A method of removing penicillin G and/or pharmaceutical antibiotics which contaminated milk by:
(a) Subjecting the contaminated milk to an ultrafiltration process which produces a permeate containing the contaminating antibiotic and a retentate comprising milk proteins and fats.
(b) Adding a non-antibiotic containing retentate diluting (washing) aqueous fluid including uncontaminated ultrafiltered milk permeate, uncontaminated whole milk, uncontaminated skim milk, or uncontaminated acid or sweet whey, or a mixture thereof to the retentate to dilute the retentate.
(c) Subjecting the diluted (washed) retentate to the ultrafiltration process from additional antibiotic containing permeate thereby forming a milk product comprising retentate having a reduced level of or substantially free of antibiotics.
(d) After the last dilution (wash) step and the milk retentate is returned to selected protein concentration the retentate is reconstituted with either uncontaminated ultrafiltered milk permeate, or uncontaminated whole milk, or uncontaminated skim milk, or acid whey or sweet whey.

8 Claims, 5 Drawing Figures
FIG. 4A

Antibiotic Contaminated HOLDING TANK

Permeate or Whey (acid or sweet).

FIG. 4B

Antibiotic Contaminated MODULAR MEMBRANE RETENTATE

Permeate + Antibiotic

Permeate + Antibiotic
METHOD FOR REMOVAL OF PHARMACEUTICAL ANTIBIOTICS FROM CONTAMINATED MILKS

The present invention relates to the method of removing antibiotics from contaminated milk and more particularly to the method of removing the antibiotics by passing the contaminated milk through an ultrafiltration membrane wherein the antibiotic products are small enough to pass through the membrane as a part of the permeate, (which also includes water, soluble food components, sugars, salts, and non-protein nitrogen. The larger soluble components of milk along with fats, proteins, insoluble salts, bacteria and enzymes, are retained in the retentate of the ultrafiltration equipment.

Residual pharmaceutical antibiotic have been found in milk since early national and regional surveys showed an incidence of 7 to 15%. Reference is made to the following publications:


The increased testing for antibiotics and the enforcement of regulations regarding their entry into milk have not eradicated the problem. One reason has been the higher sensitivity of new or improved assays to detect trace penicillin and other antibiotics in milk. The higher retain fat, protein, insoluble salts, bacteria, viruses and enzymes. Antibiotics can permeate molecular membranes, a characteristic employed by the pharmaceutical industry to separate and harvest large concentrations of antibiotics from liquid substrate. However, separation of trace antibiotics from milk by ultrafiltration and its effectiveness have not been shown prior to the present invention.

One of the teachings of the present invention is the provision of a method to remove penicillin G and other pharmaceutical antibiotics to non-detectable levels in contaminated whole milks by a combination of ultrafiltration separations and permeate washes to fully recover fat and milk-solids-non-fat in an unaltered state. An essential discovery underlying this method is that residual antibiotics are not strongly bound to the milk protein.

BRIEF DESCRIPTION OF THE FIGURES

FIG. 1 is an ultrafiltration (UP) wash removal of penicillin G from raw whole milk purposely contaminated to 0.05 IU/ml. Retentate concentrated 3:1, Upper plate (PI) represents, 1-control raw milk, 2-same milk contaminated with 0.05 IU penicillin/ml, 3-UF retentate without wash (dilution), 4-retentate after first permeate wash (dilution) and reultrafiltration, 5-UF retentate after second permeate wash (dilution) and reultrafiltration.

Lower Plate (P2) represents same as above but after retentates were reconstituted to original whole milk volume with fresh, penicillin-free permeate.

FIG. 2 is an ultrafiltration (UF) wash removal of penicillin G from raw whole milk purposely contaminated 0.01 IU penicillin/ml. Retentate concentrated 3:1, Upper Plate (P1) represents, 1-control raw milk, 2-same milk contaminated with 0.10 penicillin/ml, 3-UF retentate without wash (dilution), 4-UF retentate after first permeate wash (dilution) and reultrafiltration, 5-UF retentate after second permeate wash (dilution) and reultrafiltration and 6-UF retentate after third permeate wash (dilution) and reultrafiltration.

Lower Plate (P4) represents same as above but after retentates were reconstituted to original whole milk volume with penicillin-free permeate.

FIG. 3 is an ultrafiltration (UF) wash removal of penicillin G from raw whole milk purposely contami-
nated with 0.20 IU penicillin/ml. Retentate concentrated 3:1.

Upper plate (PV) represents 1-control raw milk, 2-
same milk contaminated with 0.20 penicillin/ml, 3-UF
retentate without wash dilution), 4-UF retentate first
permeate wash and reultrafiltration, 5-UF retentate
after second after permeate wash (dilution) and reul-
trafiltration and 6-UF retentate after third permeate
wash (dilution) and reultrafiltration.

Lower Plate (PVI) represents same as above but after
retentates were reconstituted to original whole milk
volume with penicillin-free permeate.

FIG. 4A discloses the equipment in block diagram
form which is usable to practice the new and improved
method of the present invention.

FIG. 4B disclosed a straight line modular configura-
tion for placing a plurality of pumps and modular mem-
brane units in the ultrafiltration unit shown in FIG. 4A.

DESCRIPTION OF THE INVENTION

The teachings of the present invention provide a new
and improved method of removing penicillin G and/or
pharmaceutical antibiotics which contaminated milk by:
(a) Subjecting the contaminated milk to an ultrafiltra-
tion process which produces a permeate containing the
contaminating antibiotic and a retentate comprising
milk proteins and fats.
(b) Adding a non-antibiotic containing retentate dilut-
ing (washing) aqueous fluid including uncontam-
inated ultrafiltered milk permeate, uncontaminated
whole milk, uncontaminated skim milk, or uncontam-
inated acid or sweet whey, or a mixture thereof to the
retentate to dilute the retentate.
(c) Subjecting the diluted (washed) retentate to the
ultrafiltration process from additional antibiotic con-
taining permeate thereby forming a milk product
comprising retentate having a reduced level of or
substantially free of antibiotics.
(d) After the last dilution (wash) step and the milk reten-
tate is returned to selected protein concentration the
retentate is reconstituted with either uncontaminated
ultrafiltrated milk permeate, or uncontaminated
whole milk, or uncontaminated skim milk, or acid
whey or sweet whey.

As used herein, the words dilution and wash have the
same meaning. Moreover, the aqueous liquids which are
used in the dilution and reconstitution step are intended
to be clean and uncontaminated even though for brevity
these adjectives may not be used herein.

Referring now to FIG. 4A, Block 1 is an ultrafiltration
unit of sanitary design of the type now available in
the United States, France and Denmark and presently
used for cheese and other food manufacture. Chapter 5
of a book entitled "Membrane Filtration: A User's
Guide and Reference Manual" authored by Thomas D.
Brock and published by Science Tech, Inc., Madison,
Wis. (1983), lists various manufacturers of ultrafiltration
equipment. The ultrafiltration equipment used to make
the present invention was an Abcor 225 unit with HFM
membranes of 20,000 daltons manufactured by Abcor,
Inc., 850 Main Street, Wilmington, Mass. 01877. In
handling large volumes of milk, membrane-type need
not be changed in pore size, but the volume handling
capabilities of the equipment (membrane surface area
and fluid pressure) may well be adjusted as appropriate.
The milk product going into the ultrafiltration unit is
cycled therethrough at a selected temperature across a
membrane comprising cellulose acetate with polyvinyl
chlorine backing, or polysulfone, or other acceptable
member material in a forced turbulent flow. The tem-
perature used depends upon the desired concentration
of proteins and fat in the output. When milk contami-
nated with antibiotics is passed through this ultrafiltra-
tion membrane means, the soluble components of milk
of sizes less than approximately 20,000 daltons, includ-
ing the antibiotics associated therewith, can pass
through the membrane as permeate and the larger mo-
lemacular components and fats are concentrated in the
retentate output. The typical temperature range for the
milk to subject to ultrafiltration is 52°-54° C. While the
pore size of the membrane used was 20,000 daltons, the
pore size may be altered to another value as long as it
matches the molecular size compatible with ultrafiltra-
tion of milk. Ultrafiltration of milk as used herein
means the passing of the contaminated milk through an
ultrafiltration membrane wherein the antibiotic prod-
ucts are small enough to pass through the membrane as
a part of the permeate (which also includes water, solu-
tible food components, sugars, salts and non-protein ni-
trogen). The larger components of milk along with fats,
proteins, insoluble salts, bacteria and enzymes, are re-
tained in the retentate of the ultrafiltration equipment.

For example, a pore size of 50,000 daltons has been
successfully used to remove penicillin G through ultra-
filtration in accordance with the present invention. The
membranes of the ultrafiltration equipment may take
several forms, plates, tubes, hollow fiber or spiral
wound, and are mounted for support on stainless steel
stands.

Referring again to FIG. 4A, the contaminated milk to
be processed in accordance with this invention is in a
holding tank 2 with the output of the tank being con-
ected to pass the milk to the ultrafiltration unit 1. The
contaminated milk is repetitively passed across to the
membrane under pressure and back to the holding tank
at a selected temperature across a membrane comprising
retentate output. The typical temperature range for the
ultrafiltration unit 1 may contain any number of sepa-
rate and modular membrane sub-units in series or in
parallel receiving the milk to be ultrafiltered and each
sub-unit may be fed by a separate pump. With plural
membrane sub-units in the ultrafiltration unit 1, it is
possible to separate out as a part of the permeate anti-
biotics in the milk to reduce the level of antibiotics such
that only one pass through ultrafiltration unit 1 is re-
quired. For example, FIG. 4B shows a series arrange-
ment of plural modular membrane sub-units with a
pump associated with each which might be included
within ultrafiltration unit 1 of FIG. 4A. A requirement
of passing the milk through the ultrafiltration unit 1 a
plurality of times in order to reduce the level of antibiot-
cics in the retentate is characterized as a batch process.

Passing the milk through the ultrafiltration unit 1 but
once when the number of membranes therein is suffi-
cient to reduce the antibiotic level in one pass through
the ultrafiltration unit is called continuous processing.
In unit 1 the contaminated milk is repetitively passed
through to be ultrafiltered, the retentate volume in the
holding tank 2 becomes more concentrated and includes
all of the larger molecular sizes of the components of
milk (the proteins) and fats, and the greater amount of
the unwanted antibiotics are removed via exit 4 as part
of the permeate. This process is continued until a se-
lected concentration of retentate is reached (ratio of
retained volume as retentate of the initial volume of
milk in the holding tank 2). If the initial level of un-

defined.
An Abcor 22S unit using a spiral-wound polysulfone membrane of 4.65 m2 per molecule weight cut-off of 20,000 daltons. Inlet and outlet pressure were 340 and 140 kPA.

The resulting 3:1 retentate from each lot was washed by adding an equal volume of fresh, uncontaminated UF milk permeate by stirring the two components for 1 min. Thereafter the mixture was ultrafiltered again to 3:1 volume concentration. The washing and re-ultrafiltration step was repeated for each lot up to four times depending upon initial penicillin G level. Alternatively, for comparison on separate lots clean tap water was the washing medium with sweet whey used as the reconstituting medium at the end of the process.

Milk, retentates and permeates were analyzed for the presence and size (diameter) of inhibiting zone presence using the Difco disk assay involving Bacto-PM indicator agar and thermospores of Bacillus stearothermophilus. Gross composition of milk and retentates were obtained by using AOAC methods. Sensory evaluation of retentates and reconstituted retentates was conducted by the authors using a graduated scale of 10 to 0, indicating excellent to non-acceptable qualities, and listing defects outlined in the official ADSA milk scorecard.

Penicillin removal by direct ultrafiltration of 3 trial lots of raw whole milks were obtained purposely in the winter period on the same day. These were contaminated with penicillin G, at approximately 0.05, 0.10 and other ultrafiltration trials on contaminated milk conducted several weeks apart with permeate washes (data not shown) gave similar results. Criterion for determining efficiency of removal was the presence or absence of a zone of bacterial inhibition and the diameter measurement of zone. Initial cottonized test discs before being wetted with milk and placed on agar surfaces were 13 mm.

Table 1. shows milk contaminated to approximately 0.05 IU/ml penicillin G, prior to ultrafiltration gave a 24 mm diameter zone including the original disc.

**TABLE 1**

<table>
<thead>
<tr>
<th>Zone Diameter - mm</th>
<th>Penicillin contamination</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1U/ml milk</td>
</tr>
<tr>
<td></td>
<td>treatment of retentates</td>
</tr>
<tr>
<td></td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td>.10</td>
</tr>
<tr>
<td></td>
<td>.20</td>
</tr>
<tr>
<td>No wash</td>
<td></td>
</tr>
<tr>
<td>After 1st wash</td>
<td></td>
</tr>
<tr>
<td>After 2nd wash</td>
<td></td>
</tr>
<tr>
<td>After 3rd wash</td>
<td></td>
</tr>
<tr>
<td>After 4th wash</td>
<td></td>
</tr>
<tr>
<td>[Retentate Concentrated 3-fold with Permeate]</td>
<td></td>
</tr>
</tbody>
</table>

| Raw milk = no zone; contaminated raw milk = 23.5, 28 and 34 mm. |
| New York State interprets non-detectable milk as absence of zones or diameters up to 13.9 mm. Assay disc before use = 13 mm. |
| --- = no assay |

Before addition of penicillin this milk showed no zone. Ultrafiltering the antibiotic-positive milk to 3:1 volume concentration effectively removed penicillin G with succeeding washes Table I, FIG. 1. After removing 80 l of permeate from 120 l of contaminated milk by
UF of the zone diameter of the unwashed retentate was 24 mm. Washing this retentate 1:1 with 401 of permeate and reultrafiltrating to remove 401 contaminated permeate reduced the zone diameter to 22 mm. Following a second 1:1 wash and re-ultrafiltration the zone diameter was 18 mm. and a third wash gave a retentate without any zone. Reconstituting the three separately washed and reultrafiltered retentates to their original milk volume with fresh uncontaminated permeate produced whole milks either without any inhibiting zones or so small as to be classified as non-detectable by New York State standards.

Milk purposely contaminated with 0.1 IU penicillin/ml displayed an initial zone of 28 mm and that contaminated with 0.2 IU/ml of zone of 34 mm, Table 1. Ultrafiltration followed by three permeate washings and reultrafiltrations eliminated the zone developed by non-wash retentate from the 0.10 IU/ml milk lot and reduced it to below the New York non-detectable levels (<15.9 mm) after three and four washings and reultrafiltrations in a similar retentate from 0.20 IU/ml milk. When retentates from 0.10 IU penicillin/ml contaminated milk were reconstituted with uncontaminated permeates, resulting whole milks were classified non-detectable for penicillin after only one wash. Table 1, FIG. 2. In milks purposely contaminated to approximately 0.20 IU/ml penicillin G, an almost non-detectable penicillin situation (16 mm) occurred after the second wash, Table 1, FIG. 3.

The penicillin-contaminated 3:1 retentate and the same penicillin-free 3:1 retentate after three permeate washes and reultrafiltrations display only minor differences in composition, Table 2.

### TABLE 2

<table>
<thead>
<tr>
<th>HISTORY</th>
<th>T.S.</th>
<th>%</th>
<th>LACTOSE</th>
<th>FAT</th>
<th>PROTEIN</th>
<th>ASH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whole Milk</td>
<td>12.0</td>
<td>3.5</td>
<td>0.7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:1 Retentate</td>
<td>23.9</td>
<td>9.5</td>
<td>1.0</td>
<td>3.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3:1 Retentate</td>
<td>24.0</td>
<td>9.9</td>
<td>0.9</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washed 3x With Permeate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Four lots of raw milk purposely contaminated to approximately 0.10 IU penicillin/ml initially gave a mean inhibitory zone diameter of 27.4 mm. All lots were ultrafiltered then washed with clean tap water and reultrafiltrated. Reconstitution of the unwashed retentates to the original volume of raw whole milk were made using sweet whey.

Table 3 shows mean inhibitory zone diameter reduction.

### TABLE 3

<table>
<thead>
<tr>
<th>Water wash treatment of retentate</th>
<th>Trials</th>
<th>Mean Zone Diameter - mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Retentate concentrated 3:1]</td>
<td>4</td>
<td>28.2 (1.4)</td>
</tr>
<tr>
<td>After 1st wash</td>
<td>4</td>
<td>24.9 (1.4)</td>
</tr>
<tr>
<td>After 2nd wash</td>
<td>4</td>
<td>21.6 (1.4)</td>
</tr>
<tr>
<td>After 3rd wash</td>
<td>4</td>
<td>16.4 (2.5)</td>
</tr>
</tbody>
</table>

Penicillin G contamination grew in permeates from the first washed retentate were non-detectable (15 mm) for penicillin G, while reconstituted mixtures from the second and third washed retentates showed no zones.

Composition of 3:1 whole milk retentates after three washings with tap water, differed from starting unwashed retentates, Table 4. Also whey reconstituted (3:1) washed retentate showed a different composition from the original whole milk, Table 4.

### TABLE 3-continued

<table>
<thead>
<tr>
<th>Water wash treatment of retentate</th>
<th>Penicillin G contamination</th>
<th>Trials</th>
<th>Mean Zone Diameter - mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>No wash</td>
<td>[Retentate concentrated 3:1]</td>
<td>4</td>
<td>22.1 (0.63)</td>
</tr>
</tbody>
</table>

After three water washings the mean zone diameter of the washed retentate was 16.4 mm. Reconstituted milk mixtures from the first washed retentate were non-detectable (15 mm) for penicillin G, while reconstituted mixtures from the second and third washed retentates showed no zones.

Composition of 3:1 whole milk retentates after three washings with tap water, differed from starting unwashed retentates, Table 4. Also whey reconstituted (3:1) washed retentate showed a different composition from the original whole milk, Table 4.

### TABLE 4

<table>
<thead>
<tr>
<th>Retentate plus 2 parts sweet whey</th>
<th>No zone</th>
<th>0.6</th>
<th>3.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washed 3x With Water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Penicillin G in Permeates

Large inhibiting zone diameters as high as 34 mm were observed on agar surface when testing permeates obtained from ultrafiltration of penicillin contaminated milk. Levels of penicillin in permeate decreased after each washing indicating that this avenue was mainly responsible for the effective removal of traces amount of penicillin G from contaminated milk.

### FLAVOR OF ULTRAFILTERED-WASHED RECONSTITUTED MILKS

Penicillin contaminated milks ultrafiltered and then washed with permeate gave retentate and permeate reconstituted milks of excellent flavor quality. Table 5 making it virtually impossible to differentiate between reconstituted and fresh whole milk. Contaminated milks ultrafiltered and then washed with water followed by reconstitution with fresh permeate possessed a clean but flat flavor as did their retentates.

### ANTIBIOTICS OTHER THAN B-LACTAM GROUP

Six antibiotics, including a number outside the B-lactam group were tested for their sensitivity to *B. stearothermophilus* disc assay in anticipation of studying their removal behavior in milk. All exhibited sensitivity to the assay but 5 demonstrated less sensitivity than a...
blend of penicillin G and novobiocin. While the additional antibiotics outside the B-lactam group are progressively removed from the starting milk as a part of the permeate during the ultrafiltration step, the lack of sensitivity of the state of the art assay does affect the certainty with which it may be determined, that these additional antibiotics have been removed to a selected level. As measuring techniques improve for the presence of these additional antibiotics in milk, the precision with which the teachings of the present invention can be used to remove these antibiotics. These antibiotics, like penicillin G are not strongly bound to the milk protein.

Contamination of milk and milk products by pharmaceuticals as residues from dairy cow mastitis treatment still occurs nationally. A USDA national antibiotic study showed that among 2265 skim milk powders almost 3% were contaminated. See an article entitled "Surveillance of Milk Products for Penicillin", as done by The Dairy Division of The USDA Department of Agriculture Journal of Milk Technology 38 (No. 10) 621-23. Antibiotic residues have been reported in a silo of Agriculture Journal of Milk Technology 38 (No. 10) 621-23. Antibiotic residues have been reported in a silo containing 136,000 l. milk.

Much research has dealt with developing antibiotic detection methods and organizing control or prevention programs. Little activity has been directed to totally removing pharmaceutical antibiotics from contaminated milk. Removal attempts have been focused on dilution or on centrifugation of components but neither has been effective and both induce physical alteration of the milk product or its components. It is stated in U.S. Pat. No. 4,238,521 that adsorption of penicillin G from milk on charcoal columns additionally removes milk nutrients and that it is also necessary to centrifuge out activated charcoal fine particulates accumulating in the milk from the treatment.

Removal of penicillin G to non-detectable levels from milk by ultrafiltration, washing permeate, and re-ultrafiltering followed by reconstitution with fresh permeate leads to no loss of milk components, nutrients, or flavor nor is there any accumulation of extraneous material. In the absence of fresh antibiotic-free permeate as wash material when can be substituted to remove penicillin G from milk but the washed retentates will not possess the same composition as the unwashed and would be limited to supplementing foods or cheese milks.

Penicillin G, a beta lactam, was the antibiotic studied here but in the treatment of cattle afflicted with mastitis, perhaps 20-30% or more of the antibiotics used, in combination with penicillin or alone, are not beta-lactams. These include oxytetracycline, erythromycin, ampicillin and novobiocin. All display less sensitivity then penicillin G to inhibition by test assay organism B, stearothermophilus. Any removal process for pharmaceutical antibiotics should endeavor to remove the above. However, all these antibiotics meet two basic requirements for effective separation by ultrafiltration: high solubility and low molecular weight.

The highest penicillin concentrations in milk treated by ultrafiltration in the present study was approximately 0.2 IU/ml which required four washings of retentate to achieve non-detectable status. In New York State, and perhaps others, it is rare for milks legally condemned for containing antibiotics to exceed a 25 mm inhibition zone and the usual range is 19-22 mm. Experience indicates then that removal of pharmaceutical antibiotics from a milk showing approximately 24 mm zones (0.05 IU/ml) could be accomplished by one wash of the retentate. At even lower penicillin levels it is likely that a smaller volume of permeate is required. Ultrafiltering antibiotic contaminated milk to total protein levels higher than 3:1 may fit well with operations at cheese plants utilizing the MMV prechess concept of Maubois et al. French Pat. No. 2,052,121.

Antibiotic removal from milk with less loss of milk may be applicable at the farm of the future equipped to ultrafilter milk on the premises. The milk producer might segregate his mastitis-treated cows at the end of the milking line and ultrafilter-wash-reultrafilter milk only from cows after 48 hours of treatment using permeate for wash from ultrafiltered milk of untreated cows. The antibiotic-free retentate then might be added to the main body of the retentate in the bulk tank. (LKR) cheesemaking up to 2:1 volume concentrate the opportunity for disruption

It is understood that the embodiments of the invention described herein are merely illustrative of the application of the principles of the invention. Reference herein to details of the illustrated embodiments is not intended to limit the scope of the claims which themselves recite those features regarded as essential to the invention.

1 claim:

1. A method of removing trace amounts of residual penicillin G or other residual pharmaceutical antibiotics which have contaminated milk comprising:

(a) subjecting the said contaminated milk having trace amounts of residual penicillin G or other residual pharmaceutical antibiotics to an ultrafiltration process which produces a permeate containing the contaminating antibiotic and a retentate comprising milk proteins and fats;

(b) adding a non-antibiotic containing aqueous fluid including uncontaminated ultrafiltered milk permeate, uncontaminated whole milk, uncontaminated skim milk, or unenantaminated acid or sweet whey, or a mixture thereof to the retentate to dilute the retentate;

(c) subjecting the diluted retentate to the ultrafiltration process to form additional antibiotic containing permeate thereby forming a milk product comprising retentate having a reduced level of or substantially free of antibiotics.

(d) the said dilution cycle being repeated until the level of antibiotics in the milk retentate is reduced to a non-detectable level.

2. The method of claim 1 wherein the milk retentate output of ultrafiltration is placed in a holding tank which also receives the diluting aqueous fluid and which provides the diluted milk retentate for further separation in the ultrafiltration process.

3. The method of claim 2 wherein after the last dilution step the milk retentate is returned to selected protein concentration by reconstituting with either uncontaminated ultrafiltered milk permeate, or uncontaminated whole milk, or uncontaminated skim milk, or uncontaminated acid whey or sweet whey.

4. The method of claim 2 wherein the holding tank is the tank of the retentate or milk silo which collected or carries or holds the contaminated milk.

5. The method of claim 1 wherein other pharmaceutical antibiotics are those which:

(a) may be effectively separated by ultrafiltration;

(b) have high solubility in water
(c) possess low molecular weights consistent with milk ultrafiltration and the membrane used therefore;
(d) may be measured in milk with reasonable sensitivity.

6. A method of removing trace amounts of residual penicillin G or other residual pharmaceutical antibiotics which have contaminated milk comprising the following steps:
(a) passing the said contaminated milk having trace amounts of residual penicillin G or other residual pharmaceutical antibiotics into a holding container of a selected size;
(b) repetitively passing said milk in the said holding container through an ultrafiltration membrane means whereby soluble components of milk of molecular sizes compatible with ultrafiltration including the antibiotic associated therewith pass through the membrane in permeate and the larger molecular sized components and fats are connected as retentate until a selected concentration is reached;
(c) diluting and washing a selected volume of resulting milk retentate by adding a selected volume of uncontaminated ultrafiltration milk permeate or fluid whey and repetitively passing through said ultrafiltration membrane means until the milk retentate is returned to a related protein concentration;
(d) the said washing cycle being repeated until the level of antibiotics in the milk retentate is reduced to a non-detectable level.

7. The method of claim 6 wherein after the last dilution step and the milk retentate is returned to selected protein concentration the retentate is reconstituted with either uncontaminated ultrafiltrated milk permeate, or uncontaminated whole milk, or uncontaminated skim milk, or acid whey or sweet whey.

8. The method of claim 6 wherein the holding container is the tank of the truck or milk silo which collected or carries or holds the contaminated milk.

* * * * *