# A Study on the Extraction of Essential Oil from Marigold (*Tagetes erecta* L.) and its Characterization

**THESIS**

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# Summary of the Thesis

- The highest yield of essential oil was obtained from solvent extraction method by using n-hexane as a solvent, was recorded (8.33 %) in the Dry Flower Soxhlet Extract (DFSE) followed by the Dry Leaf Soxhlet Extracts (DLSE) which showed (6.33 %) oil yield.
- The highest yield of essential oil from Hydro-distillation method from various samples of African marigold plant parts was recorded in the Fresh Flower Clevenger Extract (FFCE) sample (0.45 %) followed by the Dry Flower Clevenger Extracts (DFCE) which showed (0.42%) oil yield.
- For standardization of extraction procedure, it can be concluded that solvent extraction exhibited higher extraction efficiency than the hydro distillation method.
- In the preliminary qualitative phytochemical screening, total eleven phytochemical tests were performed. Out of which 4 phytochemicals which is flavonoid, terpenoids, alkaloid and Coumarins were identified in all the samples.
- Steroids, glycosides and saponins were absent in all the samples.
- Phenols were present in fresh and dry flowers oil extracted by both methods.
- Triterpenoids were present only in the dry flower sample, extracted by soxhlet.
- Tannins present in fresh and dry flowers oil extracted by hydro-distillation and dry flowers oil sample extracted by soxhlet apparatus.
- Quinones were absent in fresh leaves sample extracted by both methods
- Qualitative screening of Fresh Flower Clevenger Extract (FFCE) using FT-IR Spectroscopy showed the presence of total 16 peaks. The main functional groups found were amide, alkane, aldehydes, carboxylic acid and aliphatic amines.

- In Dry Flower Clevenger Extract (DFCE) sample, total 15 peaks were obtained with alcohols, phenols, alkanes and aromatics.
- The screening of Fresh Leaves Clevenger Extract (FLCE) showed the presence of 14 peaks. The main functional groups were 1* 2* amines, amides, alkanes and carboxylic acid.
- Dry Leaves Clevenger Extract (DLCE) showed the existence of 17 peaks and the main functional groups found were alkanes, nitro compounds, aliphatic amines and aromatics.
- The observations recorded from the qualitative screening of Fresh Flower Soxhlet Extract (FFSE) showed the presence of minimum peaks i.e. eleven (11) from the frequency ranges from 400 to 4000$cm^{-1}$. The characteristic functional group found were alcohols, phenols and alkanes.
- Dry Flower Soxhlet Extract (DFSE) showed the existence of 16 peaks. The main functional groups found were alkanes and aliphatic amines.
- The maximum number of peaks i.e. 22 was found in the Fresh leaves Soxhlet Extract (FLSE). Presence of more peaks clearly indicates the presence of more phytochemicals in the sample. Alkanes, aliphatic amines, phenols, alcohols,
- The observations recorded from the qualitative screening of Dry Leaves Soxhlet Extract (DLSE) showed the presence of 14 peaks from the frequency ranges from 400 to 4000$cm^{-1}$. The characteristic functional group found were alcohols, aromatics, aliphatic amines.
- The quantitative screening of Fresh Flower Clevenger Extract (FFCE) by DART-MS showed the existence of major compounds at *m/z* values from 50 to 1000. The sample exhibited the major compounds like tagetone (Relative intensity 90%),

linalool, fenchol, terpinen-4-ol ((Relative intensity 13%), piperitenone, ocimenone, umbellulone, verbenone (Relative intensity 10%).

- The Dry Flower Clevenger Extract (DFCE) showed the presence of many peaks which could be best match with the compounds like tagetone (Relative intensity 91%), trans dihydro-carvone epoxide, a-campholenic acid (Relative intensity 16%), phenolic compound galic acid (Relative intensity 7%).
- Quercetagetin (Relative intensity 7%), 6b-Acetoxyeudesm-4 (15)-en-7bol (Relative intensity 11%), 2-Acetoxyfuranoelemene (Relative intensity 12%), were the compounds which could be best match with the peak obtained in the Fresh Leaves Clevenger Extract (FLCE).
- Quercetagetin (Relative intensity 7.2%), n-Heneicosane (C21), Methyl oleate (Relative intensity 19.8%) were obtained in the Dry Leaves Clevenger Extract (DLCE) sample was best match with the *m/z* values of sample.
- The peaks obtained in Fresh Flower Soxhlet Extract (FFSE) were best matched with the compounds tagetone (Relative intensity 40.8%), linalool, fenchol, tterpinen-4-ol (Relative intensity 7.4%), terpinolene, thujene, sabinene, α-terpinolene, α pinene, β-ocimene, limonene (Relative intensity 2.3%).
- In Dry Flower Soxhlet Extract (DFSE) the peak obtained were could be due to tagetone (Relative intensity 52%), linalool, fenchol, terpinen-4-ol (Relative intensity 14%), mannitol (Relative intensity 7.9%).
- In quantitative screening of Fresh Leave Soxhlet Extract (FLSE), the peaks were obtained were best matched with the Quercetagetin (Relative intensity 95%). 2-Acetoxyfuranoelemene (Relative intensity 97.5%). Kaempferol-3-O-α-L-arabinoside (Relative intensity 3.5%).

- Terpinolene, thujene, sabinene, α-terpinolene, α pinene, β-ocimene, limonene (Relative intensity 8%). Lemnalone, Taylorione (Relative intensity 15%).8, 9-Dehydrothymol acetate (Relative intensity 8.5%) were the compounds which could be best match with the peak obtained in the Dry Leaves Soxhlet Extract (FLCE).
- The highest yield of essential oil from flowers was obtained from winter crop from the sample DFSE (8.33%) through solvent extraction method by using n-hexane as a solvent followed by summer crop from DFSE (7.0 %). The minimum recovery of essential oil from flowers was recorded in the summer crop from the sample FFSE (0.36%).
- The highest yield of essential oil from leaves was obtained from winter crop from the sample DLSE (6.33%) through solvent extraction method by using a non-polar solvent n-hexane as a solvent followed by summer crop from DLSE (5.33 %). The minimum recovery of essential oil from leaves was recorded in the summer crop from the sample FLSE (0.30%).
- It was concluded from season wise yield of essential oil, that the winter crop is more suitable for the extraction of essential oil from African marigold (*Tagetes erecta* L.). The solvent extraction method exhibited higher extraction efficiency than the hydro distillation method using n-hexane as solvent by solvent extraction method, recorded maximum essential oil yield in both the winter and summer.
- The Fresh leaf (FL) sample (IC50=32.71±0.35) showed highest radical scavenging ability as compared to the other essential oils in the order: Fresh Leaf> Dry Leaf> Fresh Flower>Dry Flower.