Summary and conclusion
The major objectives of this study investigated by extraction of garden cress oil form its seeds. Oil was characterized oil for its physiochemical and its bioactive compounds. Oil also used dietary supplementary by blending with edible vegetable oils and in vivo studies. Oil also microencapsulated and supplemented in food product (biscuits). Major findings of the study are summarized below.

1. *Lepidium sativum* L commonly called garden cress belongs to the family Brassicaceae. The plant is native to Southwest Asia (Persia) and spread many centuries ago to Western Europe. It figures prominently in Indian materia medica with Sanskrit name Chandrasura. The seeds of garden cress claimed to possess varied medicinal properties like galactogogue, aperient, diuretic, alterative, tonic, demulcent, aphrodisiac, carminative and emmenagogue.

2. Despite its great medicinal and nutritional value, garden cress has not received the attention it deserves. The United Nation Organization’s FAO has classified garden cress is one of the underutilized or neglected (cultural suppression) crop among age old crops.

3. Garden cress seeds contain 24% of oil in which 32–34% is ALA.

4. Refractive index of GCO from cold pressed and solvent extracted oil was to that of mustard and flaxseed oils.

5. Also, the saponification value of GCO in cold pressed and solvent extracted oils were almost similar to those of flaxseed and mustard oils. Iodine value for GCO was in the range of 134-136.

6. The unsaponifiable and acid values for GCO were well within the limits of FSSAI-2011, prescribed to edible mustard and flaxseed oils.

7. Test for argemone oil and hydrocynic acid contamination showed negative or nil result in GCO, FTIR spectrum of GCO was found to be similar and qualitatively comparable with mustard and flax seed oil. There were no unusual functional groups observed in the spectra.
8. GC-MS profile of GCO Shows that α-linolenic acid was the major peak (32.1%), other notable peaks were linolenic acid, gondoic acid, palmitic acid. Some of the minor peaks detected were those of stearic acid, erucic acid. There wasn’t any unusual fatty acid found in the GC-MS profile of GCO.

9. GCO showed very high content of total tocopherols (1117 mg/kg), in which γ-tocopherol was the major constituent (1080 mg/kg) as opposed to the tocopherol contents in mustard and flaxseed oils which are 608 and 442 mg/kg respectively.

10. The total phenolic content of GCO was found to be 124 mg of Gallic acid Equivalents. (GAE)/kg of oil. While, the total phenolic contents of Mustard oil and Flaxseed oil are 12 and 14 mg GAE /kg oil.

11. GCO showed a total phytosterol content of 12.1 mg/kg, whereas, in Mustard oil it was estimated to be 10.6 mg/g, and in flaxseed oil it was 6.8 mg/g. It was found that GCO has about two folds higher phytosterol content compared to that Flaxseed oil.

12. GCO has good radical scavenging activity when compared to mustard and flaxseed oil.

13. Accelerated storage stability test was monitored by measuring the peroxide value (PV), P-anisidine value, Conjugated dienes and trienes (CD &CT) for a period of 21 days. In general, the oxidative stabilities of crude oils were stronger than those of their stripped counterparts and the order of oxidative stability of crude and antioxidant stripped oils were as follows: Mustard oil > GCO> Flaxseed. These results indicate that the n-3 PUFA content of oils correlated with their oxidative stabilities.

14. Blending of GCO with edible vegetable oil like Sunflower, Rice bran and Sesame oils in different ratios has increased ALA levels and decreased LA (18:2) levels. And also decreased LA/ALA ratio from 50-150 (native oils) to 8-1.8 in the blended oils.

15. GCO blended oil showed increased total tocopherol content compared to native oils. Blended oil also comprised of oryzanol and lignans in RBO and SESO blends.
respectively. Blending of oil has brought variety of minor compounds together which are potential antioxidant activities. GCO and its blended oils showed good DPPH$^*$ radical scavenging activity when compared to respective individual oils.

16. *In-vivo* animal experiment carried out by feeding rats with GCO and its blended oils, in 8 different groups viz., GCO, RBO, SFO, SESO and GCO blended oils SFO+GCO, RBO+GCO, SFO+FLAX and SESO+GCO. Rats fed blended oils has n-6/n-3 PUFA ratio of 2.3 to 2.6 and in native oils 50.2-157.

17. GCO and GCO blended oil fed rats did not cause mortality, no significant changes in food intake, body weight gain, organ weights, clinical enzymes, histological changes in vital organs thus indicating that GCO did not affect the growth and produced any adverse effect in the rats.

18. Dietary feeding of GCO and its blended oils significantly increased ALA, EPA and DHA content and decreased AA levels significantly in serum, liver heart and brain. Hence, GCO and blended oil significantly influenced the long-chain fatty acid metabolism.

19. Feeding of GCO and GCO blended oils significantly decreased TC, TAG, LDL-C in liver and serum compared to native oil fed rats. GCO, when fed as the sole source of lipid in the diet showed relatively higher hypolipidemic effect compared to GCO blended oils with other vegetable oils.

20. Dietary feeding of ALA rich GCO and its blended oils to rats induced hypotriglyceridemic effect by decreasing the rate of fatty acid synthesis by down-regulating fatty acid synthase enzymes and up-regulating fatty acid oxidation enzymes in mitochondria compared to n-6 PUFA rich oils fed rats.

21. Dietary lipids have influenced the lipid peroxide content of serum and liver of rats. Rat fed diet containing oil group GCO, SFO and SFO+GCO has significantly higher lipid peroxide levels in serum & liver when compare to RBO, SESO, RBO+GCO and SESO+GCO. However, the blends of GCO with RBO and SESO didn’t show any difference compare to their respective native oils. However, the presence of antioxidants namely oryzanol and lignans in RBO and SESO may
have protected the liver from lipid peroxidation. Further, a significant increase in
tissue tocopherol and other minor constituent levels in serum and liver could offer
protection against lipid peroxidation in tissues of rats fed with vegetables oils
blended with GCO

22. GCO and its blended oils significantly increased the serum & liver tocopherols
levels and activity of antioxidant enzymes namely catalase, glutathione peroxidase
(GPx), but did not affect the activity of glutathione reductase (GR), superoxide
dismutase (SOD) and glutathione S-transferase (GST). Thus, blending of n-3 rich
GCO with edible vegetable oil may potentiate the antioxidant status and
antioxidant enzyme activity of oil in in-vivo.

23. Feeding of GCO and blended oils has significantly lowered platelet aggregation
by increasing n-3 PUFA levels in platelets and decreasing proaggregatroy
prostaglandin thromboxane and prostacyclin, thus reducing the risk for events
leading to thrombosis.

24. Microencapsulation of Garden cress oil (GCO) using different wall materials such
as sodium caseinate (SACA), whey protein concentrate (WPC), blend of
maltodextrin and gum arabica (MDGA) and skimmed milk powder (SKM) was
examined using spray-drying method.

25. Physicochemical properties of GCO microencapsules were evaluated with
reference to encapsulate size, shape, surface oil, encapsulation efficiency and
oxidative stability as a function of storage temperature and time.

26. The surface oil content increased significantly and microencapsulation efficiency
(ME) decreased as oil/wall material ratio increased irrespective of type of wall
material used. Highest ME efficiency of 85.4% was obtained with SACA
followed by WPC, MDGA and SKM.

27. The particle sizes of microencapsulae were in the range of 13.3–31.3 μm and no
significant change was observed with respect to the type of wall material and
oil/wall material ratio. The topography (SEM image) of spray dried powder
showed spherical shape with void volume inside. The outer surface the capsule
was smooth surface without any cracks irrespective of wall material used. It is observed dents on the microcapsule surface of the SACA, WPC and SKM. The numbers of dents were more on the SACA and WPC capsule surface when compared to SKM. However the MD+GA capsules did not show any dents on the surface.

28. The influence of microencapsulation on fatty acid profile was evaluated especially with respect to α-linolenic acid levels in microencapsules. SACA offered good oxidative stability and the microencapsulation process did not affect fatty-acid composition of GCO in the all wall material used. Thus, the encapsulated GCO powder can be supplemented in food products to enhance plant-based n-3 fatty acid.

29. Microcapsulation of GCO (MGCO) was prepared in whey protein concentrate with oil/protein ratio of 0.4, by spray-drying method. Microencapsulated GCO powder (MGCO) contained 25 g of GCO/100 g with microencapsulation efficiency of 64.8% and particle size of 15.4 ± 9.1 microns. Biscuits were prepared by supplementing MGCO at 20 g/100 g or GCO at 5.0 g/100 g by replacing flour and fat or fat in biscuit formula.

30. The diameter or spread had slightly decreased in MGCO biscuits compared to controls. The thickness of control, GCO and MGCO biscuits was 0.56, 0.50 and 0.67 cm, respectively. The weight of the MGCO biscuits was 6.83 g and these were slightly lighter than control biscuits (7.23 g). This may be due to whey protein in MGCO biscuits. Density of biscuits which is a measure of texture of biscuit significantly decreased in MGCO biscuits compared to control which could be due to the porous nature of the MGCO biscuits. Slightly higher breaking strength observed in MGCO biscuits than control biscuits, this could be due to higher thickness of MGCO biscuits.

31. The nutritional composition of the biscuits shows that the protein content of MGCO was found to be 55% higher than control and GCO biscuits. The ALA content was 1.02 and 1.05 g/100 g respectively in MGCO and GCO biscuits and there was no significant loss as its retention was 96% after baking. Thus, the
biscuits prepared from the MGCO were nutritionally superior in terms of protein and ALA (n-3 PUFA).

32. Biscuits were packed in metalized PET film (MPET) pouches, stored at three different storage conditions, viz., 90%RH/38 °C for 3 months, 30–40%RH/38–40 °C for 4 months and 65%RH/27 °C for 5 months. Biscuits stored at 90% RH/38 °C had one month shelf-life, whereas at 30–40% RH/38–40 °C and 65%RH/27 °C, they lasted 4 and 5 months, respectively. However, in all the three storage conditions oxidation rate of ALA was high in GCO-supplemented biscuits compared to MGCO biscuits indicating that the encapsulation prevented oxidation of ALA in biscuits.

33. The sensory score rating of color, crumb color and surface characteristics of MGCO biscuits were found to be equal or comparable to the control biscuits. Texture and mouth feel scores of MGCO were significantly low compared to control biscuits. MGCO biscuits were moderately harder in texture due to the presence of WPC and Maillard reaction, which may also, affected their mouth feel.