oxygenase, COX) inhibition which is involved in the initial steps of the arachidonic acid cascade, resulting in the reduced formation of prostaglandins, thromboxanes and prostacylin.

SUMMARY

[0003] Meloxicam and some other NSAIDs have poor aqueous solubility which may reduce bioavailability and slow the onset of pain relief resulting from their use. One means of increasing the solubility and bioavailability of meloxicam is through the use of cyclodextrins. Cyclodextrin (also known as cycloamyloses) are generally cyclic polysaccharides which form a bucket-like shape. Cyclodextrins help to increase bioavailability of other molecules because cyclodextrins are hydrophobic on the inside and hydrophilic on the inside which helps to facilitate the transport of molecules. The naturally occurring cyclodextrins include six, seven, and eight glucose units (α, β, and γ-cyclodextrin, respectively). However, synthetic cyclodextrins containing more or less glucose units are possible. In aqueous solutions, cyclodextrins can form complexes (i.e., an inclusion

complex) with drugs by incorporating the drug into the center/hydrophobic portion of the cyclodextrin ring; although cyclodextrin compounds are also known to aggregate around a drug in a micelle-type structure. This ability of cyclodextrins may allow them to act as carriers to increase the bioavailability of less soluble drugs.

[0004] Some embodiments include an inclusion complex of meloxicam in a cyclodextrin.

[0005] Some embodiments include a dosage form comprising: 1) an inclusion complex of meloxicam and a cyclodextrin, or 2) meloxicam and a carbonate or a bicarbonate.

[0006] Some embodiments include a method of administering meloxicam orally, comprising orally administering a dosage form described herein to a patient in need of treatment.

[0007] Some embodiments include a method of administering meloxicam intravenously, comprising intravenously administering a dosage form described herein to a patient in need of treatment.

[0008] Disclosed herein are formulations for an inclusion complex of cyclodextrin and meloxicam with bicarbonate and methods of use thereof.

[0009] Disclosed herein are formulations and methods for delivering meloxicam with cyclodextrin to a subject by oral, enteral, intravenous, intramuscular, subcutaneous, intranasal, or other parenteral means.

[0010] Disclosed also are methods for treating pain and pain associated with conditions by delivering a dosage form with meloxicam, cyclodextrin, and bicarbonate by oral, enteral, intravenous, intramuscular, subcutaneous, intranasal, or other parenteral means to a subject.

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[0010a] According to one aspect of the present invention, there is provided use a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for improving dissolution of meloxicam in simulated gastric fluid as compared with a first reference pharmaceutical composition that: 1) contains the same amount of meloxicam; 2) does not contain the bicarbonate; and 3) does not contain a carbonate, wherein the solid pharmaceutical composition comprises about 1 mg to 50 mg of meloxicam and about 400 mg to about 1000 mg of the bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

[0010b] According to another aspect of the present invention, there is provided use a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for improving dissolution of meloxicam in simulated gastric fluid as compared with a second reference pharmaceutical composition that: 1) contains the same amount of meloxicam; 2) contains an amount of a carbonate that achieves about the same pH as the bicarbonate; and 3) does not contain the bicarbonate, wherein the solid pharmaceutical composition comprises about 1 mg to 50 mg of meloxicam and about 400 mg to about 1000 mg of the bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

[0010c] According to still another aspect of the present invention, there is provided use a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for improving oral bioavailability of meloxicam in a mammal as compared with a first reference pharmaceutical composition that: 1) contains the same amount of meloxicam; 2) does not contain the bicarbonate; and 3) does not contain a carbonate, wherein the solid pharmaceutical composition comprising about 1 mg to 50 mg of meloxicam and about 400 mg to about 1000 mg of the bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 is a depiction of the results described in Example 2 and contained in Table 6.

[0012] Figure 2 is another depiction of the results described in Example 2 and contained in Table 6.

[0013] Figure 3 is another depiction of the results described in Example 2 and contained in Table 6.

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[0014] Figure 4 is another depiction of the results described in Example 2 and contained in Table 6.

[0015] Figure 5 is another depiction of the results described in Example 2 and contained in Table 6.

[0016] Figure 6 is another depiction of the results described in Example 2 and contained in Table 6.

[0017] Figure 7 is another depiction of the results described in Example 2 and contained in Table 6.

[0018] Figure 8 is another depiction of the results described in Example 2 and contained in Table 6.

[0019] Figure 9 is another depiction of the results described in Example 2 and contained in Table 6.

[0020] Figure 10 is another depiction of the results described in Example 2 and contained in Table 6.

DETAILED DESCRIPTION

[0021] Provided herein are dosage forms with NSAIDs (such as meloxicam) and cyclodextrin (optionally in an inclusion complex), and/or bicarbonate, and methods of treatment using the dosage form.

[0022] A dosage form may be given enterally including, but not limited to, oral, sublingual, or rectal delivery, or parenterally including, but not limited to, intravenous, intramuscular, intranasal, or subcutaneous delivery.

[0023] Some methods include administration of a product that combines an NSAID that is formulated with: a) a cyclodextrin and/or b) a buffering agent. In some embodiments, the method involves treating a patient with a pharmaceutical formulation comprising meloxicam and a cyclodextrin and/or a carbonate/bicarbonate. Method embodiments may also include treating a patient to increase the bioavailability of meloxicam in the patient or increase the rate at which the meloxicam becomes bioavailable.

[0024] The term "treating" or "treatment" broadly includes any kind of treatment activity, including the diagnosis, cure, mitigation, or prevention of disease in man or other animals, or

any activity that otherwise affects the structure or any function of the body of man or other animals.

[0025] The dosage form may be used to treat, or provide relief of, any type of pain including, but not limited to, inflammatory pain, musculoskeletal pain, neuropathic pain, chronic pain, acute pain, localized pain, systemic pain, cancer-related pain, acute pain, pain due to injury, pain due to illness (e.g., fever), post-operative pain, etc. In some instances, pain relief may be palliative, or pain relief may be provided independent of improvement of the disease or condition or the underlying cause of the disease or condition. For example, although the underlying disease may not improve, or may continue to progress, an individual suffering from the disease may experience pain relief. In some embodiments, the pain affects a muscle, nerve, cartilage, bone, ligament, tendon, tendon sheaths, bursae, or joint.

[0026] In some embodiments, the dosage form may also be administered to relieve arthritis pain. In some embodiments the dosage form may be administered to relieve other signs and/or symptoms of arthritis. Examples of arthritis include, but are not limited to, rheumatoid arthritis, juvenile rheumatoid arthritis (pauciarticular and polyarticular course), osteoarthritis, erosive osteoarthritis, sero-negative (non-rheumatoid), arthropathies, non-articular rheumatism, peri-articular disorders, axial spondyloarthritis, transient osteoarthritis of the hip, vertebral crush fractures, osteoporosis, and neuropathic arthropathies including Charcot's foot, axial spondyloarthritis including ankylosing spondylitis, and SAPHO syndrome. In other embodiments, the arthritis pain may be chronic or acute. In some embodiments the dosage form may be administered to relief the signs and/or symptoms of an arthritis including but not limited osteoarthritis

[0027] For some methods, administration of the dosage form may achieve a reduction in pain that lasts at least about one hour, two hours, three hours, four hours, six hours, at least about eight hours, about eight to about 24 hours, or about 24 hours. In other embodiments, administration of the dosage form may achieve a reduction in pain that is observed at about 10 minutes, at about 30 minutes, at about one hour, at about two hours, at about three hours, at about four hours, at about five hours, at about six hours, at less than 15 minutes, at less than 20 minutes, 30 minutes, at less than one hour, at less than two hours, at less than three hours, at about 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, or 60 minutes, or other time period bound by these ranges, after administration of the dosage form.

[0028] In some embodiments, the dosage form may also be administered to relieve neuropathic pain, including diabetic peripheral neuropathy, post-herpetic neuralgia, trigeminal neuralgia, monoradiculopathies, phantom limb pain, sciatica, pudendal neuralgia, and central pain. Other causes of neuropathic pain may include, but are not limited to,

cancer-related pain, lumbar nerve root compression, spinal cord injury, post-stroke pain, central multiple sclerosis pain, HIV-associated neuropathy, and radio-therapy or chemo-therapy associated neuropathy. The neuropathic pain treated may be chronic or acute.

[0029] In some methods, the dosage form may be administered to relieve inflammatory pain including inflammatory musculoskeletal pain, pain due to injury, arthritis pain, and complex regional pain syndrome. In other embodiments, the inflammatory pain may be chronic or acute.

[0030] Arthritis refers to inflammatory joint diseases that can be associated with pain. Examples of arthritis pain include but are not limited to pain associated with osteoarthritis, erosive osteoarthritis, rheumatoid arthritis, juvenile rheumatoid arthritis, sero-negative (non-rheumatoid) arthropathies, non-articular rheumatism, peri-articular disorders, neuropathic arthropathies including Charcot's foot, axial spondyloarthritis including ankylosing spondylitis, and SAPHO syndrome. The inflammatory joint disease treated may be chronic or acute.

[0031] For some methods, the meloxicam may be administered to relieve musculoskeletal pain. Examples of musculoskeletal pain may include, but are not limited to, back pain, low back pain (e.g., lumbosacral pain), neck pain, infection, cramps, tendonitis, epidondylitis, carpal tunnel syndrome, joint pain, fibromyalgia, pain due to injury, Tunnel syndromes, pain associated with bone fractures, sprains, fibrous dysplasia, osteogenesis imperfecta, Paget's disease of bone, transient osteoporosis, and transient osteoporosis of the hip. In other embodiments, the musculoskeletal pain may be chronic or acute.

[0032] A human being that is treated for a disease or condition with the dosage forms described herein may be of any age. For example the person may have an age of about 10 years to about 90 years, about 20 years to about 80 years, about 30 years to about 75 years, about 40 years to about 70 years, about 1 year to about 16 years, about 80 years to about 95 years, about 18 years or more, about 20 years or more, about 25 years or more, about 30 years or more, about 40 years or more, about 45 years or more, about 50 years or more, about 55 years or more, about 60 years or more, about 65 years or more, or any other age in a range bounded by, or between, these values.

[0033] In some embodiments, a human being that is treated for a disease or condition with a dosage form comprising meloxicam or another NSAID has suffered from the pain or condition associated with the pain for at least 1 day, at least one week, at least 2 weeks, at least 1 month, at least 6 weeks, at least 2 months, at least 3 months, at least 6 months, or at least 1 year, or any duration in a range bounded by, or between, these values.

[0034] A cyclodextrin used in a dosage form with meloxicam could include a cyclodextrin, a cyclodextrin derivative, and/or a salt thereof. An inclusion complex of meloxicam and cyclodextrin may be more water-soluble relative to the non-complexed meloxicam. The cyclodextrin may be a naturally-occurring cyclodextrin (e.g., α, β, or γ-cyclodextrins) or a synthetic cyclodextrin. In some embodiments, α-cyclodextrins, derivatives, or salts thereof may be used. α-Cyclodextrins may include, but are not limited to, (2,3,6-tri-O-acetyl)-α-cyclodextrin, (2,3,6-tri-O-methyl)-α-cyclodextrin, (2,3,6-tri-O-octyl)-α-cyclodextrin, 6-bromo-6-deoxy-α-cyclodextrin, 6-iodo-6-deoxy-α-cyclodextrin, (6-O-tertbutyl-dimethylsilyl)-α-cyclodextrin, butyl-α-cyclodextrin, succinyl-α-cyclodextrin, (2-hydroxypropyl)-α-cyclodextrin, or combinations thereof.

[0035] In some embodiments, β-cyclodextrins, derivatives, or salts thereof may be used. β-cyclodextrins may include, but are not limited to, hydroxypropyl-β-cyclodextrin, 6-monodeoxy-6-monoamino-β-cyclodextrin, glucosyl-β-cyclodextrin, maltosyl-β-cyclodextrin, 6-O-α-D-glucosyl-β-cyclodextrin, 6-O-α-maltosyl-β-cyclodextrin, 6-azido-6-deoxy-β-cyclodextrin, (2,3-di-O-acetyl-6-O-sulfo)-β-cyclodextrin, methyl-β-cyclodextrin, dimethyl-β-cyclodextrin (DMβCD), trimethyl-β-cyclodextrin (TMβCD), (2,3-di-O-methyl-6-O-sulfo)-β-cyclodextrin, (2,6-di-O-methyl)-β-cyclodextrin, (2,6-di-O-ethyl)-β-cyclodextrin, (2,3,6-tri-O-methyl)-β-cyclodextrin, (2,3,6-tri-O-acetyl)-β-cyclodextrin, -(2,3,6-tri-O-benzoyl)-β-cyclodextrin, (2,3,6-tri-O-ethyl)-β-cyclodextrin, 6-iodo-6-deoxy-β-cyclodextrin, 6-(dimethyl-tert-butylsilyl)-6-deoxy-β-cyclodextrin, 6-bromo-6-deoxy-β-cyclodextrin, monoacetyl-β-cyclodextrin, diacetyl-β-cyclodextrin, triacetyl-β-cyclodextrin, (3-O-acetyl-2,6-di-O-methyl)-β-cyclodextrin, (6-O-maltosyl)-β-cyclodextrin, (6-O-sulfo)-β-cyclodextrin, (6-O-t-butyldimethylsilyl-2,3-di-O-acetyl)-β-cyclodextrin, succinyl-(2-hydroxypropyl)-β-cyclodextrin, (2,6-di-O-)ethyl-β-cyclodextrin, (2-carboxyethyl)-β-cyclodextrin (CMEβCD), hydroxyethyl-β-cyclodextrin (HEβCD), (2-hydroxypropyl)-β-cyclodextrin, (2-hydroxypropyl)-β-cyclodextrin (HPβCD), (3-hydroxypropyl)-β-cyclodextrin (3HPβCD), (2,3-hydroxypropyl)-β-cyclodextrin (DHPβCD), butyl-β-cyclodextrin, methyl-β-cyclodextrin, silyl((6-O-tert-butyldimethyl)-2,3,-di-O-acetyl)-β-cyclodextrin, succinyl-β-cyclodextrin, (2-hydroxyisobutyl)- β-cyclodextrin, randomly methylated-β-cyclodextrin, branched-β-cyclodextrin, or combinations thereof.

[0036] In other embodiments, a β-cyclodextrin may be a sulfoalkyl ether cyclodextrin, derivative, or salt thereof. Examples of sulfoalkyl ether cyclodextrin derivatives may include, but are not limited to, sulfobutyl ether-β-cyclodextrin (e.g., SBEβCD, betadex, CAPTISOL®). In some embodiments, a SBEβCD may have about 4-8, about 5-8, about 4-7, about 6-7, or about 6.5 sulfobutyl ether groups per cyclodextrin molecule.

[0037] In some embodiments, γ-cyclodextrins, derivatives, or salts thereof may be used. γ-cyclodextrins may include carboxymethyl-γ-cyclodextrin, (2,3,6-tri-O-acetyl)-γ-cyclodextrin, (2,3,6-tri-O-methyl)-γ-cyclodextrin, (2,6-di-O-pentyl)-γ-cyclodextrin, 6-(dimethyl-tert-butylsilyl)-6-deoxy-γ-cyclodextrin, 6-bromo-6-deoxy-γ-cyclodextrin, 6-iodo-6-deoxy-γ-cyclodextrin, (6-O-t-butyldimethylsilyl)-γ-cyclodextrin, succinyl-γ-cyclodextrin, hydroxypropyl-γ-cyclodextrin (2-hydroxypropyl)-γ-cyclodextrin, acetyl-γ-cyclodextrin, butyl-γ-cyclodextrin, or combinations thereof.

[0038] In some embodiments, the dosage form may include a bicarbonate, such as sodium bicarbonate, potassium bicarbonate, magnesium bicarbonate, calcium bicarbonate, ammonium bicarbonate, or a combination thereof. A bicarbonate may help to increase bioavailability of the meloxicam.

[0039] In other embodiments, the dosage form may include a carbonate, derivatives, or salts thereof. Examples of carbonates may include aluminum carbonate, ammonium carbonate, barium carbonate, calcium carbonate, cobalt(II) carbonate, lanthanum carbonate, lithium carbonate, magnesium carbonate, manganese(II) carbonate, potassium carbonate, sodium carbonate, or combinations thereof.

[0040] In some embodiments, enhanced bioavailability of the dosage form may be achieved in treating one of these conditions by administering a dosage form comprising a salt form of the meloxicam, by creating an inclusion complex with meloxicam and cyclodextrin, and/or by including a bicarbonate. This may allow a reduced molar amount of the meloxicam to be used as compared to other meloxicam dosage forms.

[0041] Unless otherwise indicated, any reference to a compound herein, such as meloxicam or a cyclodextrin, by structure, name, or any other means, includes pharmaceutically acceptable salts, alternate solid forms, such as polymorphs, solvates, hydrates, enantiomers, tautomers, deuterium-modified forms, or any other chemical species that may rapidly convert to a compound described herein under conditions in which the compounds are used as described herein.

[0042] In some embodiments, use of a cyclodextrin, a carbonate, or a bicarbonate may improve the oral bioavailability of meloxicam by at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, up to about 100%, up to about 200%, or any amount in a range bounded by, or between, these values as compared to administration of meloxicam alone.

[0043] Due to the improved bioavailability, the dosage form may contain, or a subject may receive, on a molar basis, less of the meloxicam than would otherwise be administered. For example, a dosage form may contain, or a mammal may receive, at least about 10 mole% less, at least about 20 mole% less, at least about 30 mole% less, at least about 40 mole% less, at least about 50 mole% less, at least about 60 mole% less, at least about 70 mole% less, at least about 80 mole% less, at least about 85 mole% less, and/or up to about 90 mole% less, 95 mole% less, or any amount in a range bounded by, or between, these values as would otherwise be administered of meloxicam.

[0044] In other embodiments, use of other NSAIDs, opioids, or other pain medications may be reduced by at least about 5%, at least about 10%, at least about 15%, at least about 20%, at least about 25%, at least about 30%, at least about 35%, at least about 40%, at least about 45%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, or at least about 90%, up to about 100%, as compared to the use of other NSAIDs, opioids or other pain medications without administration of meloxicam with cyclodextrin, carbonate, and/or bicarbonate.

[0045] In some embodiments, a dosage form may contain meloxicam in an amount from about 1-50 mg; about 1-10 mg; about 1-5 mg; about 10-40 mg; about 1-35 mg; about 1-25 mg; about 1-15 mg; about 5-20 mg; about 5-10 mg; about 5-15 mg; about 10-20 mg; about 20-30 mg; about 30-40 mg; about 40-50 mg; about 5 mg; about 7.5 mg; about 10 mg; about 15 mg; about 30 mg; or any amount in a range bounded by, or between, any of these values. These doses may be a safe dose for repeated administration, such as once hourly dosing to once daily dosing, twice daily dosing, dosing one to 12 times daily, doing 3, 4, 5, or 6 times daily, etc. In some embodiments, the meloxicam may be safely administered 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15 times, or about 3 to about 10 times a day, once a day, or less frequently, such as once a week, once every two weeks, once a month, etc.

[0046] For some dosage forms, meloxicam forms a complex with the substituted-β-cyclodextrin or other another cyclodextrin which may be formulated into a solid dosage form. Such a dosage form may be suitable for oral administration. A meloxicam-cyclodextrin inclusion complex may also be dissolved in water or another solvent to form a parenteral formulation. However, physical mixtures of meloxicam and the substituted-β-cyclodextrin or other cyclodextrins may also be used in oral or parenteral dosage forms.

[0047] Formation of an inclusion complex of meloxicam and a cyclodextrin may help to improve the properties of a dosage form. For some inclusion complexes, the meloxicam and the cyclodextrin (e.g., SBEβCD) may have a molar ratio of about 0.5-2 (a molar ratio of 0.5 is 0.5 moles of meloxicam to 1 mole of cyclodextrin), about 0.5-0.7, about 0.6-0.8, about 0.7-

0.9, about 0.8-1, about 0.9-1.1, about 1-1.2, about 1.1-1.3, about 1.2-1.4, about 1.3-1.5, about 1.4-1.6, about 1.5-1.7, about 1.6-1.8, about 1.7-1.9, about 1.8-2, about 0.8-1.2, about 1, or any ratio in a range bounded by any of these values.

[0048] For some dosage forms, a cyclodextrin (e.g., SBEβCD) may be employed in a weight ratio to the meloxicam within the range from about 1-1000 (e.g. 1 g of cyclodextrin per 1 g of meloxicam is a weight ratio of 1); about 1-20; about 1-10; about 1-15; about 2-4, about 3-5, about 4-6, about 5-7, about 6-8, about 7-9, about 8-10, or any weight ratio in a range bounded by, or between, any of these values. For some dosage forms, a cyclodextrin (e.g., SBEβCD) may be employed in a weight ratio to the meloxicam within the range from about 0.001-1 (e.g. 0.1 g of cyclodextrin per 1 g of meloxicam is a weight ratio of 0.1); about 0.01-1; about 0.05-1; about 0.1-1; about 0.2-1; about 0.3-1, about 0.4-1, about 0.5-1, about 0.6-1, about 0.7-1, about 0.8-1, or any weight ratio in a range bounded by, or between, any of these values. Each type of cyclodextrin employed may have a different ratio.

[0049] For some dosage forms, the cyclodextrin may be present in an amount from about 1-200 mg; 25-175 mg; about 50-150 mg; about 25-100 mg; about 75-150 mg; about 100-175 mg; about 20-80 mg; about 25-50 mg; about 60-100 mg; about 80-100 mg; about 80-120 mg; about 100-120 mg; about 100-140 mg; about 120-160 mg; about 140-180 mg; about 30-90 mg; about 40-80 mg; about 50-70 mg, about 55-65 mg, about 60-62 mg, or any amount in a range bounded by, or between, any of these values.

[0050] For some methods, the inclusion complex of meloxicam and cyclodextrin such as a substituted-β-cyclodextrin is delivered orally (for example by tablet, capsule, elixir, or the like). Other potential routes of administration include intravenous, intramuscular, intranasal, lyophilized parenteral, subcutaneous, transdermal, transmucosal, or through other parenteral means. The meloxicam may also be delivered alone or non-complexed with cyclodextrin.

[0051] Some dosage forms contain a bicarbonate (e.g., sodium bicarbonate) in amount from about 1-2000 mg; about 1-1000 mg; about 100-1000 mg; about 200-800 mg; about 1-500 mg; about 1-200 mg; about 1-100 mg; about 50-750 mg; about 500-1000 mg; about 100-500 mg; about 100-300 mg; about 500-1000 mg; about 300-700 mg; about 400-600 mg; about 50-250 mg; about 250-750 mg; about 100-200 mg; about 200-300 mg; about 300-400 mg; about 400-500 mg; about 500-600 mg; about 600-700 mg; about 700-800 mg; about 800-900 mg; about 150-650 mg; about 350-850 mg; or any amount in a range bounded by, or between, any of these values.

[0052] Some dosage forms contain a carbonate in amount from about 1-1000 mg; about 1-500 mg; about 1-200 mg; about 1-100 mg; about 50-750 mg; about 500-1000 mg; about

100-500 mg; about 100-300 mg; about 200-800 mg; about 500-1000 mg; about 300-700 mg; about 400-600 mg; about 50-250 mg; about 250-750 mg; about 100-200 mg; about 200-300 mg; about 300-400 mg; about 400-500 mg; about 500-600 mg; about 600-700 mg; about 700-800 mg; about 800-900 mg; about 150-650 mg; about 350-850 mg; or any amount in a range bounded by, or between, any of these values.

[0053] In some embodiments, the daily dose of meloxicam (e.g., an oral dose, a parenteral dose, etc.) is about 2-5 mg, about 2-6 mg, about 2-7 mg, about 2-8 mg, about 2-9 mg, about 2-10 mg, about 2-11 mg, about 2-12 mg, about 2-13 mg, about 2-14 mg, about 2-15 mg, about 2-16 mg, about 2-17 mg, about 2-18 mg, about 2-19 mg, about 2-20 mg, about 2-21 mg, about 2-22 mg, about 2-23 mg, about 2-24 mg, about 2-25 mg, about 2-26 mg, about 2-27 mg, about 2-28 mg, about 2-29 mg, about 2-30 mg, about 2-35 mg, about 2-40 mg, about 5-10 mg, about 10-15 mg, about 15-20 mg, about 20-25 mg, about 25-30 mg, about 30-35 mg, or any amount in a range bounded by any of these values.

[0054] In some embodiments, the weekly dose of meloxicam (e.g., an oral dose) is about 1-1000 mg; about 1-500 mg; about 10-250 mg; about 100-300 mg; about 10-100 mg; about 10-150 mg; about 10-300 mg; about 20-150 mg; about 20-60 mg; about 30-70 mg; about 40-60 mg; about 50-70 mg; about 70-90 mg; about 90-110 mg; about 50 mg; about 55 mg; about 100-150 mg; about 30-100 mg; or any amount in a range bounded by, or between, any of these values. The weekly dose may be given as a single dose, given once during the week, or may be given in 2, 3, 4, 5, 6, or 7 individual doses during the week.

[0055] In some embodiments, the monthly dose of meloxicam (e.g., an oral dose), or a dose administered over a period of a month, is about 5000 mg or less; about 4000 mg or less; about 3000 mg or less; about 2000 mg or less; about 1000 mg or less; about 700 mg or less; about 600 mg or less; about 1-4000 mg; about 1-1000 mg; about 10-1000 mg; about 50-1000 mg; about 10-600 mg; about 40-600 mg; about 50-600 mg; about 40-400 mg; about 50-200 mg; about 200-240 mg; about 240-280 mg; about 280-320 mg; about 320-360 mg; about 360-400 mg; about 400-450 mg; about 450-500 mg; about 500-600 mg; about 250-350 mg; about 100-600 mg; about 40-2000 mg; about 40-800 mg; about 100-900 mg; about 100-800 mg; about 40-1000 mg; about 50-1000 mg; about 100-1000 mg; or any monthly dose in a range bounded by, or between, any of these values. A monthly dose may be given as a single dose, or as two or more individual doses administered during the month. In some embodiments, the monthly dose is administered in 2 or 3 bi-weekly doses. In some embodiments, the monthly dose is administered in 4 or 5 weekly doses. In some embodiments, the monthly dose is administered in 28 to 31 daily doses, or in 56 to 62 daily doses or more. In some embodiments, the monthly dose is administered in 5 to 15

individual doses during the month. The monthly dose may be administered for only 1 month, or may be repeatedly administered for 2 or more months.

[0056] In other embodiments, the dosage form may be administered weekly for about one, two, three, four, or more consecutive weeks, every other week or bi-weekly, or once every three weeks. This regimen may be repeated once weekly, twice in a month, three times in a month, once monthly, once every two months, once every three months, or as directed by a medical professional.

[0057] In certain embodiments, the pharmaceutical composition results in increased bioavailability (e.g., reduced T_{max}, increased C_{max}, increased AUC, etc.) of the meloxicam from the dosage form as compared to a dosage form containing meloxicam but not containing a cyclodextrin, an acid inhibitor, or a buffering agent (such as a bicarbonate). In some embodiments, the bioavailability of meloxicam will increase with multiple dosing. For example, the bioavailability of meloxicam in the dosage form may increase after about 1-10 days of dosing; about 2-6 days of dosing; about 3-5 days of dosing; about 4-6 days of dosing; about 5-8 days of dosing; about 5 days of dosing; about 6 days of dosing; about 7 days of dosing; about 8 days of dosing; about 10 days of dosing; about 15 days of dosing; or time in any range bounded by, or between, any of these values; as compared to the bioavailability of meloxicam in a dosage form not containing a cyclodextrin, an acid inhibitor, or a buffering agent (such as a bicarbonate).

[0058] Some of the dosage forms may result in a desired range for an area under the plasma concentration curve (AUC) of meloxicam. For example the dosage with meloxicam may result in an AUC of meloxicam of about 1-150 μg·hr/mL; about 10-30 μg·hr/mL; about 20-40 μg·hr/mL; about 30-50 μg·hr/mL; about 40-60 μg·hr/mL; about 50-70 μg·hr/mL; about 60-80 μg·hr/mL; about 70-90 μg·hr/mL; about 80-100 μg·hr/mL; about 10-100 μg·hr/mL; about 50-150 μg·hr/mL; about 25-125 μg·hr/mL; about 75-150 μg·hr/mL; about 20-50 μg·hr/mL; about 40-70 μg·hr/mL; about 60-90 μg·hr/mL; about 80-110 μg·hr/mL; about 100-130 μg·hr/mL; about 120-150 μg·hr/mL; or any AUC in a range bounded by, or between, any of these values.

[0059] Unless otherwise indicated, the AUC refers to the AUC calculated to the last measured concentration (AUC_{0-t}), over a period of 24 hours (AUC_{0-24}), or extrapolated to infinity (AUC_{0-inf}).

[0060] In some embodiments, the dosage form may result in a C_{max} of meloxicam of about 10-2500 ng/mL; about 100-2250 ng/mL; about 500-2000 ng/mL; about 1000-2500 ng/mL; about 1000-2000 ng/mL; about 100-900 ng/mL; about 750-1500 ng/mL; about 1250-

2000 ng/mL; about 1500-2300 ng/mL; about 800-1200 ng/mL; about 1900-2400 ng/mL; about 50-500 ng/mL; about 400-950 ng/mL; about 900-1500 ng/mL; about 1100-2200 ng/mL; about 1300-1600 ng/mL; about 1200-1500 ng/mL; about 1400-2100 ng/mL; about 1500-1900 ng/mL; about 1600-2100 ng/mL; about 1700-2000 ng/mL; about 1800-2000 ng/mL; about 1900-2500 ng/mL; about 150-1700 ng/mL; about 1600-1800 ng/mL; about 1700-1900 ng/mL; about 1800-2000 ng/mL; about 1900-2100 ng/mL; about 2000-2200 ng/mL; about 2100-2300 ng/mL; about 2200-2400 ng/mL; about 2300-2500 ng/mL; about 2500-3000 ng/mL; or any C_{max} in a range bounded by, or between, any of these values.

[0061] For example, a method described herein may reduce the T_{max} of meloxicam. In some embodiments, the method may include treating a patient to achieve the T_{max} of meloxicam in the patient within about 10 minutes; about 20 minutes; about 30 minutes; about 40 minutes; about 50 minutes; about 60 minutes; about 70 minutes; about 80 minutes; about 90 minutes; about 100 minutes; about 110 minutes; about 120 minutes; about 180 minutes; about 1-10 hr; about 2-9 hr; about 3-7 hr; about 4-6 hr; about 1-5 hr; about 2-7 hr; about 3-8 hr; about 4-9 hr; about 1-4 hr; about 2-5 hr; about 3-6 hr; about 4-7 hr; about 5-8 hr; about 6-9 hr; about 7-10 hr; after administration or any T_{max} in a range bounded by, or between, any of these values.

[0062] In some embodiments, a dosage form comprising meloxicam may result in a plasma concentration of meloxicam at 12 hours that is about 0.01-0.5 µg/mL; about 0.5-0.7 µg/mL; about 0.6-0.8 µg/mL; about 0.7-0.9 µg/mL; about 0.8-1 µg/mL; about 0.9-1.1 µg/mL; about 1-1.2 µg/mL; about 1.1-1.3 µg/mL; about 1.2-1.4 µg/mL; about 1.3-1.5 µg/mL; about 1.4-1.6 µg/mL; about 1.5-1.7 µg/mL; about 1.6-1.8 µg/mL; about 1.7-1.9 µg/mL; about 1.8-2 µg/mL; about 1.9-2.1 µg/mL; about 2-2.2 µg/mL; about 2.1-2.3 µg/mL; about 2.2-2.4 µg/mL; about 2.3-2.5 µg/mL; about 2.4-2.6 µg/mL; about 2.5-2.7 µg/mL; about 2.6-2.8 µg/mL; about 2.7-2.9 µg/mL; about 2.8-3 µg/mL; about 2.9-3.1 µg/mL; about 3-3.2 µg/mL; about 3.1-3.3 µg/mL; about 3.2-3.4 µg/mL; about 3.3-3.5 µg/mL; about 3.4-3.6 µg/mL; about 3.5-3.7 µg/mL; about 3.6-3.8 µg/mL; about 3.7-3.9 µg/mL; about 3.8-4 µg/mL; or any plasma concentration in a range bounded by, or between, any of these values.

[0063] In some embodiments, meloxicam is administered at a dose that results in a meloxicam plasma level (such as a C_{ave}, or average plasma level) of about 0.01-0.5 µg/mL; about 0.5-0.7 µg/mL; about 0.6-0.8 µg/mL; about 0.7-0.9 µg/mL; about 0.8-1 µg/mL; about 0.9-1.1 µg/mL; about 1-1.2 µg/mL; about 1.1-1.3 µg/mL; about 1.2-1.4 µg/mL; about 1.3-1.5 µg/mL; about 1.4-1.6 µg/mL; about 1.5-1.7 µg/mL; about 1.6-1.8 µg/mL; about 1.7-1.9 µg/mL; about 1.8-2 µg/mL; about 1.9-2.1 µg/mL; about 2-2.2 µg/mL; about 2.1-2.3 µg/mL; about 2.2-2.4 µg/mL; about 2.3-2.5 µg/mL; about 2.4-2.6 µg/mL; about 2.5-2.7 µg/mL; about

2.6-2.8 µg/mL; about 2.7-2.9 µg/mL; about 2.8-3 µg/mL; about 2.9-3.1 µg/mL; about 3-3.2 µg/mL; about 3.1-3.3 µg/mL; about 3.2-3.4 µg/mL; about 3.3-3.5 µg/mL; about 3.4-3.6 µg/mL; about 3.5-3.7 µg/mL; about 3.6-3.8 µg/mL; about 3.7-3.9 µg/mL; about 3.8-4 µg/mL; about 0.1-20 µg/mL; about 0.5-15 µg/mL; about 0.5-10 µg/mL; about 5-15 µg/mL; about 10-20 µg/mL; about 7.5-15 µg/mL; about 2-10 µg/mL; about 1-8 µg/mL; about 1-6 µg/mL; about 1-2 µg/mL; about 0.5-3.5 µg/mL; about 0.5-7 µg/mL; about 12-20 µg/mL; about 8-12 µg/mL; about 1-4 µg/mL; about 4-7 µg/mL; about 7-11 µg/mL; about 11-15 µg/mL; about 15-19 µg/mL; about 16-20 µg/mL; or any amount of meloxicam plasma level in a range bounded by, or between, any of these values.

[0064] One embodiment is a method for reducing the risk of gastrointestinal side effects in people taking NSAIDs for pain relief and for other conditions, particularly during chronic treatment, and improving the bioavailability of the NSAID. In one embodiment, the method involves the administration of a product that combines: a) an agent that actively raises intragastric pH; and b) an NSAID that is formulated with a cyclodextrin. In another embodiment, the method involves the administration of a product that combines: a) an agent that actively raises intragastric pH; b) an NSAID that is formulated with a cyclodextrin; and c) a buffering agent. Either short or long acting acid inhibitors can be effectively used in the dosage forms. This method has the added benefit of being able to protect patients from other gastrointestinal ulcerogens whose effect may otherwise be enhanced by the disruption of gastroprotective prostaglandins due to NSAID therapy.

[0065] The meloxicam formulation in an aqueous parenteral form may include a buffer to adjust the pH of an aqueous formulation, within a range of about 2 to about 5; about 3.5 to about 5; about 5 to about 11; about 6 to about 9; about 6 to about 8; about 6 to about 7; or any other pH in a range bounded by, or between, any of these values. The meloxicam formulation in an oral form may include a buffer to adjust the pH of stomach fluid within a range of about 2 to about 5; about 3.5 to about 5; about 5 to about 11; about 6 to about 9; about 6 to about 8; about 6 to about 7; or any other pH in a range bounded by, or between, any of these values. Examples of buffers suitable for use herein include sulfate buffers, phosphate buffers, borate buffers, carbonate buffers, citrate buffers, etc.

[0066] In some embodiments, the dosage form may be formulated for oral administration, for example, with an inert diluent or with an edible carrier, or it may be enclosed in hard or soft shell gelatin capsules, compressed into tablets, or incorporated directly with the food of the diet. For oral therapeutic administration, the active compound may be incorporated with an excipient and used in the form of ingestible tablets, buccal

tablets, coated tablets, troches, capsules, elixirs, dispersions, suspensions, solutions, syrups, wafers, patches, and the like.

[0067] Tablets, troches, pills, capsules and the like may also contain one or more of the following: a binder such as gum tragacanth, acacia, corn starch or gelatin; an excipient, such as dicalcium phosphate; a disintegrating agent such as corn starch, potato starch, alginic acid and the like; a lubricant such as magnesium stearate; a sweetening agent such as sucrose, lactose or saccharin; or a flavoring agent such as peppermint, oil of wintergreen or cherry flavoring. When the unit dosage form is a capsule, it may contain, in addition to materials of the above type, a liquid carrier. Various other materials may be present as coating, for instance, tablets, pills, or capsules may be coated with shellac, sugar or both. A syrup or elixir may contain the active compound, sucrose as a sweetening agent, methyl and propylparabens as preservatives, a dye and flavoring, such as cherry or orange flavor. It may be desirable for material in a dosage form or pharmaceutical composition to be pharmaceutically pure and substantially non-toxic in the amounts employed.

[0068] Some compositions or dosage forms may be a liquid, or may comprise a solid phase dispersed in a liquid.

[0069] In some embodiments, the dosage form may further comprise an acid inhibitor present in an amount effective to raise the gastric pH of a patient to at least 2, to at least 2.5, to at least 3, to at least 3.5, to at least 4, and more to at least 5, when one or more unit dosage forms are administered. The term "acid inhibitor" refers to agents that inhibit gastric acid secretion and increase gastric pH. Specific H_2 blockers, also referred to as H_2 antagonists or histamine H_2 blockers or antagonists, that may be used include but are not limited to cimetidine, ranitidine, ebrotidine, pabutidine, lafutidine, loxtidine, famotidine, or combinations thereof.

[0070] Other agents that may be effectively used as acid inhibitors are the proton pump inhibitors such as omeprazole, esomeprazole, pantoprazole, lansoprazole, dexlansoprazole, rabeprazole, pariprazole, leminoprazole and tenatoprazole. In some embodiments the daily dose of the acid inhibitor is about 1-200 mg, about 1-100 mg, about 1-50 mg, about 40-80 mg, about 5-50 mg, about 20-40 mg, about 10-50 mg, about 10-20 mg, about 20-40 mg, about 15-50 mg, about 30-60 mg, about 10 mg, about 20 mg, about 30 mg, about 40 mg or any other amount in a range bounded by, or between, any of these values.

[0071] Examples of particular proton pump inhibitors include esomeprazole, present in unit dosage forms in an amount of between 5 mg and 50 mg; omeprazole, present in unit dosage forms in an amount of between 5 mg and 50 mg; lansoprazole, present in unit

dosage forms in an amount of between 5 mg and 150 mg (and preferably at between 5 mg and 30 mg); and pantoprazole, present in unit dosage forms in an amount of between 10 mg and 200 mg. In some embodiments, the proton pump inhibitor is present in the dosage form in an amount of about 10-30 mg, about 20-40 mg, about 30-50 mg, about 40-60 mg, about 50-70 mg, about 60-80 mg, about 70-90 mg, or about 80-100 mg. Recently, a newer class of acid inhibitor has been developed which competes with potassium at the acid pump. The compounds in this class have been referred to as "reversible proton pump inhibitors" or "acid pump antagonists" and may also be used. Examples include AZD-0865, AR-H047108, CS-526, pumaprazole, revaprazan and soraprazan (see WO9605177 and WO9605199). Other compounds in this group are H-335/25 (AstraZeneca, Dialog file 128, accession number 020806); Sch-28080 (Schering Plough, Dialog file 128, accession number 009663); Sch-32651 (Schering Plough, Dialog file 128, accession number 006883) and SK&F-96067 (CAS Registry no. 115607-61-9).

[0072] In some embodiments, the dosage form or treatment also further comprises administering a second non-steroidal anti-inflammatory drug in an amount effective to reduce or eliminate pain or inflammation. The NSAID may include, but is not limited to, celecoxib, rofecoxib, lumiracoxib, valdecoxib, parecoxib, etoricoxib, CS-502, JTE-522, L-745,337, NS398, aspirin™, acetaminophen (considered to be an NSAID for the purposes of the present disclosure), ibuprofen, flurbiprofen, ketoprofen, naproxen, oxaprozin, etodolac, indomethacin, ketorolac, lornoxicam, meloxicam, piroxicam, droxicam, tenoxicam, nabumetone, diclofenac, meclofenamate, mefenamic acid, diflunisal, sulindac, tolmetin, fenoprofen, suprofen, benoxaprofen, aceclofenac, tolfenamic acid, oxyphenbutazone, azapropazone, phenylbutazone, or combinations thereof. It will be understood that, for the purposes of the present disclosure, reference to an acid inhibitor, NSAID, or analgesic agent will include all of the common forms of these compounds and, in particular, their pharmaceutically acceptable salts. The amounts of NSAIDs which are therapeutically effective may be lower in the current embodiments than otherwise found in practice due to potential positive kinetic interaction and NSAID absorption in the presence of an acid inhibitor, and or in the presence of a buffering agent.

[0073] In other embodiments, the dosage form or treatment may further comprise administering an opioid in an amount effective to reduce or eliminate pain or inflammation. The opioid may include, but is not limited to, (dextro)propoxyphene, A-methylfentanyl, alfentanil, allylprodine, bezitramide, buprenorphine, butorphanol, carfentanyl, desmethylprodine, dextromoramide, dezocine, diacetylmorphine, dihydrocodeinone, dihydroetorphine, dimorphone, diphenoxylate, dipipanone, etorphine, fentanyl,

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ketobemidone, lefetamine, levacetylmethadol, levomethorphan, levorphanol, loperamide, meperidine, meptazinol, methadone, methylmorphine, morphine, nalbuphine, nalmefene, naloxone, naltrexone, nicomorphine, ohmefentanyl, oripavine, oxycodone, oxymorphone, PEPAP, paramorphine, pentazocine, phenazocine, piritramide, prodine, remifentanil, sufentanil, tapentadol, tilidine, tramadol, or combinations thereof.

[0074] A pharmaceutical composition may be in the form of a tablet or capsule that has: (a) the acid inhibitor; and/or (b) a buffering agent; and (c) the non-steroidal anti-inflammatory drug (NSAID) present in an amount effective to reduce or eliminate pain or inflammation in a patient upon administration of one or more of said unit dosage forms. The components of the pharmaceutical composition may be in an immediate or extended release form individually or in total.

[0075] The term "unit dosage form" as used herein refers to a single entity for drug administration. For example, a single tablet or capsule combining both an acid inhibitor and an NSAID would be a unit dosage form. A "unit dosage form" (or "unit dose form") may also be referred to as a "fixed dosage form" (or "fixed dose form") or "fixed dosage combination" (or "fixed dose combination") and are otherwise interchangeable. In one embodiment, the unit dosage form is a multilayer tablet.

[0076] In another embodiment, the unit dosage form is suitable for oral administration to a patient. In yet another embodiment, the unit dosage form is a tablet. In still another embodiment, the unit dosage form is a multilayer tablet comprising a single core and one or more layers outside of the core. In some embodiments, the pharmaceutical composition may have an effective amount of meloxicam, a cyclodextrin, and a carbonate or bicarbonate to increase bioavailability of meloxicam. In other embodiments, the pharmaceutical composition may have an effective amount of meloxicam, sulfobutylether-β-cyclodextrin (SBEβCD), and sodium bicarbonate to increase bioavailability of meloxicam or reduce the T_{max} of meloxicam.

[0077] Some oral dosage forms may have enteric coatings or film coatings. In some embodiments, a dosage form may comprise a tablet or a capsule having an enteric coating. In some embodiments, a dosage form may comprise a tablet or a capsule having a film coating.

[0078] An embodiment of the present disclosure is directed to a pharmaceutical composition in unit dosage form suitable for administration to a patient, comprising:

(a) esomeprazole, which may or may not be surrounded by an enteric coating;

(b) sodium or potassium bicarbonate and/or sodium or potassium carbonate; and

(c) meloxicam, which may or may not be formulated with a cyclodextrin, and which may or may not be surrounded by an enteric coating

[0079] In certain embodiments, the pharmaceutical composition results in faster release or dissolution of the meloxicam from the dosage form as compared to a dosage form containing meloxicam but not containing the acid inhibitor, or not containing the buffering agent.

[0080] The following embodiments are contemplated:

Embodiment 1. An inclusion complex of meloxicam in a cyclodextrin.

Embodiment 2. A dosage form comprising: 1) the inclusion complex of embodiment 1, or 2) meloxicam and a carbonate or a bicarbonate.

Embodiment 3. The dosage form of embodiment 2 comprising the inclusion complex, wherein the cyclodextrin comprises substituted β-cyclodextrin.

Embodiment 4. The dosage form of embodiment 3, wherein the substituted β-cyclodextrin is a sulfobutyl ether β-cyclodextrin (SBEβCD) or hydroxypropyl β-cyclodextrin (HPBCD).

Embodiment 5. The dosage form of embodiment 4, wherein the cyclodextrin is the SBEβCD.

Embodiment 6. The dosage form of embodiment 5, wherein the SBEβCD has about 6 to about 7 sulfobutyl ether groups for each molecule of β-cyclodextrin.

Embodiment 7. The dosage form of embodiment 6, wherein the meloxicam and the SBEβCD have a molar ratio of about 0.8 to about 1.2.

Embodiment 8. The dosage form of embodiment 6, wherein the meloxicam and the SBEβCD have a molar ratio of about 1.

Embodiment 9. The dosage form of embodiment 2, 3, 4, 5, 6, 7, or 8, comprising a bicarbonate.

Embodiment 10. The dosage form of embodiment 9, wherein the bicarbonate comprises sodium bicarbonate.

Embodiment 11. The dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, or 10, which is an oral dosage form.

Embodiment 12. The dosage form of embodiment 2, 3, 4, 5, 6, 9, 10, or 11, wherein about 50 mg to about 200 mg of SBEβCD is present in the dosage form.

Embodiment 13. The dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, or 12, wherein the carbonate or bicarbonate is present in an amount in a range of about 400 mg to about 600 mg.

Embodiment 14. The dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, or 13, wherein the T_{max} of meloxicam is decreased as compared to a dosage form not having a carbonate, a bicarbonate, or a cyclodextrin.

Embodiment 15. The method of embodiment 14, wherein the T_{max} of meloxicam is achieved in the patient at a time in a range of about 10 minutes to about 180 minutes after administration.

Embodiment 16. The dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, or 15, having an oral bioavailability of meloxicam that is higher than a dosage form not having a carbonate, a bicarbonate, or a cyclodextrin.

Embodiment 17. The dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20, further comprising an acid inhibitor.

Embodiment 18. The dosage form of embodiment 17, wherein the acid inhibitor is a proton pump inhibitor.

Embodiment 19. The dosage form of embodiment 18, wherein the proton pump inhibitor is esomeprazole.

Embodiment 20. The dosage form of embodiment 19, wherein about 30 mg to about 50 mg of esomeprazole is present in the dosage form.

Embodiment 21. A method of administering meloxicam orally, comprising orally administering a dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, or 20 to a patient in need of treatment.

Embodiment 22. The method of embodiment 21, wherein the dosage form is administered to treat pain.

Embodiment 23. The method of embodiment 21, wherein the dosage form is administered to treat inflammatory pain.

Embodiment 24. The method of embodiment 21, wherein the dosage form is administered to treat osteoarthritis, rheumatoid arthritis, or juvenile rheumatoid arthritis.

Embodiment 25. A method of administering meloxicam intravenously, comprising intravenously administering a dosage form of embodiment 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 13, 14, or 15, to a patient in need of treatment.

Example 1

[0081] The effect of varying amounts of potassium carbonate (K_2CO_3) and sodium bicarbonate ($NaHCO_3$) on the pH of acidic media was tested. The acidic media was chosen to simulate gastric conditions. K_2CO_3 or $NaHCO_3$ was added to 50 mL of a 0.01 N HCl solution (pH 2). The pH of the solution was measured after addition of the K_2CO_3 or NaHCO3. Deionized water (240 mL) was then added to the mixture and pH was measured again. The results are shown in Tables 1-4.

Table 1. Results with K_2CO_3 (0.01 N HCl)

K_2CO_3 (mg)	pH
25	2.84
35	6.29
45	8.05
50	8.29
100	9.43
200	10.14
300	10.39
400	10.55
450	10.58

Table 2. Results with K_2CO_3 (0.01 N HCl + Water)

K_2CO_3 (mg)	pH
200	10.27
300	10.46
400	10.57
450	10.63

Table 3. Results with $NaHCO_3$ (0.01 N HCl)

$NaHCO_3$ (mg)	pH
200	5.28
300	5.90
400	6.44
450	6.86
500	8.23
750	8.30
1000	8.36

Table 4. Results with $NaHCO_3$ (0.01 N HCl + Water)

$NaHCO_3$ (mg)	pH
200	5.41
300	5.89
400	6.11
450	6.46
500	8.33
750	8.54
1000	8.60

Example 2

[0082] Tablets containing meloxicam and combinations of cyclodextrin, K_2CO3, or $NaHCO_3$ were manufactured and tested for dissolution. Tablets containing meloxicam alone (MOBIC®) were purchased and also tested for dissolution. The tested tablets are listed in Table 5. Meloxicam in the form of meloxicam/cyclodextrin inclusion complexes was used in the tablets containing meloxicam and cyclodextrin. The inclusion complexes were formed by mixing meloxicam and cyclodextrin in an aqueous pH-adjusted solution. The pH of the solution was adjusted using buffering agents. The resulting soluble meloxicam/cyclodextrin inclusion complexes were then spray dried. This spray-dried dispersion was used in the manufacture of the tablets containing cyclodextrin.

Table 5. Tablets

Tablet A	15 mg meloxicam + 25 mg K_2CO3
Tablet B	15 mg meloxicam + 50 mg K_2CO3
Tablet C	15 mg meloxicam + 100 mg K_2CO3
Tablet D	15 mg meloxicam + 150 mg K_2CO3
Tablet E	15 mg meloxicam + 500 mg NaHCO3
Tablet F	15 mg meloxicam + cyclodextrin
Tablet G	15 mg meloxicam + cyclodextrin + 25 mg K_2CO3

Tablet H	15 mg meloxicam + cyclodextrin + 50 mg K_2CO3
Tablet I	15 mg meloxicam + cyclodextrin + 100 mg K_2CO3
Tablet J	15 mg meloxicam + cyclodextrin + 150 mg K_2CO3
Tablet K	15 mg meloxicam + cyclodextrin + 500 mg NaHCO3
Tablet L	15 mg meloxicam (MOBIC®)

[0083] Dissolution testing in acidic medium (chosen to simulate gastric conditions) was performed by placing the tablets in a 0.01 N HCl solution, at an agitation rate of 75 RPM, and vessel temperature of approximately 37 °C. The results are presented in Tables 6 and in Figures 1-10. Results at various time points (0, 15, 30, 45, 60, 90, and 120 minutes) are presented as percent (%) of meloxicam dissolved.

Table 6. Dissolution Results

	0 mins	15 mins	30 mins	45 mins	60 mins	90 mins	120 mins
Tablet A	0%	23%	17%	15%	13%	12%	11%
Tablet B	0%	27%	20%	17%	16%	17%	15%
Tablet C	0%	31%	26%	25%	24%	23%	21%
Tablet D	0%	30%	26%	25%	24%	23%	22%
Tablet E	0%	50%	66%	77%	84%	92%	95%
Tablet F	0%	26%	17%	14%	12%	11%	10%
Tablet G	0%	48%	39%	26%	20%	16%	14%
Tablet H	0%	44%	30%	22%	17%	16%	13%
Tablet I	0%	32%	33%	27%	21%	16%	15%
Tablet J	0%	26%	27%	19%	15%	12%	11%
Tablet K	0%	85%	86%	86%	86%	86%	86%
Tablet L	0%	2%	2%	2%	2%	2%	2%

[0084] Dissolution of meloxicam was greater with the tablets containing various combinations of meloxicam and cyclodextrin, K_2CO3, or $NaHCO_3$, as compared to tablets containing meloxicam alone. For example, after 120 minutes, dissolution of meloxicam tablets containing $NaHCO_3$ was 95% as compared to 2% for tablets containing meloxicam alone.

[0085] Dissolution of meloxicam increasing with increasing amounts of K_2CO_3 in the absence of cyclodextrin. However, in the presence of cyclodextrin, increasing amounts of K_2CO_3 did not appear to increase meloxicam dissolution. At the highest dose of potassium bicarbonate tested, meloxicam dissolution in the presence of cyclodextrin was reduced by approximately 50% as compared to meloxicam dissolution in the absence of cyclodextrin at 120 minutes.

[0086] Dissolution of meloxicam with $NaHCO_3$ was significantly greater than that observed with the highest dose of K_2CO_3 at 15 minutes (50% versus 30%), and at 120 minutes (92% versus 23%). Meloxicam dissolution in the presence of cyclodextrin was also significantly greater with $NaHCO_3$ as compared to the highest dose of K_2CO_3 at 15 minutes (85% versus 26%), and at 120 minutes (86% versus 12%). $NaHCO_3$ in the presence of cyclodextrin increased meloxicam dissolution at 15 minutes as compared to potassium bicarbonate which resulted in a reduction in dissolution.

[0087] Unless otherwise indicated, all numbers expressing quantities of ingredients, properties such as molecular weight, reaction conditions, and so forth used in the specification and claims are to be understood in all instances as indicating both the exact values as shown and as being modified by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the specification and attached claims are approximations that may vary depending upon the desired properties sought to be obtained. At the very least, and not as an attempt to limit the application of the doctrine of equivalents to the scope of the claims, each numerical parameter should at least be construed in light of the number of reported significant digits and by applying ordinary rounding techniques.

[0088] The terms "a," "an," "the" and similar referents used in the context of describing the invention (especially in the context of the following claims) are to be construed to cover both the singular and the plural, unless otherwise indicated herein or clearly contradicted by context. All methods described herein can be performed in any suitable order unless otherwise indicated herein or otherwise clearly contradicted by context. The use of any and all examples, or exemplary language (e.g., "such as") provided herein is intended merely to better illuminate the invention and does not pose a limitation on the scope of any claim. No language in the specification should be construed as indicating any non-claimed element essential to the practice of the invention.

[0089] Groupings of alternative elements or embodiments disclosed herein are not to be construed as limitations. Each group member may be referred to and claimed individually or in any combination with other members of the group or other elements found herein. It is anticipated that one or more members of a group may be included in, or deleted from, a group for reasons of convenience and/or patentability. When any such inclusion or deletion occurs, the specification is deemed to contain the group as modified thus fulfilling the written description of all Markush groups used in the appended claims.

[0090] Certain embodiments are described herein, including the best mode known to the inventors for carrying out the invention. Of course, variations on these described

embodiments will become apparent to those of ordinary skill in the art upon reading the foregoing description. The inventor expects skilled artisans to employ such variations as appropriate, and the inventors intend for the invention to be practiced otherwise than specifically described herein. Accordingly, the claims include all modifications and equivalents of the subject matter recited in the claims as permitted by applicable law. Moreover, any combination of the above-described elements in all possible variations thereof is contemplated unless otherwise indicated herein or otherwise clearly contradicted by context.

[0091] In closing, it is to be understood that the embodiments disclosed herein are illustrative of the principles of the claims. Other modifications that may be employed are within the scope of the claims. Thus, by way of example, but not of limitation, alternative embodiments may be utilized in accordance with the teachings herein. Accordingly, the claims are not limited to embodiments precisely as shown and described.

CLAIMS:

1. Use of a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for improving dissolution of meloxicam in simulated gastric fluid as compared with a first reference pharmaceutical composition that: 1) contains the same amount of meloxicam; 2) does not contain the bicarbonate; and 3) does not contain a carbonate, wherein the solid pharmaceutical composition comprises about 1 mg to about 50 mg of meloxicam and about 400 mg to about 1000 mg of the bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

2. Use of a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for improving dissolution of meloxicam in simulated gastric fluid as compared with a second reference pharmaceutical composition that: 1) contains the same amount of meloxicam; 2) contains an amount of a carbonate that achieves about the same pH as the bicarbonate; and 3) does not contain the bicarbonate, wherein the solid pharmaceutical composition comprises about 1 mg to about 50 mg of meloxicam and about 400 mg to about 1000 mg of the bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

3. Use of a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for improving oral bioavailability of meloxicam in a mammal as compared with a first reference pharmaceutical composition that: 1) contains the same amount of meloxicam; 2) does not contain the bicarbonate; and 3) does not contain a carbonate, wherein the solid pharmaceutical composition comprises about 1 mg to about 50 mg of meloxicam and about 400 mg to about 1000 mg of the bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

4. Use according to claim 1, 2, or 3, wherein the pharmaceutical composition further comprises an acid inhibitor.

5. Use according to claim 4, wherein the acid inhibitor is esomeprazole.

6. Use according to claim 1, 2, 3, 4, or 5, wherein the medicament is in a tablet form.

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7. Use according to claim 1, 2, 3, 4, 5, or 6, wherein the pharmaceutical composition comprises about 10 mg to about 50 mg of meloxicam.

8. Use according to claim 7, wherein the pharmaceutical composition comprises about 15 mg of meloxicam.

9. Use according to claim 1, 2, 3, 4, 5, 6, 7, or 8, wherein the bicarbonate is sodium bicarbonate.

10. Use according to claim 9, wherein the sodium bicarbonate is present in an amount of about 500 mg to about 1000 mg.

11. Use according to claim 10, wherein the sodium bicarbonate is present in an amount of about 500 mg.

12. Use according to claim 1, 2, 3, 4, 5, 6, 7, or 8, wherein the bicarbonate is potassium bicarbonate.

13. Use according to claim 2, wherein the carbonate in the second reference pharmaceutical composition is potassium carbonate.

14. Use according to claim 13, wherein the potassium carbonate is present in an amount of about 100 mg to about 150 mg.

15. Use according to claim 14, wherein the potassium carbonate is present in an amount of about 150 mg.

16. Use according to claim 5, wherein about 30 mg to about 50 mg of esomeprazole is present in the dosage form.

17. Use according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 70%.

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18. Use according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 80%.

19. Use according to claim 1 or 3, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 5 times that of the first reference pharmaceutical composition.

20. Use according to claim 1 or 3, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 30 times that of the first reference pharmaceutical composition.

21. Use according to claim 2, 13, 14, or 15, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 3 times that of the second reference pharmaceutical composition.

22. Use according to claim 2, 13, 14, or 15, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 4 times that of the second reference pharmaceutical composition.

23. Use according to claim 2, 13, 14, or 15, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 7 times that of the second reference pharmaceutical composition.

24. Use according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 40%.

25. Use according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 50%.

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26. Use according to claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, or 16, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 70%.

27. Use according to claim 1 or 3, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 2 times that of the first reference pharmaceutical composition.

28. Use according to claim 1 or 3, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 3 times that of the first reference pharmaceutical composition.

29. Use according to claim 1 or 3, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 10 times that of the first reference pharmaceutical composition.

30. Use according to claim 1 or 3, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 20 times that of the first reference pharmaceutical composition.

31. Use according to claim 2, 13, 14, or 15, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 10% more than the second reference pharmaceutical composition.

32. Use according to claim 2, 13, 14, or 15, wherein, 15 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 2 times that of the second reference pharmaceutical composition.

33. Use according to claim 1, 2, or 3, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 7 times that of the first reference pharmaceutical composition or the second reference pharmaceutical composition.

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34. Use according to claim 1, 2 or 3, wherein, 120 minutes after administration of the pharmaceutical composition, the dissolution of meloxicam is at least 3 times that of the first reference pharmaceutical composition or the second reference pharmaceutical composition.

35. Use according to any one of the claims 1-34, the oral bioavailability of meloxicam in the pharmaceutical composition is improved at least by 10%.

36. Use according to any one of the claims 1-34, the oral bioavailability of meloxicam in the pharmaceutical composition is improved at least by 30%.

37. Use according to any one of the claims 1-34, the oral bioavailability of meloxicam in the pharmaceutical composition is improved at least by 50%.

38. Use according to any one of the claims 1-34, the oral bioavailability of meloxicam in the pharmaceutical composition is improved by about 100%.

39. Use according to any one of the claims 1-34, the oral bioavailability of meloxicam in the pharmaceutical composition is improved by about 200%.

40. Use according to any one of claims 1-39, wherein the medicament is formulated for administration to the mammal to treat pain.

41. Use according to claim 40, wherein the pain is inflammatory pain.

42. Use according to any one of claims 1-41, wherein the medicament is formulated for administration to the mammal to treat osteoarthritis, rheumatoid arthritis, or juvenile rheumatoid arthritis.

43. Use of a bicarbonate in a solid pharmaceutical composition comprising meloxicam in the manufacture of a medicament for treating pain, wherein the solid pharmaceutical composition comprises about 1 mg to about 50 mg of meloxicam and about 400 mg to about 1000 mg of a bicarbonate, and wherein the medicament is formulated for oral administration to a mammal.

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44. Use of claim 43, wherein the pain is acute pain.

45. Use of claim 43 or 44, wherein the pain is localized pain.

46. Use of claim 43, 44, or 45, wherein the composition comprises about 20 mg of meloxicam.

47. Use of any one of claims 43-46, wherein the composition comprises about 500 mg of the bicarbonate.

48. Use of any one of claims 43-47, wherein the bicarbonate is sodium bicarbonate.

49. Use of any one of claims 43-48, wherein a T_{max} of meloxicam is less than 60 minutes when the solid pharmaceutical composition is formulated for oral administration to the mammal, and wherein the mammal is a human being.

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FIG. 1

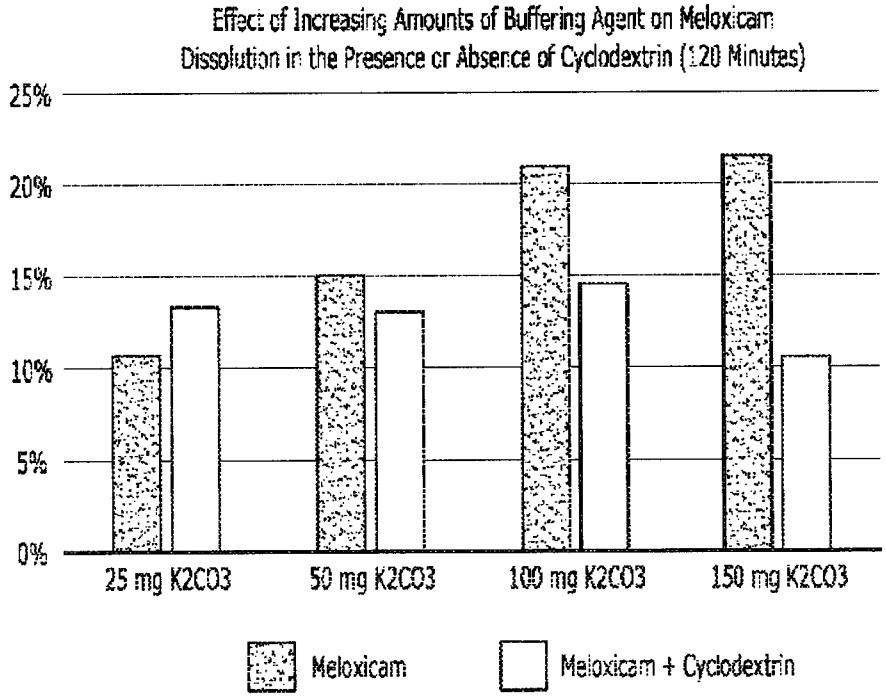

Effect of Increasing Amounts of Buffering Agent on Meloxicam
Dissolution in the Presence or Absence of Cyclodextrin (120 Minutes)
25%
20%
15%
10%
5%
0%
25 mg K2CO3
50 mg K2CO3
100 mg K2CO3
150 mg K2CO3
Meloxicam
Meloxicam + Cyclodextrin

FIG. 2

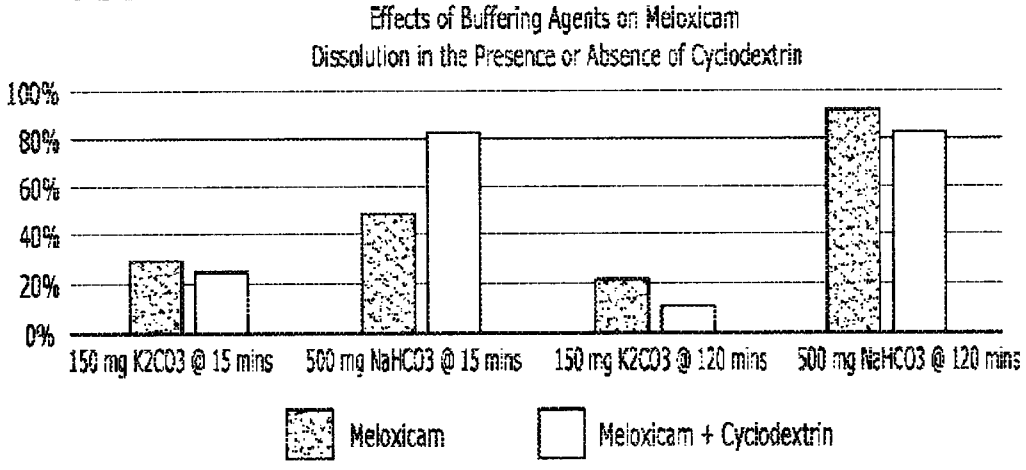

Effects of Buffering Agents on Meloxicam
Dissolution in the Presence or Absence of Cyclodextrin
100%
80%
60%
40%
20%
0%
150 mg K2CO3 @ 15 mins
500 mg NaHCO3 @ 15 mins
150 mg K2CO3 @ 120 mins
500 mg NaHCO3 @ 120 mins
Meloxicam
Meloxicam + Cyclodextrin

FIG. 3

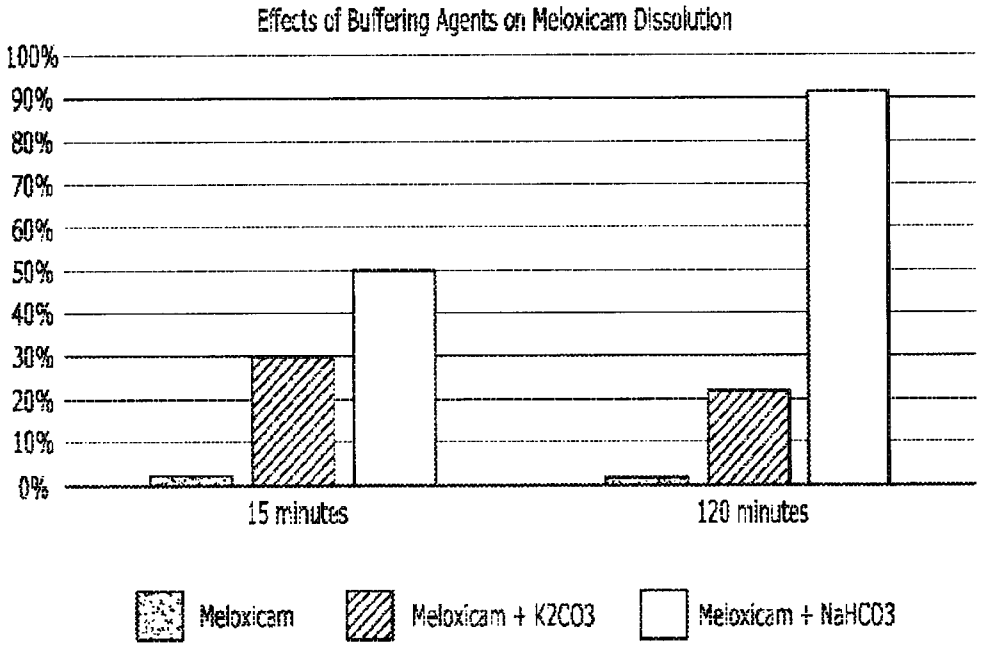

Effects of Buffering Agents on Meloxicam Dissolution
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15 minutes
120 minutes
Meloxicam
Meloxicam + K2CO3
Meloxicam + NaHCO3

FIG. 4

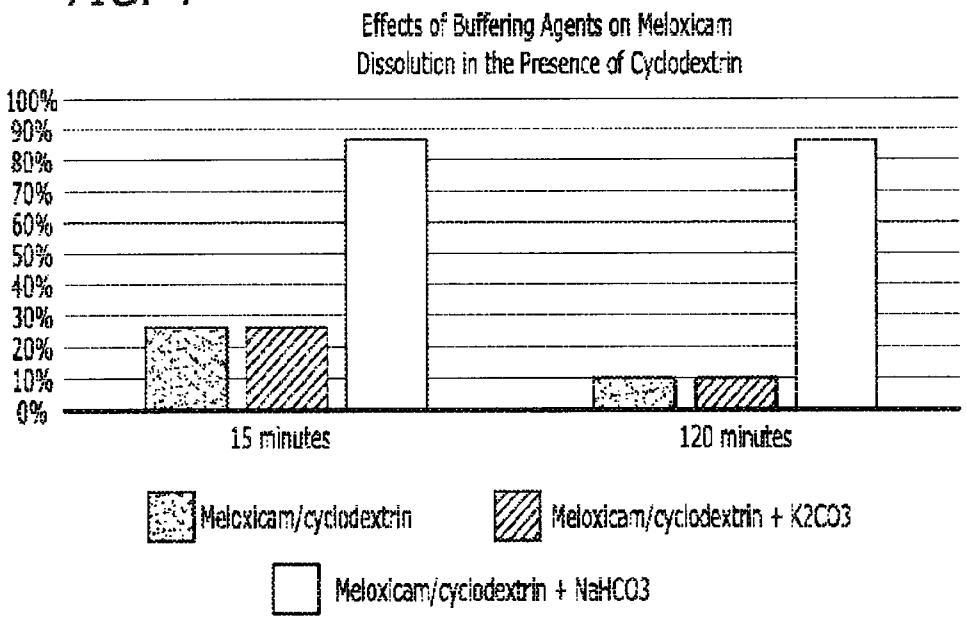

Effects of Buffering Agents on Meloxicam Dissolution in the Presence of Cyclodextrin
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
15 minutes
120 minutes
Meloxicam/cyclodextrin
Meloxicam/cyclodextrin + K2CO3
Meloxicam/cyclodextrin + NaHCO3

FIG. 5

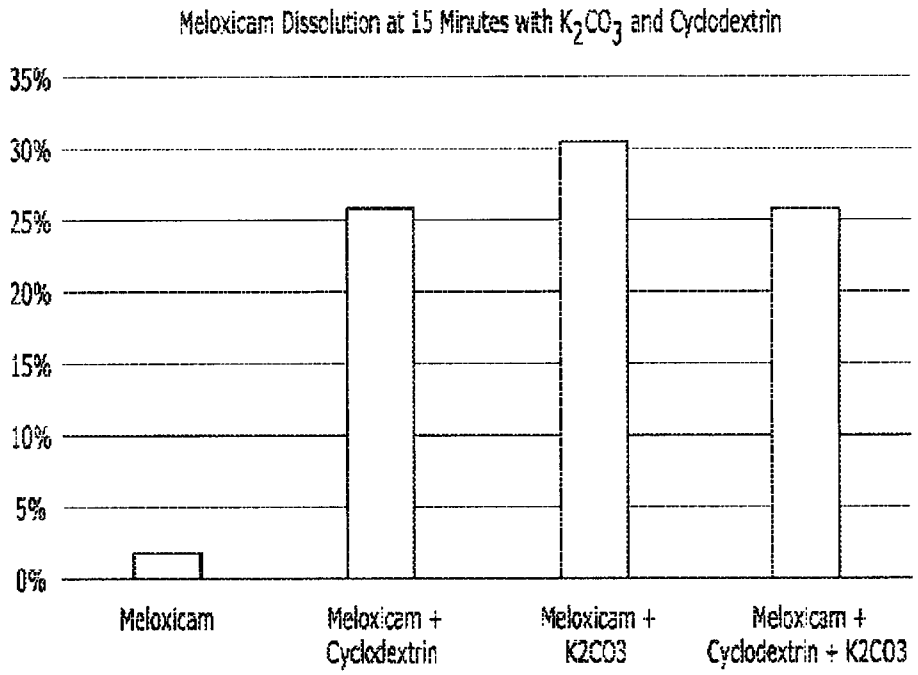

Meloxicam Dissolution at 15 Minutes with K_2CO_3 and Cyclodextrin
35%
30%
25%
20%
15%
10%
5%
0%
Meloxicam
Meloxicam + Cyclodextrin
Meloxicam + K2CO3
Meloxicam + Cyclodextrin + K2CO3

FIG. 6

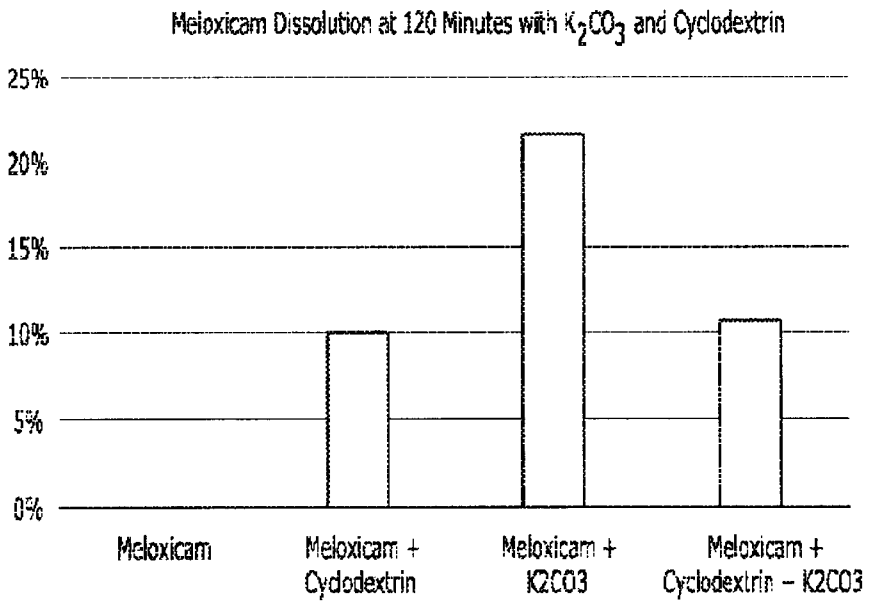

Meloxicam Dissolution at 120 Minutes with K_2CO_3 and Cyclodextrin
25%
20%
15%
10%
5%
0%
Meloxicam
Meloxicam + Cyclodextrin
Meloxicam + K2CO3
Meloxicam + Cyclodextrin – K2CO3

FIG. 7

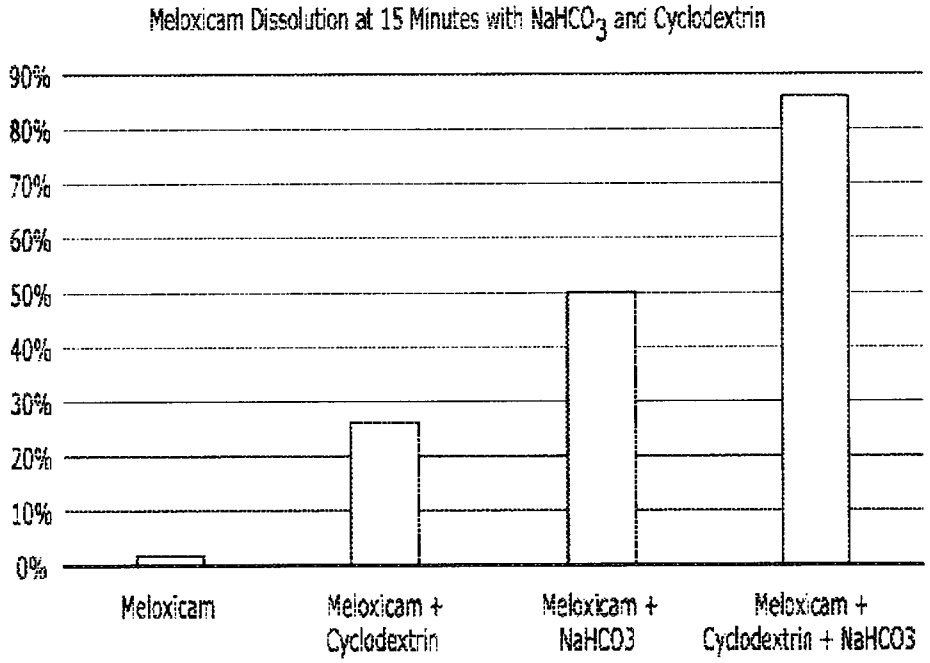

Meloxicam Dissolution at 15 Minutes with NaHCO3 and Cyclodextrin
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Meloxicam
Meloxicam + Cyclodextrin
Meloxicam + NaHCO3
Meloxicam + Cyclodextrin + NaHCO3

FIG. 8

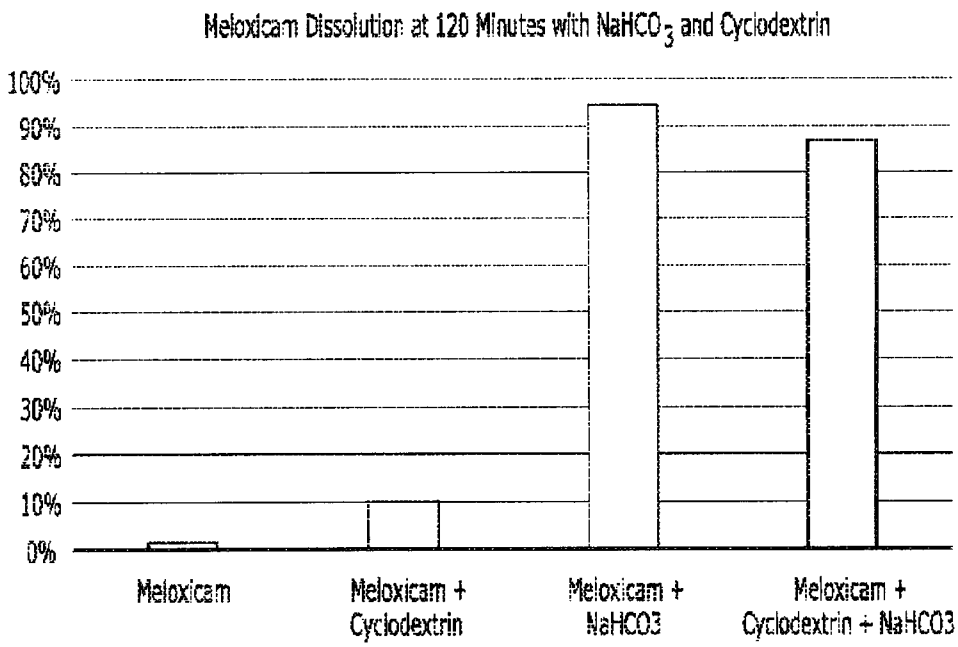

Meloxicam Dissolution at 120 Minutes with NaHCO3 and Cyclodextrin
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Meloxicam
Meloxicam + Cyclodextrin
Meloxicam + NaHCO3
Meloxicam + Cyclodextrin + NaHCO3

FIG. 9

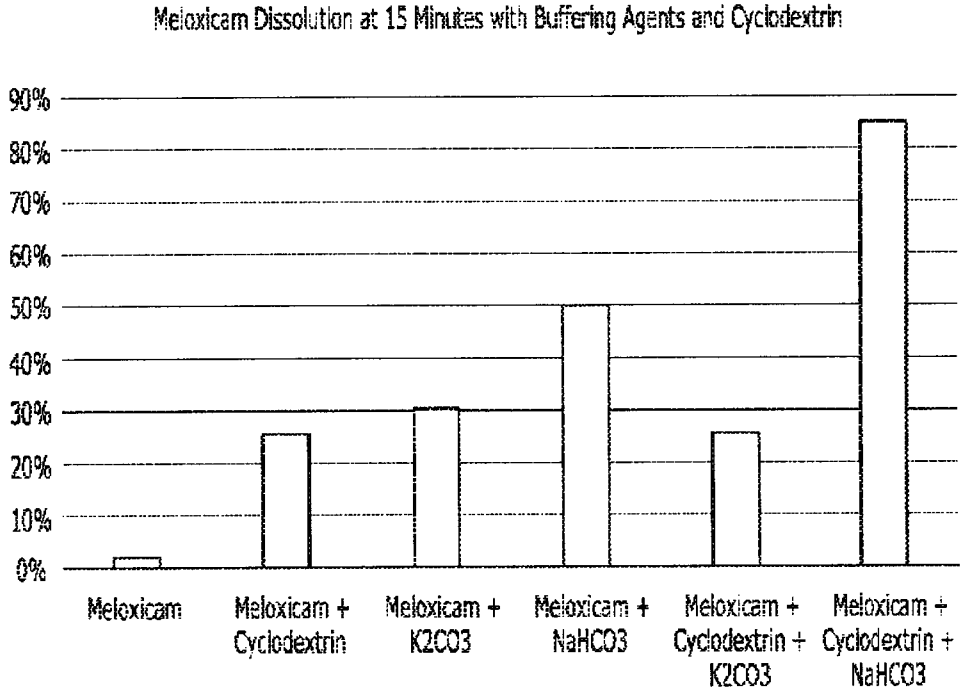
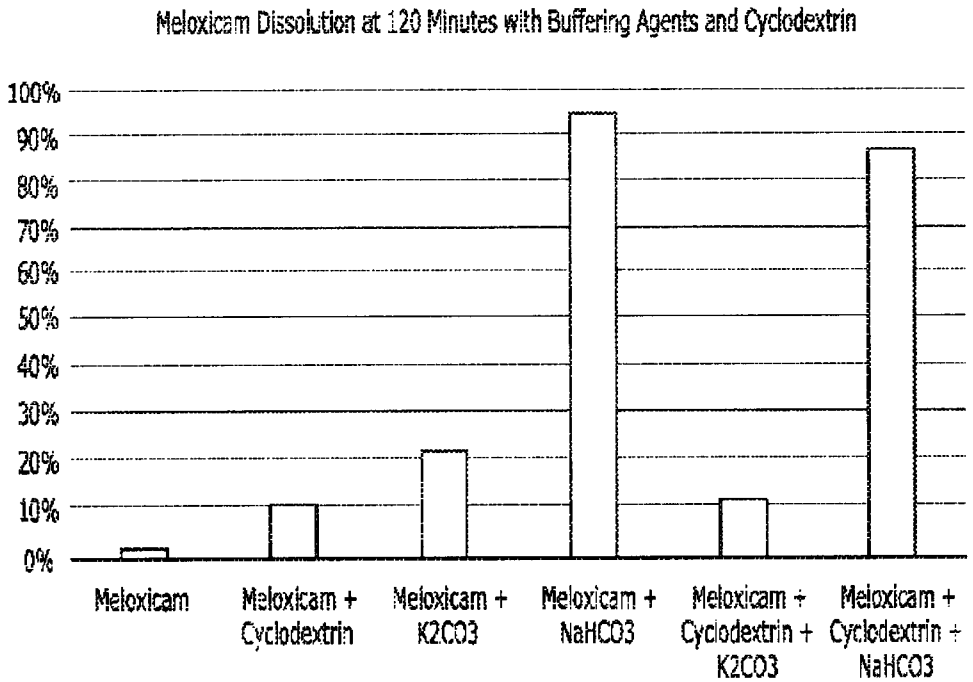

Meloxicam Dissolution at 15 Minutes with Buffering Agents and Cyclodextrin
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Meloxicam
Meloxicam + Cyclodextrin
Meloxicam + K2CO3
Meloxicam + NaHCO3
Meloxicam + Cyclodextrin + K2CO3
Meloxicam + Cyclodextrin + NaHCO3

FIG. 10


Meloxicam Dissolution at 120 Minutes with Buffering Agents and Cyclodextrin
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Meloxicam
Meloxicam + Cyclodextrin
Meloxicam + K2CO3
Meloxicam + NaHCO3
Meloxicam + Cyclodextrin + K2CO3
Meloxicam + Cyclodextrin + NaHCO3