Review And Approaches in Extraction of Phytochemicals

A.Sunellkumhar[1], DR.M.Chellapa[2]
[1, 2] Dept of pharmaceutics
[1, 2] Pallavan pharmacy college, Iyyengarkkulam, Kolivakkam, Kanchipuram-631502

Abstract- *Phytochemicals are herbal compounds produced with the aid of vegetation via primary or secondary metabolism. Phytochemicals have been used as a conventional remedy, nowadays research is completed on the usage of phytochemicals as antibiotics as microorganisms had turned out to be resistant to antibiotics. as a result this review article discusses the extraction of such phytochemicals from vegetation. Extraction of phytochemicals which includes tannins, phenols, terpenoids, carotenoids, and alkaloids was mentioned in this evaluation article.*

Keywords- Phytochemicals, herbal, metabolism, erpenoids, carotenoids,tannins,extract.

I. INTRODUCTION

Herbal Medicine = Botanical or Phytotherapy[(4).] By the use of seeds, berries, roots, leaves, bark, or flowers for medicinal purposes

Medicinal plants, abutment for curing the disease for mankind as well as animals worldwide since antiquity to date, back in the thirdmillennium bc, SUMMARIAN and AKKADIAN civilization describes the therapeutic use of plants, an ancient record has the evidence of creating clay tablets and a list of hundreds of medicinal plants by the Sumerians, HIPPOCRATES (ca. 460-377 BC). One of the ancient authors enlisted approximately more than 400 different plant species for medicinal purposes[(1)].

During the 21st century there was no interest in the knowledge of advanced plant-based chemistry by the pharmaceutical companies and scientists, The researchers show greater interest in synthetic drugs because there was easy mass–produced compared to natural ones (Schmidt and ribnicky, 2008) [(2)].

During the past decade traditional herbal medicine has gained considerable momentum worldwide and played various roles in health care programs especially in developing countries[(4)].

Key obstacles that may be problematic such as poor standardization levels and not good manufacturing practices and the lack of documentation have hindered the acceptance of herbal medicine in developing countries[(4)].plant mediate their effect in a biological system by their chemical constituents by their processes similar to already well-understood chemical compounds of conventional drugs[(7)].

Raw materials having medicinal properties obtained from the desired plant by the means of extraction include solvent extraction, distillation method, pressing, and sublimation according to the extraction principle [(6)].

This article is intended to show an indiscriminate view of the various method used In the extraction and extraction of phytochemicals.

II. PHYTOCHEMICALS

Generally, the plant produces chemical compounds by primary and secondary metabolism that help them to resist fungi, bacteria, and plant virus infection, and the chemical compound is termed phytochemicals or phytoconstituents.[(10)]

Table 1 Classification of Phytochemical

MAJORCLASSES	SUBCLASSES	REPRESENTATIVES
Phenols	Polyphenol	flavonoids, isoflavonoids,chalconoids,lignans, Stilbenoids (eg.resveratrol),curcuminoids, Tannins (eg., protocatechuic and chlorogenic Acid)
	Aromatic acid	phenoic acid (eg., gallic acid, tannic acid, Vanillin, ellagic acid), hydroxycinnamic acid (eg., coumarin)
Terpenes	monoterpene(C10 myrcene Sesquiterpenes(C15) Diterpenes(C20) Triterpenes(C30)	Geraniol, limonene, pyrethroids Costunolides Abietic acid, cafestol, gibberellin Azadirachtin, phytoecdysones
Polyterpenes(C5)n	Tetraterpenes,	carotenoids, rubber
Terpenoids	Carotenoids (tetraterpenes) Xanthophylls Triterpenoid Steroids	β-carotene, lycopene, phytoene lutein, zeaxanthin saponins,ursolic acid tocopherols (Vit E),phytosterols
N(orano-Nitrides)	alkaloids	nicotine, morphine, caffeine, theobromide,theophylline
Glycoside	Cyanogenic-Nonprotein amino	canavanine, azetidine-2-carboxyliacid
S(organo- sulfides)	allicin,alliin,piperine, Glutathione, Phytoalexins	canavanine, azetidine-2- carboxyliacid

Phytochemicals have been classically classified into primary and secondary metabolites. Primary metabolites include the common sugar, amino acids, proteins, purines, and pyrimidines of nucleic acid, chlorophylls, etc .remaining chemicals are secondary metabolites such as alkaloids, terpenes, flavonoids, lignans, plant steroids, curcumins, saponins, phenols and glycosides (HAHN,1998; RAMAWAT*et. Al.*, 2009).[9]

III. EXTRACTION TECHNOLOGY

Extraction is the empirical or mechanical process as bioactive components are extracted from plants, and co-extractive components are essential for its further separation [8]

IV. FACTORS INFLUENCING THE QUALITY OF THE EXTRACTION

- Plant parts (starting material)
- The solvent used for extraction
- Extraction procedure
- Plant materials: solvent ratio etc

V. THE TYPICAL EXTRACTION PROCESS INVOLVES THE FOLLOWING STEPS [5]

- Collection and authentication of plant material and drying
- Size reduction
- Extraction
- Filtration
- Concentration
- Drying and reconstitution

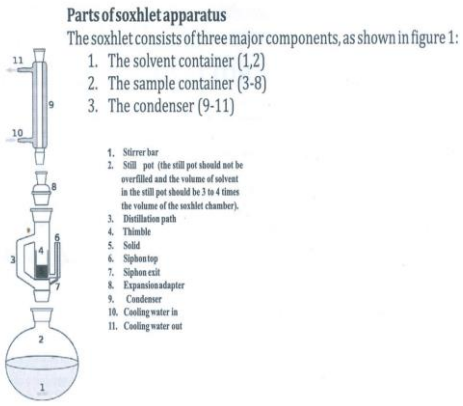
VI. HOT CONTINOUS EXTRACTION , SOXHLET EXTRACTION (SOXHLETRATION) :

Mesopotamian hot-water extractor of organic matter dating is a piece of archeological evidence which is an earlier example of a continuous extractor. approximately 350 bc. early soxhlet the french chemist ANSELME PAYEN to be the first used continuous extractor 1830's after this soxhlet is invented by FRANZ VON SOXHLET for quantification of fat in milk & it is required when the compound has desired solubility in solvent & impurity is insoluble in the solvent.[13]

WORKING :[14]

1. powdered sample material is enclosed in a thimble / porous bag which is built with strong filter paper (or) cellulose, the porous bag is placed in a thimble chamber of soxhlet apparatus
2. the solvent used for the extraction is taken in a round bottom flask & heated using a heating mantle & this employed temperature is used for extraction
3. the vapourised solvent reaches condensed and drips back to the thimble
4. when the liquid reaches the siphon arm, the liquid content is emptied into the bottom flask again.
5. the end of the process is indicated when a clear solution in a siphon tube is obtained

In this method, just one batch of solvent is recycled, rather than many warm solvents passing through the sample. thus it requires a minimum quantity of solvent compared to maceration technique, this technique applies to a higher temperature than the accelerated kinetic process, and its cost is minimal due to the absence of continuous solvent & filtration. [15]



VII. MACERATION

In this process plant extract is obtained from plant material (coarse or powder) enclosed in a closed stoppered container in a solvent allowed to stand at room temperature, the solvent used for this process may get easily evaporated so a sealed extractor is used to avoid solvent evaporation at room temperature, the soluble plant constituent release by softening and breaking the plant cell wall which is intended by this process, then the mixture is pressed (or) stained by filtration (or) decantation after a specific time, It ensures dispersal of the concentrated solution accumulating around the surface of the particle & brings fresh solvent to the surface of particles for further extraction [15]

VIII. INFUSION

It is in the form of a dilute solution.

Fresh infusions are prepared by macerating the solids for a short period with either cold or boiling water or readily soluble components of the crude drug.(23)

IX. PERCOLATION

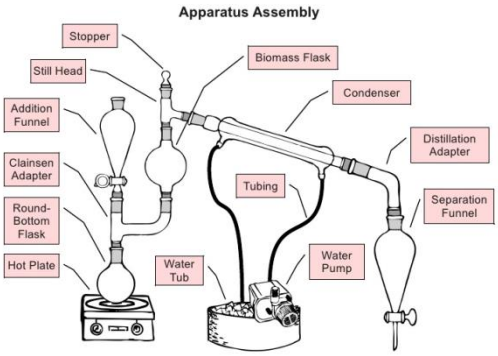
Percolationis the manner used most often toextract liv elyelements within the training of tinctures andfluid extracts. A percolator (a slender, cone-shaped vesselopen at each end) is generally used. The solid substances are moistened with the proper amount of the desired menstruum and allowed to face for about four hours in a properly closed box, and then the mass is packed andthe top of the percolator is closed. extra menstruum is delivered to form a shallow layer above the mass, and the mixture is authorized to macerate in the closed percolator for24 h. the hole of the percolator then is opened and theliquid contained therein is permitted to drip slowly.extra menstruum is delivered as required, till thepercolate measures about 3-quarters of the desired quantity of the completed product. The marc is then pressedand the expressed liquid is brought to the percolate.sufficient menstruum is brought to produce the required quantity, and the combined liquid is clarified by way of filtration or by using status accompanied by utilizing decanting. (18)

X. PRESSURIZED LIQUID EXTRACTION

Pressurized liquid extraction (PLE) appears as an advanced extraction method because of its advantages over conventional extraction approaches. PLE employs solvent extraction at high temperatures and pressures, constantly beneath their respectivecritical points, so that the solvent is maintained inside the liquid country for the duration of the complete extraction procedure. This approach is likewise called elevated solvent extraction (ASE), pressurized fluid extraction (PFE), pressurized warm solvent extraction (PHSE), excessive-pressure solvent extraction (HPSE), high-strain excessive-temperature solvent extraction (HPHTSE), and subcritical solvent extraction (SSE).(20)

XII. STEAM DISTILLATION

Steam distillation is a separation procedure that is composed in distilling water together with other volatile and non-volatile additives. The steam from the boiling water carries the vapor of the volatiles to a condenser; each are cooled and go back to the liquid or stable state, whilst the non-volatile residues stay at the back of within the boiling chamber. Steam distillation can be used while the boiling factor of the substance to be extracted is higher than that of water, and the starting material can't be heated to that temperature because of decomposition or different unwanted reactions. it is able to additionally be useful whilst the quantity of the desired substance is small in comparison to that of the non-risky residues. it is regularly used to split volatile critical oils from plant material. as an instance, to extract limonene (boiling factor 176 °C) from orange peels. (12)



XIII. DECOCTION

The cutting-edge procedure entails boiling the plant material in water to reap plant extracts. warmness is transferred through convection and conduction, and the choice of solvents will determine the sort of compound extracted from the plant fabric The sample is boiled in a distinctive extent of water for a defined time (15 to 60 minutes.) it miles then cooled, strained, filtered, and added enough water via the drug to achieve the preferred quantity. This approach is suitable for extracting thermostable (that doesn't modify with temperature) and water-soluble compounds, and hard plant substances and usually resulted in greater oil-soluble compounds than a maceration.(15)

XIV. COUNTERCURRENT EXTRACTION

In counter-modern-day extraction (CCE), themoist uncooked fabric has pulverized the use of toothed disc disintegrators to provide a first-class slurry. in this procedure, the fabric to be extracted is moved in a single route (usually within the shape of a nice slurry) within a cylindrical extractor in which it comes in touch with the extraction solvent. The addition the beginning material moves, the greater focused the extract will become. Complete extraction is accordingly viable when the quantities of solvent and material and their waft charges are optimized. The procedure is noticeably green, requiring little time and posing no danger from excessive temperature. in the end, sufficiently focused extract comes out at one to cease of the extractor while the marc (nearly free of visible solvent) falls out from the opposite end (Handa et al., 2008).(22)

XV. EXTRACTION OF PHYTOCHEMICALS

➢ EXTRACTION OF TANNIN

Ishak & Elgailani has extracted tannins from Acacia nilotica, Acacia seyal, and Acacia Senegal with the use of water, 70% acetone, and 80% methanol as solvent. among these solvents, 70% acetone turned into proved to be the great solvent for extraction of tannins. Hagerman has extracted tannin from leaves with aqueous acetone and acidic methanol. A massive amount of tannin was extracted with aqueous acetone and the quantity yielded turned dependent on the maturity of the leaf and the method with the aid of which it became preserved. Manila et al have extracted tannins from Guava leave with solvents Ishak & Elgailani have extracted tannins from Acacia nilotica, Acacia seyal, and Acacia Senegal the usage of water, 70% acetone, and eighty% methanol as solvent. among those solvents, 70% acetone became proved to be an excellent solvent for the extraction of tannins. Hagerman has extracted tannin from leaves with aqueous acetone and acidic methanol. A huge quantity of tannin turned into extracted with aqueous acetone and the amount yielded turned depending on the adulthood of the leaf and the approach by using which it was preserved. Manila et al have extracted tannins from Guava leave with solvents. (24)

➢ EXTRACTION OF TERPENES

Most of the terpenes (linear terpenes and cyclized terpenes without decoration) are solely composed of hydrocarbons, so those molecules are non-polar. The terpenes with 15 carbons or much less can be volatile due to their small length and low polarity which permit emissions to the environment, extraction of the terpenes by distillation or using an appropriate solvent or else trapping of compound (25)

A schematic depiction of terpene metabolism emphasizing the biosynthesis of the distinctive lessons of compounds and their physical properties (volatility and polarity).ionization of the prenyl precursors leads to linear and cyclized hydrocarbon scaffolds (e.g., compounds highlighted in green in the diagram that could frequently be extracted and measured using fundamental Protocol 1. (2) primary decorations can consist of the addition of methyl or hydroxyl organizations, yielding largely non-polar compounds (compounds highlighted in red in figure 1) that may be extracted and measured using simple Protocol 2. (3) further adjustments—which includes acylation, aroylation, glycosylation, and different substituent businesses—may also dramatically trade the bodily nature of the resulting terpenoids (e.g., compounds highlighted in blue in the diagram), which maximum likely require simple Protocols 2 and three for their extraction and dimension. The infinite array of scaffold bureaucracy and modifications has made the extraction and measurement of terpenes/terpenoids one of the most difficult and rewarding areas of chemical analysis

➢ EXTRACTION OF NON-VOLATILE TERPENES (PROTOCOL-1)

Non-volatile terpenes can be extracted with the usage of a completely non-polar natural solvent along with hexane. the use of silica as a stationary phase section in chromatography is any other ideal tool to split these non-polar terpenes from other compounds within the extract. throughout silica chromatography, terpenes with greater carbons typically elute more slowly than decrease molecular weight compounds, and cyclized terpenes can elute quicker than the corresponding non-cyclized terpene with an identical quantity of carbons due to their compact size. (17)

➢ EXTRACTION OF VOLATILE TERPENES (PROTOCOL-2)

Many monoterpenes and sesquiterpenes that serve crucial roles in plant interactions with their environments may be unstable and require special strategies for their analysis. unstable terpenes present in specific plant tissues may be directly studied using traditional extraction strategies (e.g., hydro distillation, extraction with the aid of organic solvent) and extra novel techniques. however, terpenes emitted to the ecosystem accumulate temporarily in leaf aqueous and lipid phases, and for this reason are found in the handiest small concentrations in tissue samples (Wu et al., 2006). subsequently, analyzing the biosynthesis and emission of terpene emissions calls for molecular trapping strategies. (25)

➢ EXTRACTION OF CAROTENOIDS

The acquired carotenoid-wealthy extract is typically used in health ingredients, meals components, medicines, and cosmetics. one of the troubles is the elimination of the residual solvents to obtain a secure extract .it's miles nicely hooked up that low efficiency in the extraction process of carotenoids can be due to the issue of the solvent molecules to penetrate the plant tissue and consequently solubilizing carotene, which is positioned inside the shape of the chromoplast, numerous extraction procedures involve the use of business enzyme preparations and they are complemented by way of extraction with organic solvents together with hexane and ethyl acetate and mixtures, which are accepted for use in foods in maximum nations. In the case of b-carotene, hexane has been one of the most broadly used solvents in the industry, because of its high affinity for carotenoids. Atmospheric liquid extraction with

maceration. Effective mobile disruption, both via physical, chemical, or mechanical way, is a prerequisite for the efficient extraction of intracellular carotenoids.(26) Pulsed electric powered field (PEF) and moderate electric area (MEF) assisted extraction. Enzyme-assisted extraction (EAE) Enzyme-assisted extraction (EAE) methods make use of hydrolytic enzymes to interrupt the structural integrity of mobile partitions to reveal intracellular materials for advanced extraction yield (19). Carotenoid extraction using inexperienced solvents. The solvents applied in the extraction approaches are commonly received from non-renewable sources. the extraction of carotenoids must be finished underneath unique situations, and be performed in the shortest feasible time for you to avoid exposure to light, oxygen, and excessive temperatures, so minimizing auto-oxidation and isomerization.(26)

- **EXTRACTION OF ALKALOIDS**

Alkaloids may be extracted using surfactant as an extracting agent. The well-known materials containing alkaloids are acidified with dilute acids which include sulphuric acid, hydrochloric acid, or acetic acid, and extracted with water. As extraction of plant material yields alkaloids collectively with different plant components such as sugar, starch, tannins, pigments, and proteins an extra extraction step with polar solvent was required. Polar solvents such as chloroform, diethyl ether, and isopropyl ether had been used amongst which chloroform had been proved to be the first-rate solvent. Jilani et al have extracted alkaloids from Hyoscyamusmuticus, Daturastramonium and Rutagraveolens wherein Mayer's reagent had been used to precipitate alkaloids. The prompted alkaloid was acidified (pH 3-4) with sulphuric acid after which basified (pH nine-10) with sodium carbonate answer and in addition, lipophilic, acidic, and neutral materials have been removed by using extracting with petroleum ether and diethyl ether, and final extraction of alkaloids became finished with chloroform. (24)

XIV. CONCLUSION

There may be a clear and developing hobby inside the extraction method which is economically viable and environmentally friendly. inside the procedure of plant extracting plant material, it's miles peremptory to reduce interference of components that may be co-extracted with the target compounds, and to bypass contaminant of the extract, furthermore to save you degradation of important metabolites or the formation of artifact due to extraction situations or solvent impurities. no matter the extraction method, the resulting answer has to be filtered to eliminate any particulates remember, The maximum suitable extraction method depends on the matrix of the vegetation and the type of compost, and should comply with clear choice criteria. the solvents for extraction of phytochemicals together with tannins, phenols, terpenoids, carotenoids, and alkaloids. Tannins are extracted with acetone and ethanol, phenols are extracted with aqueous ethanol, terpenoids are extracted with a combination of hexane and ethyl acetate, carotenoids are extracted with a combination of hexane and acetone, and alkaloids are extracted with chloroform. The yield of phytochemicals relies upon the solvent with which it's miles extracted.

REFERENCES

[1] Phytochemicals: extraction methods, basic structures and mode of action as potential chemotherapeutic agents jameshamueldoughari department of microbiology, school of pure and applied sciences, federal university of technology, yolanigeria

[2] Introduction to phytochemistry by chukwuebuka egbuna1,* , jonathan c. Ifemeje1 , toskë l. Kryeziu2 , minakshi mukherjee3 , hameed shah4 , g.m. Narasimha rao5 , laurence john francis j. Gido6 , and habibu tijjani7

[3] Health benefits and possible risks of herbal medicine shadia m. Abdel-aziz, abhinavaeron, and tarek a. Kahil

[4] Phytoconstituents, pharmacological activity, and medicinal use of lepidiumsativumlinn.: a review chetna baregama1,2*, anju goyal1

[5] Modern extraction methods for preparation of bioactive plant extracts ankitgupta, madhunaraniwal&vijaykothari institute of science, nirma university, ahmedabad-382481, gujrat, india

[6] Methods of extraction: maceration, percolation, and decoction rachmat hidayat1*, patricia wulandari2 - eureka herbaindonesia journal homepage: https://eurekabiomedical.com/index.php/ehi

[7] Wikipedia: https://pt.wikipedia.org/wiki/planta_medicinal

[8] Phytochemicals: extraction methods, identification and detection of bioactive compounds from plant extracts krishnananda p ingle, amit g deshmukh, dipika a padole, mahendra s dudhare, mangesh p moharil and vaibhav c. Khelurkar

[9] An overview of major classes of phytochemicals: their types and role in disease prevention deepak koche1, rupali shirsat2 &mahesh kawale3

[10] Wikipedia:https://en.wikipedia.org/wiki/phytochemical#definition

[11] soxhlet apparatus

[12] Https://en.wikipedia.org/wiki/steam_distillation

[13] soxhletchapter

[14] soxhletextractionprocessinphytochemical

[15] extraction of phytoconstituents and its extraction technique

[16] Extraction and analysis of terpenes/terpenoidszuodong jiang,1,2 chase kempinski,1,2 and joe chappell1 1department of pharmaceutical sciences, university of kentucky, lexington, kentucky
[17] Extraction and analysis of terpenes/terpenoidszuodong jiang,1,2 chase kempinski,1,2 and joe chappell1 1department of pharmaceutical sciences, university of kentucky, lexington, kentucky
[18] Phytochemical techniques - a review s. Velavanp.g. And research department of biochemistry, maruthupandiyar college, thanjavur, tamilnadu, s. India harman institute of science education and research, thanjavur, tamilnadu, s. India
[19]. Carotenoid extraction methods: a review of recent developments ,www.sciencedirect.com/science/article/pii/s03088146173 1259
[20] Pressurized liquid extraction gerardoalvarez-rivera*, monicabueno*, diegoballesteros-vivas* ,† , jose a. Mendiola*, elenaiban˜ez* * laboratory of foodomics, institute of food science research, cial, csic, madrid, spain, †high pressure laboratory, department of chemistry, faculty of science, universidadnacional de colombia, bogota´, colombia
[21] Extraction // steam distillation☆ f chemat, avignon university, avignon, france c boutekedjiret, ecolenationalepolytechnique, alger, alge´rie
[22] Chapter 7 - preparation, standardization, and quality control of medicinal plants in africa author links open overlay panelm.o.nafiua.a.hamidh.f.muritalas.b.adeyemi
[23] A review on extraction of phytochemicals such as tannins, phenols, terpenoids, carotenoids and alkaloids from plants 1yamuna saravanan, 2bala subramaniamdevaraj, 3nithesh kumarvelusamy, 4pooja shreesoundirarajan, 5kumaravel kandaswamy*
[24] Extraction and analysis of terpenes/terpenoidszuodong jiang,1,2 chase kempinski,1,2 and joe chappell1 1department of pharmaceutical sciences, university of kentucky, lexington, kentucky
[25] Carotenoids extraction and quantification: a review† hector arvayo-enr ´ ´ıquez, irammondaca-fernandez, pablogort ´ arez-moroyoqui, ´ jaimelopez-cervantes and robertorodr ´ ´ıguez-ram´ırez*