**Title:** REDUCTION OF BLACK BONE DEFECTS IN MEAT

**Abstract:** The invention is directed to a process to reduce blackbone occurrence in meat. The invention is further directed to reducing blackbone discoloration in meat while maintaining higher yields and without negatively affecting the appearance of the meat. The processing steps include treating the meat, preferably by injection, with an alkaline phosphate solution; and after treating the meat with the alkaline phosphate solution, contacting the meat, preferably by dipping or spraying the meat, with hexametaphosphate in an amount effective to reduce blackbone in the meat.
Reduction of Black Bone Defects in Meat

Field of the Invention

This invention relates generally to an improved process for treating and packaging fresh meat, and more particularly, to methods for chemically treating meat and packaging/storing meat to reduce blackening of the bones in the meat. The invention also relates to maintaining the meat in an unspoiled, fresh appearing condition while reducing the occurrence of black bone discoloration in the meat over an extended period of time.

Background of the Invention

The treatment and packaging of fresh meat has been a subject of research and development for several years. A variety of fresh meat treatment chemicals, packaging atmospheres and packaging materials are known. Treatment chemicals have included sugar, salts, curing compounds, organic acids, isoascorbate, and the like. Packaging atmospheres generally contain varying proportions of inert gases such as carbon dioxide, nitrogen, red pigment forming gases (such as oxygen and carbon monoxide), and other gases. Many of these packaging atmospheres have been studied in conjunction with various treatment systems.

Exposure to air or oxygen over prolonged periods results in oxidation of the meat and the formation of metmyoglobin and methemoglobin, which are brown or grey in color and which detract from the appearance and sale-ability of the meat. Accordingly, many patents and articles suggest the use of polyphosphates in preserving meat and fish products to help maintain color and freshness. In red meat, for example, after the meat is processed by removing the hide and cooling,
the meat, is cut into larger cuts for processing into cured or uncured (fresh meat). Cured meats are typically injected with a solution of polyphosphate, salt, and sodium nitrite, whereas fresh meat processed is typically injected with a solution of polyphosphate and salt. For example, case-ready meat is generally prepackaged in a modified atmosphere (MAP) to help maintain color and freshness, pre-weighed, and then enhanced up to about 25% with a solution of salt, alkaline phosphate, and seasonings to retain moisture.

“Case-ready meat” is a term which generally refers to meat which is prepared and packaged at a meat processing plant such that it is ready for immediate retail display and sale upon arrival at a store, where an optional barrier film layer may be removed to allow the red meat to “bloom” to a desired bright red color. An “Enhanced” case-ready meat refers to products wherein marinades or special processing “enhances” the meat. Enhanced case-ready meats are typically injected with a water, phosphate, and salt solution or marinade. The marinade generally improves flavor and sometimes yield, but can adversely affect meat appearance. For example, the alkaline phosphate generally used in the marinade to achieve higher yield and avoid storage losses can adversely affect the appearance of the meat.

Furthermore, case ready-meats are typically sold in modified atmosphere packaging, also referred to as "gas flushed" packaging, wherein various combinations of gases, such as oxygen, nitrogen and/or carbon dioxide are flushed into the package. Gas flush packaging uses oxygen in combination with carbon dioxide and/or nitrogen, which causes beef products to become the desired bright red color preferred by consumers. However, the presence of a high concentration of oxygen can cause rapid bone discoloration or blackening. Blackening of the bones is often referred to as "blackbone". Accordingly, black or discolored bones are not ideal because consumers associate bright white bones with freshness.
There exists a need in the art for an improved process for treating meat that achieves high yield and good appearance in both the meat and bones of modified atmosphere packaged case-ready meats particularly, throughout the shelf life.

Summary of the Invention

The present invention is directed to a composition and process for treating meat to maintain higher yields without negatively affecting the appearance of the meat, and in particular, to reduce black bone discoloration in modified atmosphere packaged meat. The process comprises contacting the meat, particularly the bone, preferably by dipping or spraying, with hexametaphosphate in an amount of hexametaphosphate effective for providing at least about 0.5% hexametaphosphate concentration on the surface of the bone. In a preferred embodiment the amount of hexametaphosphate concentration on the surface of the bone is from about 0.5% to about 10%. In a more preferred embodiment the amount of hexametaphosphate concentration on the surface of the bone is about 4%. The meat is then preferably stored in a modified atmosphere of greater than about 75% oxygen.

The present invention is also directed to a process to maintain higher yields without negatively affecting the appearance of the meat, and in particular, to reduce blackbone occurrence in modified atmosphere packaged meat. The process comprises the steps of 1) treating the meat, preferably by injection, with an alkaline phosphate solution; and 2) after treating the meat with the alkaline phosphate solution, contacting the meat, preferably by dipping or spraying the meat, with hexametaphosphate in an amount effective to reduce blackbone in the meat. An effective amount of hexametaphosphate for reducing blackbone is preferably at least about 0.5% hexametaphosphate concentration on the surface of the bone, and more preferably from about 0.5% to about 10% hexametaphosphate concentration on the surface of the bone, and
even more preferably about 4% hexametaphosphate concentration on the
surface of the bone. By treating the meat with an alkali phosphate
solution then treating the bone with a hexametaphosphate solution, a high
yield is achieved and blackbone occurrence is reduced.

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Detailed Description of Invention and Preferred Embodiments

As used herein, an amount of hexametaphosphate that is "effective
to reduce blackbone" means an amount of hexametaphosphate that
provides improved blackbone reduction in the bones of meat, as
measured by, for example, by visual evaluation or other color
measurements, as compared to directly analogous bones in meat that
have not been treated with hexametaphosphate.

It has been discovered, in accordance with the invention, that
treating meat, particularly, the bone in the meat, by contacting the bone
with hexametaphosphate (HMP) in amount of at least 0.5% HMP
concentration on the bone surface, provides a reduction in the occurrence
of blackbone in meat in comparison to meats that have not been treated
with hexametaphosphate.

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It has also been discovered, in accordance with the invention, that
by treating the meat with alkaline phosphate and also treating the bone in
the meat with hexametaphosphate in an amount of at least 0.5% HMP
concentration on the bone surface, achieves high yield while reducing the
occurrence of blackbone.

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In an embodiment of the invention, the meat is treated with
hexametaphosphate in amount effective to reduce the occurrence of
blackening of the bones in the meat, i.e., blackbone. Particularly, the
bones of the meat are contacted with a sufficient amount of HMP effective
to reduce blackbone in the meat. Any suitable amounts of HMP effective
to reduce blackbone in meat may be used. In a preferred embodiment,
HMP is present in an amount sufficient to provide at least about 0.5% w/w
HMP, more preferably from greater than about 0.5% w/w to about 10%
w/w HMP, and still more preferably about 4% w/w HMP concentration on
the surface of the bones of the meat. Any suitable hexametaphosphate
may be used. Suitable hexametaphosphates include potassium
hexametaphosphate (PHMP) and more preferably sodium
hexametaphosphate (SHMP). Various chain lengths of HMP maybe
used. For example, chain lengths of four (4) or more are preferred.
Combinations of polyphosphates and SHMP may also be used, so long
as the majority of the combination is SHMP.

The meat may be contacted with the HMP by any suitable means
for allowing the HMP to contact the bones of the meat. For example, the
meat may be contacted with the HMP either by tumbling, dipping, injection
or spraying. Dipping or spraying of an HMP solution may be preferred in
cases where it is more efficient time wise to do so. In any case, any
suitable contacting mechanism by which rapid contacting is employed is
more preferred. The meat should be contacted with the HMP solution for
a period of time sufficient to coat the bones of the meat. For example,
where the bones of the meat are exposed via cutting, the meat should be
contacted in a manner such that the HMP may contact all contactable
exposed surfaces of the bone. At atmospheric pressure, in a dip tank,
dwell times from about 1 second to about 30 minutes are effective, with a
dipping time of about 1 minute or less being preferred, and a dipping time
of about at least 2 seconds being more preferred. Dwell times using a
spray may range from about several seconds to about several minutes or
about 2 seconds to about 15 minutes with spray times of less than 30
seconds being preferred. Dwell times using tumbling may range from
about 30 seconds to several hours, with a dwell time of about less than 1
minute being preferred.

The composition of the HMP solution is preferably at least about
0.5% HMP and no more than about 99.5% water. A more preferable
HMP solution comprises from about 0.5% to about 15% HMP and from
about 85% to about 99.5% water. An even more preferable HMP solution
may comprise about 4% HMP and about 96% water.
In another embodiment of the preset invention meat is also treated with alkaline phosphate along with the hexametaphosphate treatment in order to increase yield while maintaining the meat in an unspoiled fresh appearing condition while effectively reducing backbone occurrence.

Any suitable alkaline phosphate or combination of alkaline phosphates may be used. Suitable alkaline phosphates include, but are not limited to, tetrasodium pyrophosphate (TSPP), tetrapotassium pyrophosphate (TKPP), sodium tripolyphosphate (STPP), or combinations thereof. The alkaline phosphate component may also include combinations of non-alkaline phosphates, for example, sodium hexametaphosphate (SHMP), sodium acid pyrophosphate (SAPP) or trisodium pyrophosphate (3SP), with one or more of the other preferred alkaline phosphates described above. For example, a suitable alkaline phosphate combination may include one of the following blends:

- STPP and SHMP
- STPP and SAPP
- SAPP and TKPP
- TSPP and TKPP

The alkaline phosphate may be in the form of an alkaline phosphate solution. The alkaline phosphate solution preferably comprises an alkaline phosphate (as described above), water, and salt. The alkaline phosphate solution is generally from about 1% to about 10% alkaline phosphate, from about 70% to about 95% water, and from about 1% to about 5% salt.

The meat may be treated or contacted with the alkaline phosphate in any suitable manner, including tumble or massage marinating or direct injection, with injection being preferred. Injection is preferred, because the injected phosphate contacts the protein more uniformly than other methods thereby resulting in improved yield and consistency. No matter which process is used, from about 3% to about 15% alkaline phosphate concentration in the solution is preferred in order to achieve from about 0.2% to about 0.7% alkaline phosphate concentration in the meat, and
more preferably about 0.3% to about 0.5% alkaline phosphate concentration in the meat.

In yet another embodiment, the meat may be treated with alkaline phosphate in a two-process step. For example, a suitable two-step process may comprise the steps of 1) treating the meat, preferably by injection, with a phosphate solution having a higher pH of preferably above pH 6.0; and 2) after treating the meat with the higher pH phosphate solution, contacting the meat, preferably by dipping or spraying the meat, with a lower pH acidic solution of preferably less than about pH 5.6. The second step is believed to achieve a lower surface pH and avoid a darkening of the muscle tissue resulting from higher pH.

Suitable higher pH solutions include a higher pH phosphate, such as for example, tetrasodiumpyrophosphate (TSPP), tetrapotassium pyrophosphate (TKPP), sodium tripolyphosphate (STPP), or combinations thereof. The higher pH solution may also include a combination of alkaline and non-alkaline phosphates. Suitable non-alkaline phosphates include, for example, sodium hexametaphosphate (SHMP), sodium acid pyrophosphate (SAPP) or trisodium pyrophosphate (3SP). For example, a suitable higher pH solution may include the following blends:

- STPP and SHMP
- STPP and SAPP
- SAPP and TKPP
- TSPP and TKPP

The lower pH solution preferably comprises a lower pH phosphate.

A preferred lower pH phosphate includes sodium acid pyrophosphate (SAPP). Preferred lower pH solution compositions include the following:

- 5% SAPP and 95% water
- 5% SAPP; 25% Microgard®; and 70% water
- 5% SAPP; 10% diacetate; and 85% water
- 5% SAPP; 25% Microgard®; 10% diacetate; and 60% water
For simplicity, the process will be described as the meat being treated with HMP after the meat has been treated with an alkaline phosphate. However, it should be understood, that the process may occur in any suitable order. For example, the meat may be treated with HMP first and then treated with alkaline phosphate. Accordingly, in an embodiment of the invention, after the meat is treated with alkaline phosphate, the meat is then treated with HMP. If the meat does not have any exposed surfaces of the bone, the meat may be injected to contact the bone with HMP or the meat may then be cut to expose a surface of the bone, prior to treating with HMP.

As discussed above, the bone is treated with an amount of HMP effective to reduce blackbone occurrence. Any suitable amounts of HMP effective to reduce blackbone in meat may be used. In a preferred embodiment, HMP is present in an amount sufficient to provide at least about 0.5% w/w HMP, more preferably from greater than about 0.5% w/w to about 10% w/w HMP, and still more preferably about 0.4% w/w HMP concentration on the surface of the bones of the meat.

Also as discussed above, any suitable hexametaphosphate may be used. Suitable hexametaphosphates include potassium hexametaphosphate (PHMP) and more preferably sodium hexametaphosphate (SHMP). Various chain lengths of HMP may be used. For example, chain lengths of four or more are preferred. Combinations of polyphosphates and SHMP may also be used, so long as the highest concentration of the combination is SHMP.

The bone may be contacted with the HMP either by tumbling, dipping, spraying, or injection of the meat. Dipping or spraying of an HMP solution may be preferred in cases where it is more efficient time wise to do so. In any case, any suitable contacting mechanism by which rapid contacting is employed is more preferred. The bone should be contacted with the acidic solution for a period of time sufficient to coat the surface of the bones of the meat i.e., such that the HMP may contact all contactable exposed surfaces of the bone. At atmospheric pressure, in a dip tank,
dwell times from about 1 second to about 30 minutes are effective, with a
dipping time of about 1 minute or less being preferred, and a dipping time
of about at least 2 seconds being more preferred. Dwell times using a
spray may range from about several seconds to about several minutes or
about 2 seconds to about 15 minutes with spray times of less than 30
seconds being preferred. Dwell times using tumbling may range from
about 30 seconds to several hours, with a dwell time of about less than
about 1 minute being preferred.

It should also be appreciated that the compositions of the solutions
used in the process of the invention may be varied according to the
desired characteristics of the meat. The following non-limiting examples
will further illustrate the preparation and performance of the preferred
compositions and processes in accordance with the invention. However,
it is to be understood that these examples are given by way of illustration
only and are not a limitation of the invention.

EXAMPLE

A phosphate solution was prepared by dispersing dry pre-blended
phosphate into cold water and stirring with a mixer until the phosphates
were dissolved completely. The phosphate solution used in the example
had a composition of 93.1% water, 3.8% NaCl, and 3.1% phosphates.
Fresh beef loin and pork loin strips having similar size and weight were
used. A sodium hexametaphosphate solution was prepared by mixing
sodium hexametaphosphate, water, and salt. The SHMP solution used in
the example had a composition of 96% brine (salt and water) and 4% SHMP.

The temperature of the beef loin and pork loin strips was
maintained at about 36°F. The beef loin and pork loin strips were
injected up to about 15% extension with the phosphate solution. Then the
beef loin strips were cut into 1 inch steaks and the pork loin strips were
cut into 1 inch chops by cutting the bones in half. The steaks and chops
were allowed to drip for two minutes. Next the Control steaks and Control
chops, was set aside, while the other steaks and chops were treated with the SHMP solution. The Control steaks and chops were dipped in the SHMP solution for about two (2) seconds.

The SHMP dipped steaks and chops were then drained for about one minute on a rack. All of the steaks and chops, including the Controls, were placed on trays lined with soak pads and into gas impermeable bags. The gas impermeable bags were closed using a modified atmosphere of about 80% oxygen (O₂) and about 20% carbon dioxide (CO₂). The steaks and chops were then stored at about 36°F for up to 18 days. Visual evaluations were performed before and after treatment, as well as at various time intervals.
Color Observations

<table>
<thead>
<tr>
<th></th>
<th>Visual Evaluation</th>
<th></th>
<th>Pork loin</th>
<th>Control (No Dip)</th>
<th>SHMP DIP</th>
</tr>
</thead>
<tbody>
<tr>
<td>fresh</td>
<td>meat</td>
<td>no differences</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>spots are visible on all bones</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>after treatment</td>
<td>meat</td>
<td>no differences</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>no spots are visible</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>2 days</td>
<td>meat</td>
<td>no differences</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>not as red and dryer in appearance, no spots</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>3 days</td>
<td>meat</td>
<td>no differences</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>no spots are visible</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>5 days</td>
<td>meat</td>
<td>no differences</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>no spots are visible</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>7 days</td>
<td>meat</td>
<td>no spots are visible</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>no spots are visible</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>13 days</td>
<td>meat</td>
<td></td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>4w/spots 3w/spots only slight differences</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>15 days</td>
<td>meat</td>
<td></td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>1w/out spots 2w/out spots * see comment below</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>16 days</td>
<td>meat</td>
<td>red red no difference</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>black discoloration little to no black discoloration difference big</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>18 days</td>
<td>meat</td>
<td>red red no difference</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>bone</td>
<td>intense black less black</td>
<td>A</td>
<td>B</td>
<td></td>
</tr>
</tbody>
</table>

*Control is showing more spots as well as bigger spots than SHMP treated chop.
All of the SHMP treated chops exhibited reduced blackbone
discoloration at storage times of 15 days or longer. After sixteen days the
Control showed significant blackbone discoloration while the SHMP
treated chops showed little to no blackbone discoloration.
Claims:

1. A process for treating meat to reduce blackening of the bones comprising treating meat with an amount of hexametaphosphate effective to reduce blackening of bones in the meat.

2. The process of claim 1 wherein said step of treating the meat comprises contacting the bones of the meat with hexametaphosphate.

3. The process of claim 1 wherein said step of treating the meat comprises tumbling, dipping or spraying the meat.

4. The process of claim 1 further comprising storing said meat in a modified atmosphere of greater than about 75% oxygen, after treating said meat with hexametaphosphate.

5. The process of claim 4 wherein said reduced blackening of the bones is exhibited at storage times of at least 15 days.

6. The process of claim 1 wherein said amount of hexametaphosphate is at least about 0.5% hexametaphosphate concentration on a surface of the bones.

7. The process of claim 5 wherein said amount of hexametaphosphate is between about 0.5% to about 10% hexametaphosphate concentration on a surface of the bones.

8. The process of claim 5 wherein said amount of hexametaphosphate is about 4% hexametaphosphate concentration on a surface of the bones.
9. The process of claim 1 wherein said hexametaphosphate comprises potassium hexametaphosphate.

10. The process of claim 1 wherein said hexametaphosphate comprises sodium hexametaphosphate.

11. A process for treating meat to reduce bone discoloration comprising the steps of:
   treating a bone containing meat with an alkaline phosphate;
   treating a surface of said bone in said bone containing meat with hexametaphosphate; and
   storing said bone containing meat in an oxygen atmosphere.

12. The process of claim 11 wherein said surface of said bone is treated with an amount hexametaphosphate effective to reduce discoloration of said bone.

13. The process of claim 12 wherein said amount of hexametaphosphate is at least about 0.5\% hexametaphosphate concentration on a surface of the bones.

14. The process of claim 13 wherein said amount of hexametaphosphate is between about 0.5\% to about 10\% hexametaphosphate concentration on a surface of the bones.

15. The process of claim 13 wherein said amount of hexametaphosphate is about 4\% hexametaphosphate concentration on a surface of the bones.

16. The process of claim 11 wherein said meat is treated with an amount of said alkaline phosphate effective to increase yield in said meat.
17. The process of claim 16 wherein said amount of said alkaline phosphate is from about 0.2% to about 0.7% alkaline phosphate concentration in the meat.

18. The process of claim 17 wherein said amount of said alkaline phosphate is from about 0.3% to about 0.5% alkaline phosphate concentration in the meat.

19. The process of claim 11 wherein treating said bone containing meat with an alkaline phosphate comprises a two step process.

20. The process of claim 19 wherein said two step process comprises treating the meat with a phosphate solution having a higher pH of above about 6.0; and after treating the meat with the higher pH solution, treating the meat an acidic solution having a lower pH of less than about 5.6.

21. The process of claim 11 wherein said alkaline phosphate comprises tetrasodium pyrophosphate (TSPP), tetrapotassium pyrophosphate (TKPP), sodium tripolyphosphate (STPP), or combinations thereof.

22. The process of claim 11 wherein said oxygen atmosphere is a modified atmosphere of greater than about 75% oxygen.

23. The process of claim 11 wherein said step of storing comprises gas flush packaging said meat.

24. The process of claim 11 wherein storing said meat is for at least 15 days.

25. The process of claim 11 wherein said hexametaphosphate comprises potassium.
26. The process of claim 11 wherein said hexametaphosphate comprises sodium.

27. A method for treating a meat to reduce blackbone occurrence, comprising the steps of:
   providing bone-in meat;
   treating said bone-in meat with a hexametaphosphate composition to produce hexametaphosphate treated bone-in meat;
   storing said hexametaphosphate treated bone-in meat in a modified atmosphere of at least about 75% oxygen; and
   reducing blackbone occurrence in hexametaphosphate treated meat below an amount of blackbone occurrence in a bone-in meat having no hexametaphosphates therein.

28. Bone-in meat comprising an amount of hexametaphosphate effective to reduce blackening of bones in said bone-in meat.

29. The process of claim 1 wherein said hexametaphosphate has varying chain lengths.

30. The process of claim 29 wherein said hexametaphosphate has a chain length of at least four.

31. The process of claim 11 wherein said hexametaphosphate has varying chain lengths.

32. The process of claim 31 wherein said hexametaphosphate has a chain length of at least four.

33. The process of claim 27 wherein said hexametaphosphate has varying chain lengths.
34. The process of chain 33 wherein said hexametaphosphate has a chain length of at least four.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A23B4/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A23B A23L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>X</td>
<td>US 4 818 548 A (CHENG ET AL) 4 April 1989 (1989-04-04) the whole document</td>
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<td>X</td>
<td>EP 0 028 113 A (STAUFFER CHEMICAL COMPANY) 6 May 1981 (1981-05-06) claims; examples</td>
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<td>US 4 299 852 A (UENO ET AL) 10 November 1981 (1981-11-10) claims</td>
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☐ Further documents are listed in the continuation of box C. ☒ Patent family members are listed in annex.

* Special categories of cited documents:
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'*A' document member of the same patent family

Date of the actual completion of the international search
4 April 2005

Date of mailing of the international search report
20/04/2005

Name and mailing address of the ISA
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