## Appendix 1

# Specification for a stand-alone Supercritical Fluid Extraction (SFE) plant for small scale extraction and fractionation of fat and bioactive compounds from food solid matrices and liquid extracts including production simulation and scale-up ability.

**Primary requirements:**

1. The Supercritical Fluid Extraction (SFE) plant should be a versatile system for extraction and fractionation of fat and bioactive compounds from diverse solid food matrices.
2. The SFE plant should be a stand-alone plant with 1 L and/or 5 L extraction vessels for extraction trials of small quantities of cereals, pulses, oilseed crops, fruits, food products, side streams and rest material to be used for production simulation and calculation of scale-up ability.
3. The SFE plant should include the possibility to couple a counter-current column to fractionate bioactive compounds from liquid extracts.
4. The SFE should be equipped with software that control, monitor and collect data.
5. The SFE should be equipped with a LCD screen/pc with a data dump to windows software.
6. The SFE plant should be a stand-alone plant in building blocks in a steel frame with wheels which make it easy to transport and move.
7. The SFE plant should be CE marked in compliance with EU legislation according to the PED (pressure directive).
8. All system should be mounted on a stainless-steel frame or frames with maximum dimensions of 1.2 m width, 5.0 m length and 2.6 m height in total.
9. The SFE equipment should be food grade approved.
10. The SFE equipment should include Kits containing spare parts, necessary tools to repair the equipment / damaged fittings and cleaning tools.
11. Cost for delivery by airfreight (IATA-rate) inclusive packing, FCA charges, insurance to Oslo, Norway, and transport to Nofima, Ås, Norway should be included.
12. Costs for Training and Installation in Ås, Norway should be included.
13. The SFE Plant can be equipped with 220 V, 1 phase, 50 Hz or 220 V, 3 phase, 50 Hz or 400 V, 3 phase, 50 Hz.
14. The SFE equipment should be equipped with a suitable cooling bath that goes down to at least -20ºC, good enough to support the $CO_2$ pump flows. The $CO_2$ loop should be big/long enough to enable a good residence time of $CO_2$ at a certain temperature to reach the target flow rate. The loop must be large enough to support the designed pump flows.

15. The SFE plant can be equipped with 1 or 2 $CO_2$ pumps with 1 or 2 mass flow meters, respectively to reach the targeted $CO_2$ flow rate.
16. The $CO_2$ flow rate should be at least 400g/min (24Kg/h) for a discharge pressure of at least 600 bar.
17. The SFE plant should be equipped with a co-solvent pump with a flow rate suitable for a discharge pressure of at least 600 bar with a tolerance of +/- 5%.
18. The extraction solvent should be carbon dioxide ($CO_2$) or a combination of $CO_2$ and an organic food grade solvent (for example ethanol)
19. The SFE plant should include the possibility to conduct Pressurized Liquid Extraction using water:ethanol mixtures.
20. All the SFE system connections, fittings, O-rings, pipes should withstand food grade co-solvents.
21. The SFE plant should be equipped with a pre-heater, having at least working pressure of 600 bar and temperature of 100 °C.
22. The SFE equipment should consist of 1 and/or 2 extraction vessels with a design pressure of at least 600 bar and temperatures up to 100 ºC.
23. The SFE plant 1 L extraction vessel should have at least 600 bar and up to 100 °C.
24. The SFE plant 5 L extraction vessel should have at least 600 bar and up to 100 °C.
25. The extraction vessels should contain inserted raw-material baskets easy to remove after extraction.
26. The volume of the extractors should be possible to reduce by means of appropriate baskets/parts.
27. The extraction vessels should contain thermocouples for temperature monitoring.
28. The SFE plant should be equipped with cooling around the both 1L and 5L extraction vessel (subcritical option) to control temperatures lower than room temperature.
29. The SFE plant should be equipped with an automatic back pressure regulator with heated needle.
30. The SFE plant should be equipped with pressure monitoring devices.
31. The extractors should be equipped with rupture discs and relieves valves in case of blockage.
32. The SFE plant should be equipped with at least 2 collection vessels (separators) having a capacity of 1 L each and at least 200 bar and 100 °C of design pressure and temperature, respectively.
33. The SFE plant should be equipped with 1 cold trap collector after the separators having a capacity of 1 L each and at least 200 bar and 80 °C of design pressure and temperature, respectively.
34. The separators should contain thermocouples for temperature control and pressure monitoring devices for pressure control.
35. The SFE plant should be equipped with a $CO_2$ recycling tank with condenser with a volume of at least 18 L for carbon dioxide and design pressure of at least 85 bar.
36. The $CO_2$ recycling system should contain an extra chiller, a heat exchanger and a pressure relief valve.
37. The SFE plant should be equipped with food grade steel tubing/pipes appropriate for a working pressure of at least 600 bar.

38. The SFE plant should be equipped with food grade steel fittings that avoid leakages and dead volumes.
39. The SFE plant should be equipped with a system that avoids freezing of the pipes when depressurizing the carbon dioxide stream, reducing the $CO_2$ flow rate and leading to blockage of the pipes.
40. Good piping system in accordance/agreement with the designed $CO_2$ flow of the pumps to reach at least 600 bar.
41. The Counter current column (CCC) should be split in 2 columns (2 meters each) connected to each other and should be not higher than 2.50 meters.
42. The CCC should have a sufficient diameter for a good extraction and should contain an inert packing material to enhance the surface area between $CO_2$ and the extracts.
43. Using the information gathered from the CCC trials, it should be possible to calculate the surface area of the $CO_2$ and the theoretical plates.
44. The CCC should be connected to the $CO_2$ circuit, separation and $CO_2$ recovery of the main unit.