Abstract: A method for the separation of fat from meat. The method includes, providing pieces of meat containing lean and fat; subjecting the meat to chilling for a time sufficient to render the fat into a brittle condition; and, with a machine, and with the fat in the brittle condition, subjecting the meat to a crushing force to separate particles of fat from the meat. A related method includes transferring a mixture through a conduit, wherein the mixture comprises lean particles with frozen water, fat particles, and a fluid, allowing the frozen water in the lean particles to thaw as the mixture travels through the conduit, and increases a density of the lean particles, accumulating the lean particles with non- frozen water at a first elevation in the conduit, and accumulating fat particles at a second elevation in the conduit, wherein the first elevation is lower than the second elevation.

Published:
— with international search report (Art. 21(3))

(88) Date of publication of the international search report: 7 March 2013
Date of publication of the amended claims: 25 April 2013
The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for the separation of fat from meat, comprising:
   (a) providing individual pieces of meat containing lean and fat;
   (b) subjecting the individual pieces of meat to chilling for a time sufficient to render the fat into a brittle condition and the lean into a pliable condition; and
   (c) with a machine, and with the fat in the brittle condition and the lean in a pliable condition, subjecting the individual pieces of meat to a crushing force to separate particles of fat from the individual pieces of meat.

2. The method of Claim 1, further comprising rendering the fat particles into beef tallow.

3. The method of Claim 1, further comprising exposing the individual pieces of meat after crushing to carbon dioxide at or above the critical temperature and critical pressure.

4. The method of Claim 1, further comprising centrifuging the fat particles after being separated from the individual pieces of meat.

5. The method of Claim 1, further comprising emulsifying the fat particles after being separated from the individual pieces of meat.

6. The method of Claim 1, further comprising extracting lean from the fat particles,

7. The method of Claim 1, further comprising separating fat from lean in a centrifuge.
8. The method of Claim 1, wherein lean is chilled to a temperature to cause freezing of water in the lean, and the temperature of the fat is lower than the temperature of the lean.

9. The method of Claim 1, wherein during step (c), the lean is left intact.

10. The method of Claim 1, wherein in step (b) the surface temperature of the fat is lower than the surface temperature of the lean by at least ST.

11. The method of Claim 1, wherein in step (b), the surface temperature of the lean is 26°F or less, and the surface temperature of the fat is ST or greater, and the surface temperature of the fat is lower than the surface temperature of the lean.

12. The method of Claim 1, comprising passing the pieces of meat between a pair of parallel, adjacent, non-contacting, driven rollers, each roller having alternating recesses and protrusions around the perimeter, wherein the rollers are arranged to position a recess of one roller opposite to a protrusion of the second roller, without the rollers being in contact.

13. The method of Claim 1, wherein the meat is beef.

14. A method for the separation of fat from meat, comprising:
   (a) providing individual pieces of meat containing lean and fat;
   (b) subjecting the individual pieces of meat to chilling for a time sufficient to produce a difference in temperature between the fat and lean, wherein the fat is chilled such that the fat is friable and crumbles into finer particles when subjected to a crushing force and the lean is cooled to a higher temperature than the fat and the lean is able to withstand a similar crushing force without substantially crumbling into smaller particles; and
(c) with the fat and lean at the temperatures produced in step (b), subjecting the individual pieces of meat to a crushing force to separate particles of fat from the individual pieces of meat.

15. The method of Claim 14, wherein, after subjecting the individual pieces of meat to chilling, the temperature at the surface of the fat is ST to 25°F.

16. The method of Claim 14, wherein, after subjecting the individual pieces of meat to chilling, the temperature at the surface of the lean is 16°F to about 34T.

17. The method of Claim 14, wherein the chilling time of the individual pieces of meat is approximately 2 minutes to 3 minutes.

18. The method of Claim 14, further comprising transferring the individual pieces of meat and separated particles of fat to a vessel and filling the vessel with a fluid comprising, at least, water, and allowing the particles of fat to rise in the fluid and allowing the individual pieces of meat to sink in the fluid, followed by collecting the fat and the individual pieces of meat.

19. The method of Claim 18, further comprising allowing bone to sink in the fluid to a lower elevation as compared to an elevation attained by the individual pieces of meat.

20. The method of Claim 14, further comprising transferring the individual pieces of meat and separated particles of fat within a conduit filled with a fluid comprising, at least, water, and allowing the particles of fat to rise in the fluid and allowing the individual pieces of meat to sink in the fluid while the fluid travels in the conduit, followed by collecting the fat and the individual pieces of meat.

21. The method of Claim 14, further comprising subjecting the individual pieces of meat to a crushing force produced by intermeshing teeth to separate particles of fat from the individual pieces of meat.
22. The method of Claim 14, further comprising, after separating the particles of fat from the individual pieces of meat, combining a measured portion of the fat particles with a measured portion of the individual pieces of meat to achieve a predetermined fat content for the meat.

23. The method of Claim 14, further comprising cutting raw meat to a size not exceeding 2 inches in any dimension to produce the individual pieces of meat of step (a).

24. The method of Claim 23, wherein, after producing the individual pieces of meat, the pieces are chilled to minimize agglomeration of the pieces into frozen masses.

25. The method of Claim 14, wherein after crushing, the individual pieces of meat in step (c) comprise predominantly lean meat.

26. The method of Claim 14, further comprising contacting the separate particles of fat and individual pieces of meat of step (c) with a flowing fluid comprising, at least, water, in a conduit, and allowing frozen water in the individual pieces of meat to thaw and increase in density, which causes the individual pieces of meat to fall in the flowing fluid, while the fat particles are buoyant in the fluid, and collecting the individual pieces of meat in a lower conduit of a manifold and collecting the fat particles in an upper conduit of the manifold.

27. The method of Claim 26, further comprising separating the fluid from the individual pieces of meat and fat particles, weighing the fat, and combining a portion of the fat with the individual pieces of meat to produce a meat product of predetermined fat content.

28. The method of Claim 27, further comprising centrifuging the individual pieces of meat to remove the fluid after separating the fat particles.

29. A method for separating lean from fat, comprising:
transferring a mixture through a conduit, wherein the mixture comprises lean particles with frozen water, fat particles, and a fluid;

(b) allowing the frozen water in the lean particles to thaw as the mixture travels through the conduit, and increases a density of the lean particles;

(c) accumulating the lean particles with non-frozen water at a first elevation in the conduit, and accumulating fat particles at a second elevation in the conduit, wherein the first elevation is lower than the second elevation.

30. The method of Claim 29, further comprising transferring the accumulated lean particles through a conduit branch connected to the conduit, wherein the accumulated lean particles transferred in the conduit branch comprise a majority of the lean particles in the mixture.

31. The method of Claim 29, further comprising transferring the accumulated fat particles through a conduit branch connected to the conduit, wherein the accumulated fat particles transferred in the second conduit branch comprise a majority of the fat particles in the mixture.

32. The method of Claim 29, further comprising transferring a portion of the mixture through a conduit branch connected to the conduit, wherein the mixture in the conduit branch comprises a greater percent by weight of fluid than fat and lean.

33. The method of Claim 29, wherein the lean particles and the fat particles in the mixture in the conduit prior to thawing of the frozen water have a substantially similar density that prevents the lean particles and the fat particles from accumulating at different elevations.

34. The method of Claim 29, further comprising adding carbonic acid solution to the mixture before step (a).
35. The method of Claim 29, wherein the fluid has a temperature higher than the freezing point of water.

36. The method of Claim 29, wherein the mixture further comprises bones, and allowing the bones to separate from the mixture before the thawing of water.

37. The method of Claim 36, wherein the conduit comprises a vertical section and a horizontal section, and the bones are separated at a bend from the vertical section to the horizontal section.

38. The method of Claim 29, further comprising before step (a), applying pressure to pieces of beef comprising both fat matter and lean matter to produce the lean particles and the fat particles in the mixture.

39. The method of Claim 38, further comprising, before applying pressure, chilling the pieces of beef to a temperature at which the fat matter becomes brittle and can crumble and separate from the lean matter upon the application of pressure.

40. The method of Claim 29, further comprising emulsifying the accumulated fat particles.

41. The method of Claim 29, further comprising collecting the accumulated lean particles and centrifuging the lean particles to separate fluid.

42. The method of Claim 29, wherein the conduit has an aspect ratio defined as the cross-sectional width divided by the cross-sectional height, and the aspect ratio decreases along the length of the conduit from a proximal side to a distal side.

43. A method of separating a high vapor pressure fluid from beef, comprising:
   (a) in an apparatus comprising a vessel, and a piston disposed within the vessel, wherein a space is provided adjacent to the piston, adding a high vapor pressure fluid with beef in the space; and
(b) moving the piston to compress the space to separate the fluid from the beef, wherein the fluid is compressed at a pressure to prevent evaporation and freezing of the beef.

44. The method of Claim 43, wherein the apparatus comprises a second piston, wherein the pistons are disposed opposite to each other, and the pistons are moved together to compress the space to separate the fluid from the beef.

45. The method of Claim 43, wherein the high vapor pressure fluid does not exist as a liquid at 1 atmosphere and 20°C.

46. The method of Claim 43, wherein the fluid is carbon dioxide.

47. The method of Claim 43, wherein the apparatus further comprises a space behind the piston, wherein the space adjacent to and behind the piston are in communication, and the fluid is transferred behind the piston during compression.

48. A method for producing a beef product having a predetermined fat content, comprising:
   (a) transferring a mixture through a conduit, wherein the mixture comprises lean particles, fat particles, and a fluid;
   (b) transferring a first portion of the mixture having accumulated lean particles through a first conduit branch connected to the conduit, wherein the portion of the mixture transferred in the first conduit branch has a majority of the lean particles in the mixture;
   (c) transferring a second portion of the mixture having accumulated fat particles through a second conduit branch connected to the conduit, wherein the portion of the mixture transferred in the second conduit branch has a majority of the fat particles in the mixture;
   (d) measuring the first portion of the mixture having the accumulated lean particles in the first conduit branch and determining a content of fat in the first portion;
(e) comparing the content of fat in the first portion with a target fat content; and

further performing (f1) or (f2):

(f1) increasing the massflow of the second portion of the mixture through the second conduit branch to decrease the fat content of the first portion of the mixture in the first conduit branch; or

(f2) decreasing the massflow of the second portion of mixture through the second conduit branch to increase the fat content of the first portion of the mixture in the first conduit branch.

49. The method of Claim 48, further comprising measuring the massflow of the first portion of the mixture and determining a density, and correlating the density to the fat content of the first portion of the mixture.

50. The method of Claim 48, further comprising, reducing the mass flow of the second portion of tire mixture flowing through the second conduit branch and maintaining a constant mass-flow until the fat content of the first portion of the mixture reaches a high target value, and then increasing the mass-flow of the second portion of the mixture through the second conduit branch and maintaining a constant massflow until the fat content of the first portion of the mixture reaches a low target value, wherein the high target value and the low target value are not the same.

51. A method for inactivating pathogens present on pieces of beef, comprising:

(a) introducing into an apparatus, pieces of beef, and a fluid comprising water and carbon dioxide;

(b) raising a pressure within the apparatus above a critical pressure of carbon dioxide without elevating a temperature within the apparatus above a temperature to damage the beef; and holding the pressure and temperature for a selected period of time;
(c) reducing the pressure within the apparatus, and increasing a density of the fluid to suspend and separate the pieces of beef in a suspension to enable surfaces of the beef to be in contact with low pH fluid to result in death of pathogenic microorganisms on the surfaces of the beef.

52. The method of claim 51, further comprising adjusting the density of the fluid where the beef becomes buoyant to allow spacing apart of beef.