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SOLVENT EXTRACTION AND ISOLATION PROCESS TO YIELD LUTEIN FROM MARIGOLD FLOWER USING A SINGLE POLAR ORGANIC ALKALINE SOLVENT

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ABSTRACT

Lutein and its isomer zeaxanthin are key chemical constituents of marigold flowers to build the macula (a yellow spot) located in the retina. Lutein is a nutraceutical that has antioxidant properties. Deficiency of lutein can cause macular degenerative disease mostly in old age. It is very useful for treating age-related macular degenerative diseases. This review proposal includes an extraction technique for Lutein from both wet, dry marigold flowers with alkaline methanol. It would be an effective, low-cost, and easy to time-saving process with a single polar organic solvent. Methanol is a more polar organic solvent than others alcohol substituents. Mostly used solvents (hexane, ethyl acetate, ethanol, isopropyl alcohol) in the extraction process of lutein ester and lutein. Here is a property of methanol to dissolve sodium hydroxide partially which is easy to make alkaline methanolic solution. Lutein fatty acid ester, lutein ester, and lutein diesters themselves go through hydrolysis reaction to form lutein. The boiling point of methanol is 65°C approximately. Therefore in methanol, the degradation possibilities of lutein esters and lutein are less than other polar organic solvents on reflex. The oleoresin is an impure form of lutein including lutein ester, xanthophylls, and many other carotenoid pigments. After all, they could be more easily soluble in methanol than pure lutein. The alkaline methanol could be used for the saponification reaction of oleoresin and lutein ester, lutein's fatty acid ester to yield lutein. Alkaline methanol without water can be beneficiary to reduce hours of saponification reaction. Methanol can be used for recrystallization purposes to remove polar impurities of crude lutein after a saponification reaction.

KEYWORDS: Marigold flower, Lutein, zeaxanthin, oleoresin, lutein ester, xanthophylls, carotenoids, NaOH and methanol, etc.

INTRODUCTION

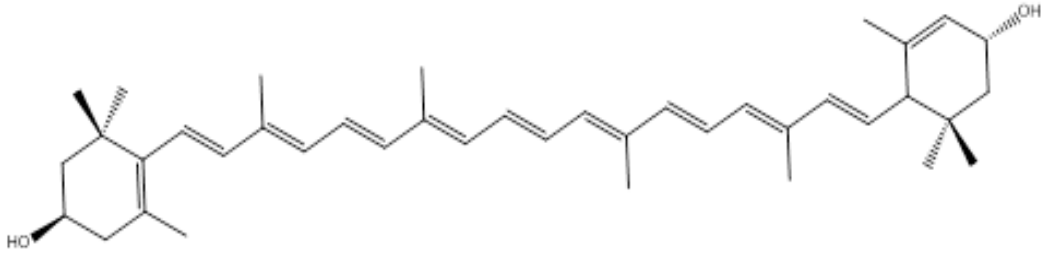
Lutein is a phytochemical that comes in a class of carotenoids which represents an antioxidant and protective property against the degradation of amino acids on heating with sugar molecules which then form a browning condensed compound of Maillard reaction.[1,5]

Lutein and lutein ester come in a crude form of oleoresin after the extraction process. A pure form of Lutein works against age-related macular degeneration disease (AMD) which is phenomenal to the macula lutea inside the retina. AMD disease of the eyes is caused by a deficiency of lutein as well as zeaxanthin in the macula lutea(which is characterized by a yellow spot therein) in the retina.[2,3]

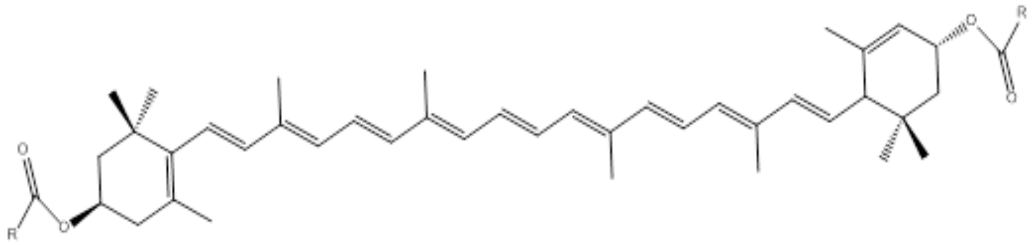
The lutein's rich natural sources are also microalgae[4] from sea and ponds, egg yolk[5], one of the sources of lutein. Higher concentration of lutein ester in petals of marigold flower including other xanthophylls. The lutein and lutein esters are also xanthophylls.[6] The macular region in the retina of the eyes can be protected by lutein's daily fixed doses and consumption by human beings. Lutein is not synthesized in humans and animals. Xanthophyll comes under carotenoids. Lutein and zeaxanthin are positional isomers of each other and protect from the generation of free radicals by the short wavelength radiation of UV rays from sunlight.[7] The polar molecule is lutein whereas carotenes stand for similar polyunsaturated hydrocarbons having more than one isoprene unit. Marigold flower a richest source of lutein esters. Effective properties of lutein against diabetes and cell growth of breast cancer.

Related chemical structures are represented in Fig.1 as below[8]

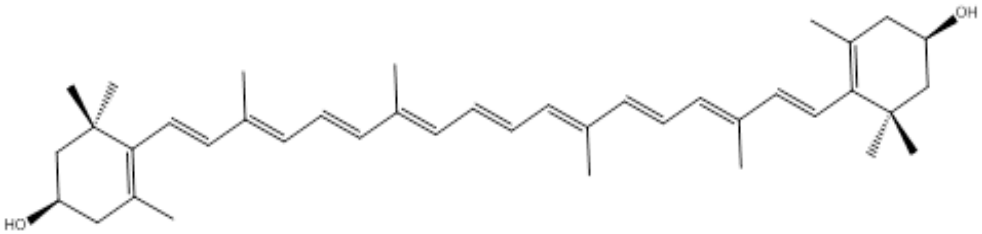
1. **Lutein**



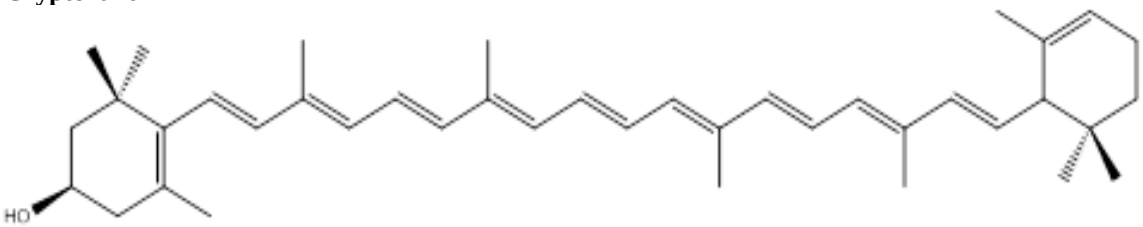
2. **Lutein ester**



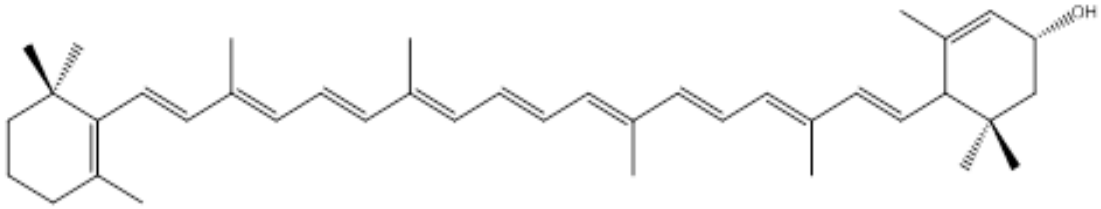
3. **Zeaxanthin**



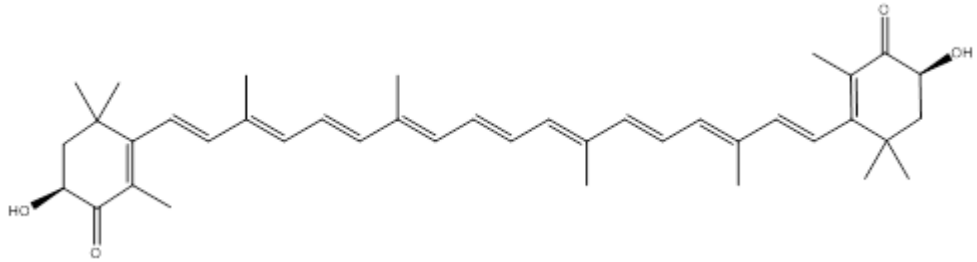
4. **β-Cryptoxanthin**



5. **α-Cryptoxanthin**



6. **Astaxanthin**



7. Fucoxanthin

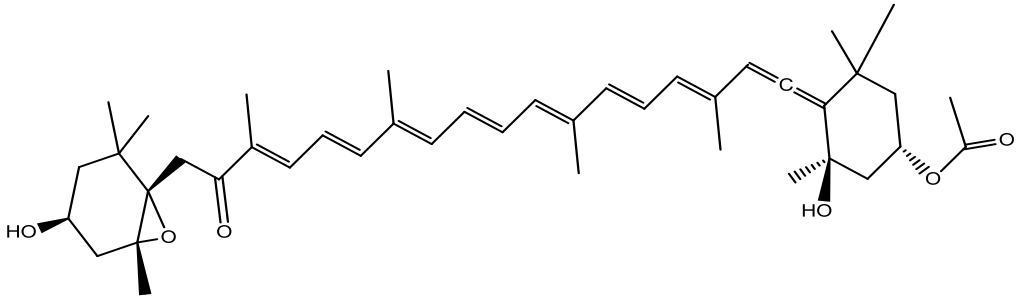


Fig. 1.

Since Lutein and zeaxanthin are positional isomers of each other based on the position of the double bond in structures 1 and 3 of Fig.1,

The structural analysis of lutein could be performed by analytical tools such as UV spectrophotometry, FTIR spectroscopy, Mass spectrometry, and NMR(13C and 1H-NMR) spectroscopy. Whereas the R.F value of lutein by preparative TLC and the purity by HPLC, GC/MS, and LC/MS, etc.

Methods of extraction: The extraction process of lutein and lutein ester of the marigold flower has been done before in many research and review articles and papers. Extraction of lutein by Supercritical carbon dioxide extraction which is quicker than other solvent's extraction.[8] The marigold flower (tagetes erecta) is the richest source of xanthophylls. Before extraction by solvents, the enzymatic treatment increases the percentage of Xanthophylls.[9] Extraction of lutein from marigold flower was done by microwave technology.[10] After extracting the lutein with the help of a supercritical liquid of carbon dioxide could be made more stable by using coconut oil as a co-solvent while doing extraction.[11] Extraction of lutein ester with the help of supercritical fluid carbon dioxide from microalgae.[12] The isopropanol with KOH as the alkaline solution was used to extract lutein from the marigold flower.[13] Marigold flower petals are one of the richest sources of lutein after microalgae.[14] Carotenoids are fat-soluble pigments as chemical constituents of plants, algae, and photosynthetic bacteria. Whereas extraction of oleoresin by hexane furthermore saponification reaction was done by using ethanolic KOH to obtain crude lutein. The extraction, saponification, and purification method involved multiple solvents including ethanol.[15] The extraction process of lutein or their related esters is suitable with polar organic solvents. However, the extraction using supercritical carbon dioxide is not efficient due to lutein is a polar molecule.[16] Lutein and other xanthophylls show anti-cancer activity and the purity peak was fined out by HPLC.[18] Dried leaves of Indian spinach Basella alba were made into powder. Two methods were used to extract lutein one by diethyl ether and methanol mixture and the other one by petroleum to get dark color thick past of oleoresin from Indian spinach.[20] The extraction process of lutein from marigold flower using dimethyl ether, KOH, and ethanol.[21] 2-methyl tetrahydrofuran is used to extract lutein from the marigold flower(tagets erecta).[22] Dimethyl ether was used for extraction of xanthophylls and ethanol and KOH was used for hydrolysis of lutein fatty esters as a saponification reaction within 1 hours.[21] 2-methyltetrahydrofuran was used for the extraction of lutein.[22] Saponification was done using alcoholic KOH.[25] Soxhlet apparatus with ethanol extraction of carotenoids from the marigold flower was reported.[26] Enzymatic extraction of lutein with the help of microwave.[27] Astaxanthin as a carotenoid has more UV protection from sunlight as well as skin whitening and anti-aging properties than the E-isomer carotenoids.[29] Lutein was extracted using a surfactant-based aqueous two-phase system.[33]

Method of extraction proposal

The extraction process of lutein ester and lutein from both wet or dry marigold flower will be developed using methanol and alkaline methanol to extract lutein and lutein ester to yield crude luiein after saponification reaction with the help of NaOH pellets.

Recrystallization or purification of crude lutein would be performed with the help of methanol a single organic solvent with water.

DISCUSSION

Methanol comes in the polar organic solvent category which would make it easy to wash out some organic sodium salts and polar impurities and unwanted oleoresin of crude lutein after the saponification reaction. Therefore methanol might be helpful while purification of crude lutein with minimal degradation of lutein at 65 to 67°C. The alkaline methanol is for saponification purposes in the manner of a less time-consuming reaction. The traces of methanol could also be removable down to less than 15 ppm because its boiling point is approx 65°C.

In this review, the alkaline methanol (methanolic NaOH) concludes a single organic polar solvent which could be introduced in the future extraction proposal. Which would be useful to develop the extraction process of lutein for process research and development purposes.

Table of contents for lutein extraction process:-

Table No.1

S.N	Solvent extraction process	In hours converting lutein esters to lutein.	For lutein isolation	Existing methods / A Single method of extraction proposal
1.	Isopropanol with KOH[13]	1.5 hours at 500 °C	The crystallization method Isopropanol	Existing methods of extraction
2.	Dimethyl ether and Ethanol with KOH[21]	4 hours at 35 °C.	The crystallization method with ethanol	
3.	2-methyl tetrahydrofuran with tetrahydrofuran and hexane[22]	-	-	
4.	Alcoholic-KOH with tetrahydrofuran[25]	4 hours at 25 to 30 °C.	The crystallization method with ethanol	
5.	Ethanolic-KOH [42] including water	30 min to 1 hour at 65 to 70 °C.	The crystallization method with ethanol/water	
6.	Methanolic-NaOH	15 min. to 30 min. at 65 °C	The crystallization method with methanol/water	Method of extraction proposal

CONCLUSION

After reviewing all aspect of extraction process from small to large scale of producing lutein in past publication of research, review articles and patents. We are close to reach a new aspect of lutein extraction and isolation with the help of methanolic-NaOH can be called an alkaline methanol during the reaction sodium methoxide forms. This alkaline media with methanol would be time saving process with rapid hydrolysis of lutein ester present in marigold flower.

REFERENCES

1. Ma, L., Dou, H. L., Wu, Y. Q., Huang, Y. M., Huang, Y. B., Xu, X. R., ... & Lin, X. M. British Journal of Nutrition, 2012; 107(3): 350-359.
2. Jager, R. D., Mieler, W. F., & Miller, J. W. New England Journal of Medicine, 2008; 358(24): 2606-2617.
3. Bone, R. A., Ruiz, C. A., Landrum, J. T., & Guerra, L. H. The Journal of nutrition, 2003; 133(4): 992-998.
4. Leong, Y. K., & Chang, J. S. Lutein biosynthesis from microalgae—Recent advances and circular economy. Environmental Technology & Innovation, 2023; 30: 103097.
5. Handelman, G. J., Nightingale, Z. D., Lichtenstein, A. H., Schaefer, E. J., & Blumberg, J. B. The American journal of clinical nutrition, 1999; 70(2): 247-251.
6. Alam, A. U., Couch, J. R., & Creger, C. R. Canadian Journal of Botany, 1968; 46(12): 1539-1541.
7. Roberts, R. L., Green, J., & Lewis, B. Clinics in dermatology, 2009; 27(2): 195-201.
8. Nwachukwu, I. D., Udenigwe, C. C., & Aluko, R. E. Trends in Food Science & Technology, 2016; 49: 74-84.
9. Sowbhagya, H. B., Sushma, S. B., Rastogi, N. K., & Naidu, M. M. Journal of food science and technology, 2013; 50: 122-128.
10. Yang, C., & Li, M. In 2016 2nd International Conference on Materials Engineering and Information Technology Applications (MEITA 2016), 2017, February; 483-486. Atlantis Press.
11. Shaikh, A. A., Ray, A., & Singhal, R. S. Co-extraction of marigold flowers (Tagetes erecta L.) and dried coconut (Cocos nucifera L.) shreds using supercritical carbon dioxide: Characterization and functional food formulations. Food Chemistry Advances, 2023; 2: 100189.
12. Liau, B. C., Shen, C. T., Liang, F. P., Hong, S. E., Hsu, S. L., Jong, T. T., & Chang, C. M. J. Supercritical fluids extraction and anti-solvent purification of carotenoids from microalgae and associated bioactivity. The Journal of Supercritical Fluids, 2010; 55(1): 169-175.
13. Wang, T., Han, J., Tian, Y., Zhang, D., Wang, Y., Wu, Y., & Ni, L., 2016; 51(9): 1490-1498.
14. Lin, J. H., Lee, D. J., & Chang, J. S. Lutein production from biomass: Marigold flowers versus microalgae. Bioresource Technology, 2015; 184: 421-428.
15. Brazana, E. Madavalappil, Bangalore (IN) lation 8 pages). Moeller et al., "The Potential Role of Dietary Xanthophyllis in Cata. Methods. In Enzymology, 1992; 213.
16. Gao, Y., Nagy, B., Liu, X., Simándi, B., & Wang, Q. The Journal of Supercritical Fluids, 2009; 49(3): 345-350.
17. Blesso, C. N., Andersen, C. J., Bolling, B. W., & Fernandez, M. L. Food & function, 2013; 4(2): 213-221.

18. P. Boonnoun, T. Opaskonkun, P. Prasitchoke, M. Goto, and A. Shotipruk, Eng. J., Jun. 2012; 16(5): 145-156.
19. Parklak, W., Ounjaijean, S., Kulprachakarn, K., & Boonyapranai, K. In vitro α-amylase and α-glucosidase inhibitory effects, antioxidant activities, and lutein content of nine different cultivars of marigold flowers (Tagetes spp.). Molecules, 2023; 28(8): 3314.
20. Prabhu, A., Abdul, K. S., & Rekha, P. D. Isolation and purification of lutein from Indian spinach Basella alba. Research Journal of Pharmacy and Technology, 2015; 8(10): 1379-1382.
21. Boonnoun, P., Tunyasitikun, P., Clowutimon, W., & Shotipruk, A. Food and bioproducts processing, 2017; 106: 193-200.
22. Kashyap, P. K., Singh, S., Singh, M. K., Gupta, A., Tandon, S., Shanker, K., ... & Verma, R. S. An efficient process for the extraction of lutein and chemical characterization of other organic volatiles from marigold (Tagetes erecta L.) flower. Food Chemistry, 2022; 396: 133647.
23. Hojnik, M., Škerget, M., & Knez, Ž. Extraction of lutein from Marigold flower petals–Experimental kinetics and modelling. LWT-Food Science and Technology, 2008; 41(10).
24. Gansukh, E., Mya, K. K., Jung, M., Keum, Y. S., Kim, D. H., & Saini, R. K. Food and chemical toxicology, 2019; 127: 11-18.
25. Kumar, R., Yu, W., Jiang, C., Shi, C., & Zhao, Y. Journal of food process engineering, 2010; 33(6): 1065-1078.
26. Núñez, S., Valero, M. S., Mustafa, A. M., Caprioli, G., Maggi, F., Gómez-Rincón, C., & López, V. Ultrasound-assisted extraction versus traditional Soxhlet apparatus for the obtention of polyphenols, carotenoids and tocopherols from Tagetes erecta L. flowers. Journal of the Science of Food and Agriculture, 2024.
27. Fu XiaoQian, F. X., Ma Na, M. N., Sun WeiPeng, S. W., & Dang YanYan, D. Y. (2018). Microwave and enzyme co-assisted aqueous two-phase extraction of polyphenol and lutein from marigold (Tagetes erecta L.) flower.
28. Eisenhauer, B., Natoli, S., Liew, G., & Flood, V. M. Lutein and zeaxanthin—Food sources, bioavailability and dietary variety in age-related macular degeneration protection. Nutrients, 2017; 9(2): 120.
29. Banik, S., Ghosh, A., Takano, T., Tsukamoto, M., Takasu, S., & Honda, M. Geometrical isomers of lutein and fucoxanthin: unveiling their antioxidant potentials and skin-related biological activities. Food Chemistry Advances, 2024; 5: 100817.
30. Fernández-Sevilla, J. M., Acién Fernández, F. G., & Molina Grima, E. Applied microbiology and biotechnology, 2010; 86: 27-40.
31. Gong, M., & Bassi, A. Biotechnology advances, 2016; 34(8): 1396-1412.
32. Becerra, M. O., Contreras, L. M., Lo, M. H., Díaz, J. M., & Herrera, G. C. Lutein as a functional food ingredient: Stability and bioavailability. Journal of Functional Foods, 2020; 66: 103771.
33. Maheshwari, N., Arya, R. K., Verros, G. D., Dhamole, P. B., & Kannan, A. Surfactant-enhanced extraction of lutein from marigold petals using an aqueous two-phase system. Separations, 2023; 10(2): 133.
34. Agrawal, A., Jain, N., & Singhal, R. Research Journal of Pharmacy and Technology, 2022; 15(1): 285-287.
35. Krishna, T. U., Pragalyaashree, M. M., & Balamurugan, P. Drug Invent. Today, 2018; 10: 2618-2621.
36. Rahman, Z., Panda, B. P., Ahmad, S., & Aeri, V. Green Extraction and Optimization of Lutein From Tagetes erecta by Ultrasound-Assisted Extraction Method and Identification by High-Performance Liquid Chromatography Method. Separation Science Plus, 2025; 8(1): e202400127.
37. Keddar, M. N., Ballesteros-Gómez, A., Siles, J. A., Rubio, S., & Martín, M. A. Lipid and lutein recovery from desertic microalgae in saline wastewater combined to abiotic stressors for sustainable antioxidant and biodiesel production. Algal Research, 2025; 86: 103903.
38. Kashyap, P. K., Singh, S., Singh, M. K., Gupta, A., Tandon, S., Shanker, K., & Verma, R. S. An efficient process for the extraction of lutein and chemical characterization of other organic volatiles from marigold (Tagetes erecta L.) flower. Food Chemistry, 2022; 396: 133647.
39. O, N., Shiekh, K. A., Jafari, S., Kijpatanasilp, I., & Assatarakul, K. Characterization of Marigold Flower (Tagetes erecta) Extracts and Microcapsules: Ultrasound-Assisted Extraction and Subsequent Microencapsulation by Spray Drying. Foods, 2024; 13(15): 2436.
40. Sharma, S., Das, A., Kumari, A., & Gupta, M. M. Phytochemistry Reviews, 2024; 1-22.
41. Sultana, H., Alakeel, K. A., Hassan, J., Mallick, S. R., Zakaria, M., Kayesh, E., & Alamri, S. Nutrients, bioactive compounds and antinutritional properties of marigold genotypes as promising functional food. Scientific Reports, 2025; 15(1): 4867.
42. Frederick khachik, Rockville (2007), The catholic university of America, Washington, DC. Process for isolation, purification, and recrystallization of Lutein from saponified Marigold oleoresin and uses thereof.