



Research Article

GCMS - Phytochemical Profiling of *Twakmustadi Yoga*: Comparative Analysis of Its *Arka* (Distillate) and *Phanta* (hot infusion)

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Abstract

Ayurveda, India's traditional system of medicine, focuses on holistic health and disease prevention through the use of herbal formulations. Among these, polyherbal combinations are widely utilized for their synergistic effects, enhancing both efficacy and safety. *Twakmustadi Yoga*, a formulation mentioned by Acharya Charaka for oral purification, includes *Cinnamomum zeylanicum*, *Cyperus rotundus*, *Elettaria cardamomum*, and *Coriandrum sativum*. This study aims to compare the phytochemical profiles of its two classical preparations—*Arka* (distillate) and *Phanta* (hot infusion)—through Gas Chromatography-Mass Spectrometry (GC-MS). The *Arka* was prepared by steam distillation and exhibited 12 distinct phytoconstituents, with the highest concentrations of 2-Methyl-Z,Z-3,13-octadecadienol (52%) and Pentadecanoic acid (21.29%). The formulation also included monoterpenes, aldehydes, and phenolic acids, indicating strong antioxidant, anti-inflammatory, and antimicrobial activity. The presence of low molecular weight, volatile compounds in *Arka* suggests rapid absorption and higher bioavailability, along with improved shelf life due to its chemical stability. In contrast, *Phanta*, prepared as a hot infusion and lyophilized before extraction, revealed 17 components. Major constituents included cis-11-Eicosenoic acid (69%) and Benzyl nitrile (17.46%), alongside long-chain fatty acids, sterols, and nucleobase analogs—highlighting its systemic health benefits. However, its susceptibility to oxidation and the presence of compounds like HMF suggest reduced stability. This comparative analysis demonstrates that preparation methods significantly influence the nature and potency of bioactive compounds. *Arka* offers an advantage in terms of stability, palatability, and quicker therapeutic action, while *Phanta* provides a broader profile of lipid-based and phenolic compounds suitable for systemic support. These findings guide optimal formulation selection in Ayurvedic practice.

Keywords: *Twakmustadi Yoga*, *Ayurveda*, *Arka Kalpana*, *Phanta Kalpana*, GC-MS analysis, Phytochemical profiling, Distillate, *Phanta* Powder.

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Introduction

Ayurveda, a traditional Indian medicinal system, uses herbal medicine to prevent diseases and promote holistic well-being. It involves combining multiple botanicals in specific ratios to optimize clinical efficacy and minimize toxicity. The WHO estimates 80% of the global population relies on traditional medicine. India, home to 45,000 plant species, has 15,000

medicinal uses, with 7,000-7,500 active in healthcare. As described in *Sharangdhar Samhita*, combining multiple herbs in specific ratios enhances therapeutic efficacy and minimizes toxicity through synergistic and sometimes antagonistic interactions. Herbal formulations are based on the principle that the phytochemical compounds from different plants interact synergistically. (1)

Twakmustadi yoga is formulation has been told by Acharya Charaka explains for *mukashodhan* (cleansing the oral cavity), which is having four ingredients: - *Twak* (*Cinnamomum zeylanicum* Blume), *Musta* (*Cyperus rotundus* Linn), *Ela* (*Elettaria cardamomum* Marton), *Dhanyaka* (*Coriandrum sativum* Linn.). The formulation is basically mentioned as *churna* (powder form) to gargle in the form of *phanta* (hot infusion) of all the ingredients mixed in equal quantity. (2)

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In Ayurvedic medicine, the method of preparation significantly influences the therapeutic efficacy of herbal formulations. *Phanta Kalpana* is a preparation method where hot water is poured over coarsely ground herbs and left to steep for a designated period. (3) This method is suitable for extracting water-soluble constituents that may be sensitive to prolonged heating like volatile drugs. (4)

Arka Kalpana is a distillation technique used to extract the volatile components of herbs. This process produces a clear, concentrated liquid called 'Arka,' which is highly potent, requires lower doses, and ensures better stability and patient compliance. This method is especially effective for preserving essential oils and other volatile bioactive compounds. Understanding the differences helps practitioners to choose the appropriate formulation based on therapeutic needs, stability, and patient-specific factors. Phytochemical profiling is crucial for analysing bioactive compounds in plant materials, ensuring the quality, efficacy, and safety of both raw extracts and formulations. It aids in standardization by providing a chemical fingerprint for consistency, optimizing extraction methods for maximum potency, and identifying compounds for targeted therapeutic effects. (5)

Comparative phytochemical analysis of *Twakmustadi Yoga* in its *Arka* (distillate) and *Phanta* (hot infusion) forms is limited. Understanding how preparation methods influence bioactive compounds extracted in them is essential. This study aims to compare and characterize the phytochemical composition of both formulations, highlighting variations in their chemical profiles and potential therapeutic implications.

Materials and Methods

Materials

The Raw drugs required for the formulation *Twakmustadi yoga* are stem bark of *Cinnamomum zeylanicum* Blume, rhizome of *Cyperus rotundus* Linn, seeds of *Elettaria cardamomum* Marton and seeds of *Coriandrum sativum* Linn. Procured from KLE Ayurveda Pharmacy Kasbhag Belagavi and were authenticated through the experts at CRF AYUSH approved Drug Testing Lab for ASU drugs at KAHER's Shri B. M. Kankanawadi Ayurveda Mahavidyalaya, Belagavi, Karnataka, India.

Methodology

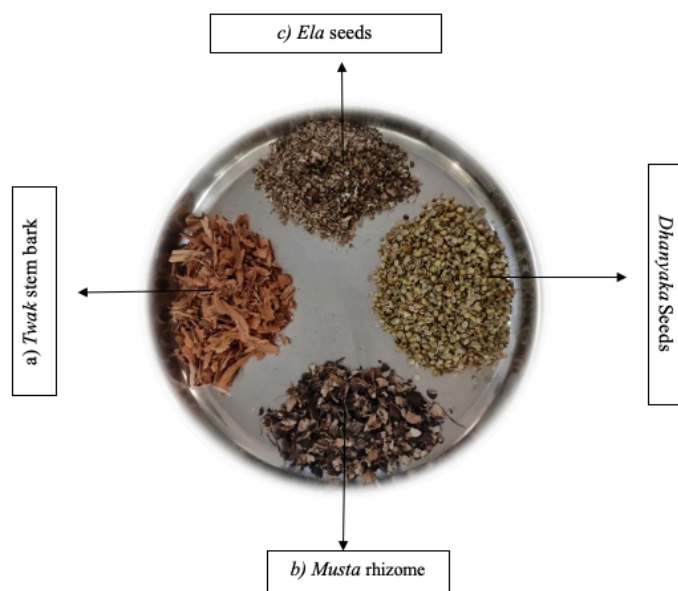
Preparation of Arka (Distillate): Ten grams each of the four raw drugs are coarsely pounded and passed through to a 20 mesh size and thoroughly mixed. The mixture is then soaked in 400ml of water (10 parts) in a steel vessel overnight. Distillation is initiated, and the vapours are condensed until 80% of the initial volume (320ml) is collected. The resulting distillate is identified as the *Arka* of *Twakmustadi Yoga* is stored in an air tight clean container (6).

Preparation of Phanta (hot infusion): Ten grams of each of the four raw drugs are coarsely pounded and passed through 20 mesh size and set aside. Meanwhile, 40 ml of water (4 parts) is heated in a steel vessel over a mild flame. Once boiling commences, coarse powder of the drugs are immediately added, the vessel is covered with a lid and the heat source is turned off. When the mixture reaches a lukewarm temperature, it is filtered into a clean container and labelled as *Twakmustadi Phanta* (7).

GCMS analysis:

GCMS analysis was performed by Centre for Analytical Instrumentation Kerala (CAI-K), KSCSTE Kerala Forest Research Institute Peechi, Thrissur, Kerala, India.

Figure 1: Raw drugs of *Twakmustadi Yoga*



- a) *Twak stem bark Cinnamomum zeylanicum* Blume.
 b) *Musta rhizome Cyperus rotundus* Linn.
 c) *Ela seeds Elettaria cardamomum* Marton.
 d) *Dhanyaka Seeds Coriandrum sativum* Linn

Figure 2: Final Product of *Twakmustadi Yoga*



- a) *Arka* (distillate) b) *Phanta* (hot infusion)

GCMS Instrumentation details: performed using a Shimadzu GC-MS QP2010S system equipped with an ELITE-5MS capillary column (30 m length, 0.25 mm internal diameter, 0.25 µm film thickness). Compound identification was carried out by knowing the mass spectra with reference spectra from the NIST 11 and WILEY 8 spectral libraries.

Sample preparation: 100 mL of distillate (*Arka of Twakmustadi yoga*) was subjected to liquid-liquid extraction using an equal volume of n-hexane in a separating funnel. The upper hexane

layer, containing the extracted volatile oil, was carefully separated. The hexane extract was then subjected to gentle evaporation at a temperature below 50°C to remove n-hexane, yielding the volatile oil, which was subsequently analysed by GC-MS (8).

100 mL of the prepared hot infusion (*Phanta of Twakmustadi Yoga*) was subjected to lyophilisation for 48 hours at -80°C under expert supervision at the Dr. Prabhakar Kore's BSRC, KAHER, Belagavi (Deemed to be University). The resulting lyophilized product, obtained as a porous, dry powder, was blended with 2 g of lactose powder to maintain its powdered form and prevent moisture induced condensation (9).

GCMS Analysis Procedure: Prior to analysis, oven temperature, carrier gas flow rate, and electron ionization parameters were pre-programmed for optimal performance. Two samples were analysed separately. The first sample, volatile oil, was directly injected into the GC-MS column. The second sample, lyophilized *Twakmustadi Phanta* (hot infusion) powder, was extracted using 99% ethanol in a flask shaker for 12 hours. The extract was then filtered, and the resulting liquid was introduced into the column for analysis. GC-MS analysis commenced with sample injection, followed by the separation of compounds based on their retention time (RT)—the duration a compound takes to travel through the GC column to reach the detector. This process produced a chromatogram, where the X-axis denoted RT and the Y-axis

reflected signal intensity, indicative of compound concentration. As compounds exited the column, they entered the electron ionization (EI) detector, where they were bombarded with electrons, resulting in fragmentation into ions characterized by specific mass-to-charge (m/z) ratios. These fragments formed a mass spectrum, effectively serving as a molecular fingerprint for compound identification. The analysis was performed with the GC oven maintained at 200°C. Helium served as both the carrier and eluent gas, with a constant flow rate of 1 mL/min. The EI detector facilitated fragmentation of eluted compounds for mass spectral analysis. Identification was carried out by comparing retention indices and fragmentation patterns with reference data from the NIST 11, Wiley, and WILEY 8 mass spectral libraries, as well as relevant published literature.

Results

Arka (Distillate) of *Twakmustadi yoga*: The GC-MS analysis of *Twakmustadi Yoga Arka* (distillate) revealed 12 peaks, with 2-Methyl-Z,Z-3,13-octadecadienol as the predominant compound (52%), indicating its significant presence as well as Pentadecanoic acid (21.29%). The distillate is enriched with volatile aldehydes such as Nonanal (1.15%), 2-Decenal (4.24%), 2,4-Decadienal (0.77%), and Dodecanal (1.54%), monoterpenes like p-Mentha-1,5-dien-8-ol (1.99%) and trans-Cinnamic acid (9.63%) a phenolic acid. This highlights the effectiveness of distillation in extracting bioactive compounds.

Figure 3: GCMS graph of the Distillate (*Arka of Twakmustadi yoga*)

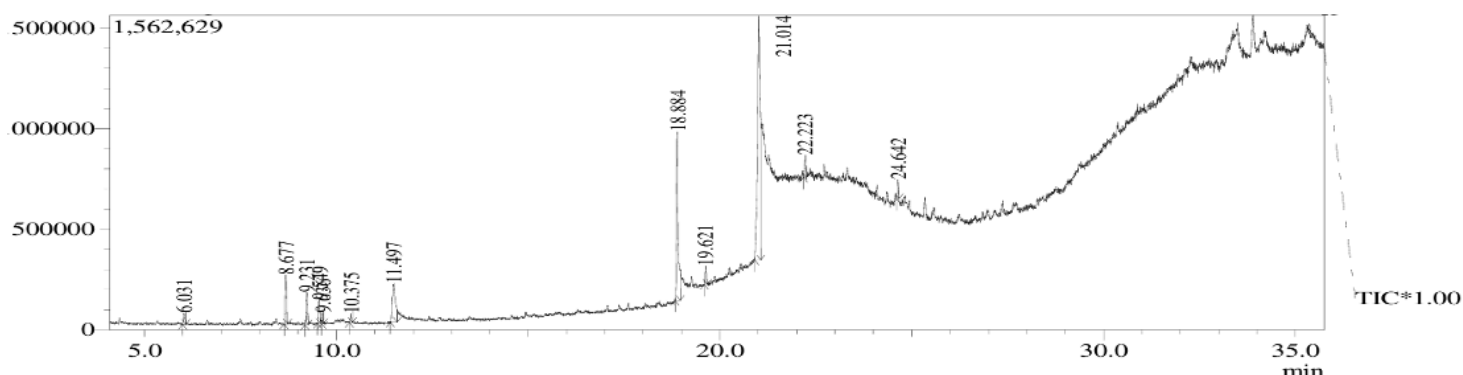
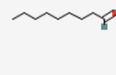
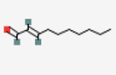
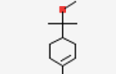
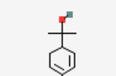
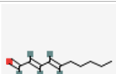
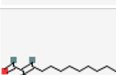
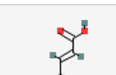

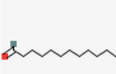
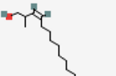

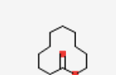


Table 1: The results and observations enlisted from the report of the GCMS of Distillate (*Arka*) of *Twakmustadiyoga*

Peak Sr. no	Retention time (rt)	Compound name	Compound formula	Molecule weight	Peak area in %
1	6.031	Nonanal	C ₉ H ₁₈ O	142	1.15%
2	8.677	2-Decenal, (Z)	C ₁₀ H ₁₈ O	154	4.24%
3	9.231	Cyclohexene, 3-acetoxy-4-(1-hydroxy-1-methylethyl)-1-methyl-	C ₁₂ H ₂₀ O ₃	212	2.95%
4	9.549	p-Mentha-1,5-dien-8-ol	C ₁₀ H ₁₆ O	152	1.99%
5	9.636	2,4-Decadienal, (E,E)-	C ₁₀ H ₁₆ O	152	0.77%
6	10.375	2-Dodecenal, (E)-	C ₁₂ H ₂₂ O	182	0.66%
7	11.497	trans-Cinnamic acid	C ₉ H ₈ O ₂	148	9.63%
8	18.884	Pentadecanoic acid	C ₁₅ H ₃₀ O ₂	242	21.29%
9	19.621	Dodecanal	C ₁₂ H ₂₄ O	184	1.54%
10	21.014	2-Methyl-Z,Z-3,13-octadecadienol	C ₁₉ H ₃₆ O	280	52%
11	22.223	9-Octadecenoic acid, 1,2,3-propanetriyl ester, (E,E,E)-	C ₅₇ H ₁₀₄ O ₆	884	1.99%
12	24.642	Oxacyclododecan-2-one	C ₁₁ H ₂₀ O ₂	184	1.67%

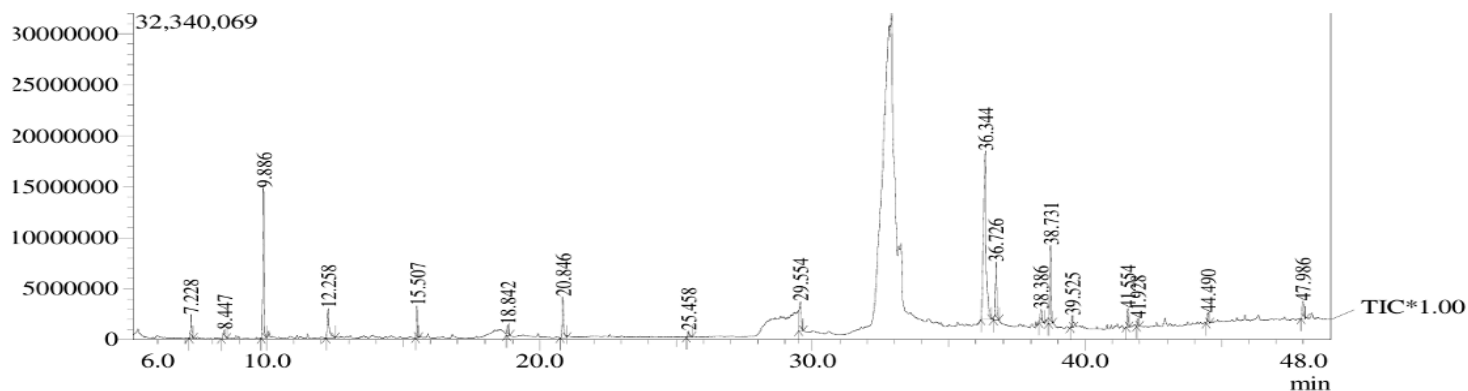
Table 2: Description of the identified chemical compounds in the GCMS of Twakmustadi arka (distillate)

Sr. No	Compound Name	Canonical Smiles	Description
1	Nonanal		It is a saturated, medium-chain n-alkanal (fatty aldehyde) that is functionally derived from nonanoic acid (10)
2	2-Decenal, (Z)		The compound contains an E-configured olefinic double bond and exhibits biological activities as an alarm pheromone, nematocide, and mutagen. (11)
3	Cyclohexene, 3-acetoxy-4-(1-hydroxy-1-methylethyl)-1-methyl-		Monoterpenoid. (12)
4	p-Mentha-1,5-dien-8-ol		Monoterpene alcohol which possess antimicrobial, anti-inflammatory and flavouring agent (13),(14)
5	2,4-Decadienal, (E,E)-		Is a polyunsaturated fatty aldehyde. (15)
6	2-Dodecenal, (E)-		Is a trans-2,3-unsaturated fatty aldehyde is an antibacterial agent.(16)
7	trans-Cinnamic acid		Is a monocarboxylic acid and derived from Cinnamomum possess anti-inflammatory, antioxidant and antimicrobial action.(17)
8	Pentadecanoic acid		Straight-chain saturated fatty acid possess antimicrobial antifungal properties. (18)
9	Dodecanal		long-chain fatty aldehyde that is dodecane is an antimicrobial (19)
10	2-Methyl-Z,Z-3,13-octadecadienol		It is a long-chain unsaturated alcohol having insecticidal and antioxidant properties (20)
11	9-Octadecenoic acid, 1,2,3-propanetriyl ester, (E,E,E)-		It is called as Trielaidin is a triglyceride (21)
12	Oxacyclododecan-2-one		It is called Undecalactone an aldehyde having antioxidant and antimicrobial properties (22)

Phanta (hot infusion) of Twakmustadi yoga

The GC-MS analysis of *Phanta* (hot infusion) identified 17 peaks, with cis-11-Eicosenoic acid 69% (peak area%) as the predominant compound, Notable bioactive compounds include Benzyl nitrile (17.46%) and 9-Octadecenoic acid (Z) (8.46%), 4-Butylbenzoic acid, 2-dimethylaminoethyl ester (8.52%), hexadecanoic acid (5.31%) and steroidal 3-Bromocholest-5-ene

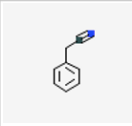
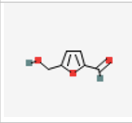
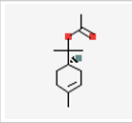
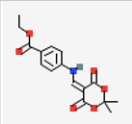
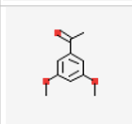




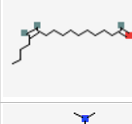
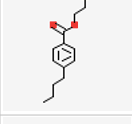
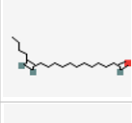

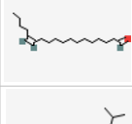
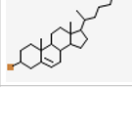
(3.35%) highlights the retention of high-molecular-weight fatty acids and sterols, absent in the distillate. Compounds like 5-Hydroxymethylfurfural (HMF) (5.88%) indicate Maillard reaction-related antioxidant activity. Phenolic ketones (3', 5'-Dimethoxyacetophenone, (6.55%). The presence of nucleobase analogs 2, 4(1H, 3H)-Pyrimidinedione (1.45%). This composition highlights the hot infusion in extracting non-volatile, lipid-based and phenolic bioactive compounds.

Figure 4: GCMS graph of hot infusion (Phanta of Twakmustadi yoga)**Table 4: The results and observations enlisted from the report of the GCMS of hot infusion Lyophilised powder Phanta of Twakmustadiyoga.**

Peak Sr. no	Retention time (rt)	Compound name	Compound formula	Molecule weight	Peak area in %
1	7.228	2-Oxabicyclo[2.2.2] Octane, 1,3,3-Trimethyl-	C ₁₀ H ₁₈ O	154	2.31%
2	8.447	2,4(1h,3h)-Pyrimidinedione, 5-Methyl-	C ₅ H ₆ N ₂ O ₂	126	1.45%
3	9.886	Benzyl nitrile	C ₈ H ₇ N	117	17.46%
4	12.258	5-Hydroxymethylfurfural	C ₆ H ₆ O ₃	126	5.88%
5	15.507	3-Cyclohexene-1-Methanol, .Alpha.,.Alpha.,4-Trimethyl-, Acetate	C ₁₂ H ₂₀ O ₂	196	3.35%
6	18.842	Benzoic acid, 2-(dimethyl amino)ethyl ester	C ₁₁ H ₁₅ NO ₂	193	1.49%
7	20.846	3',5'-Dimethoxyacetophenone	C ₁₀ H ₁₂ O ₃	180	6.55%
8	25.458	Tetradecanoic Acid	C ₁₄ H ₂₈ O ₂	228	0.96%
9	29.554	Hexadecanoic Acid	C ₁₆ H ₃₂ O ₂	256	5.31%
10	36.344	cis-11-Eicosenoic acid	C ₂₀ H ₂₈ O ₂	310	49.06%
11	36.726	9-OCTADECENOIC ACID (Z)-	C ₁₈ H ₃₄ O ₂	282	8.46%
12	38.386	cis-11-Hexadecenal	C ₁₆ H ₃₀ O	238	2.76%
13	38.731	4-Butylbenzoic acid, 2-dimethylaminoethyl ester	C ₁₅ H ₃₃ NO ₂	249	8.52%
14	41.554	13-Octadecenal, (Z)-	C ₁₈ H ₃₄ O	266	2.21%
15	41.928	Hexadecanoic Acid, 2-Hydroxy-1,3-Propanediyl Ester	C ₃₅ H ₆₈ O ₅	568	0.93%
16	44.490	13-Octadecenal, (Z)-	C ₁₈ H ₃₄ O	226	1.26%
17	47.986	3-Bromocholest-5-Ene	C ₂₇ H ₄₅ Br	448	3.35%

Table 5: Description of the identified chemical compounds from GCMS of Twakmustadi phanta (hot infusion)

Sr. No	Compound Name	Canonical Smiles	Description
1	2-Oxabicyclo[2.2.2] Octane, 1,3,3-Trimethyl-		Commonly known as eucalyptol, it is a naturally occurring cyclic ether and monoterpene. It helps regulate airway mucus hypersecretion and asthma by inhibiting inflammatory cytokines and exerting anti-inflammatory effects. (23)
2	2,4(1h,3h)-Pyrimidinedione, 5-Methyl-		Its called Thymine. It is a pyrimidine nucleobase and a pyrimidine (24)

3	Benzyl Nitrile		Appears as a colourless oily liquid with an aromatic odor. (25)
4	5-Hydroxymethylfurfural		It belongs to the class of furans and functions as both an indicator and a product of the Maillard reaction. Additionally, it is classified as a furan derivative, an arenecarbaldehyde, and a primary alcohol. (26)
5	3-Cyclohexene-1-Methanol, .Alpha.,.Alpha.,4-Trimethyl-, Acetate		This compound is the acetate ester of α -terpineol, a monoterpene alcohol, used for its fragrance and flavor properties. (27)
6	Benzoic Acid, 2-(Dimethyl Amino)Ethyl Ester		It belongs to the ester chemical group, specifically classified as an aminoester. Combining aromatic and amino alcohol functionalities. (28)
7	3',5'-Dimethoxyacetophenone		Is an organic compound characterized by an acetophenone core substituted with methoxy groups at the 3' and 5' positions are Phenolic ketones. (29)
8	Tetradecanoic Acid		Also known as myristic acid, it is a long-chain, straight-chain saturated fatty acid and serves as the conjugate acid of tetradecanoate. (30)
9	Hexadecanoic Acid		<u>Hexadecanoic acid</u> is a straight-chain, sixteen-carbon, saturated long-chain fatty acid. It has a role as an prostaglandin-E2 9-reductase inhibitor, it's also called palmitic acid (31)
10	Cis-11-Eicosenoic Acid		It is called as Gondoic Acid. is a monounsaturated long-chain fatty acid with a 20-carbon (32)
11	9-Octadecenoic Acid (Z)-		It is also known as Oleic Acid. An unsaturated fatty acid also be used as an herbicide, insecticide, and fungicide. (33)
12	Cis-11-Hexadecenal		It is classified within the fatty aldehydes group, a subclass of fatty acyls. (34)
13	4-Butylbenzoic Acid, 2-Dimethylaminoethyl Ester		Is an organic compound that belongs to the ester chemical group, specifically classified as an aminoester, combining aromatic and amino alcohol functionalities (35)
14	13-Octadecenal, (Z)-		Is an organic compound classified within the fatty aldehyde chemical group. It features a long-chain aliphatic structure (36)
15	Hexadecanoic Acid, 2-Hydroxy-1,3-Propanediyl Ester		It is functionally related to a <u>hexadecanoic acid</u> . (37)
16	13-Octadecenal, (Z)-		It is fatty aldehyde chemical group. It features a long-chain aliphatic structure (38)
17	3-Bromocholest-5-Ene		Is an organic compound classified within the steroidal bromides chemical group (39)

Discussion

Twakmustadi Yoga, referenced by *Acharya Charaka* for oral cleansing through gargling, consists of *Twak* (*Cinnamomum zeylanicum* Blume), *Musta* (*Cyperus rotundus* Linn), *Ela* (*Elettaria cardamomum* Maton), and *Dhanyaka* (*Coriandrum sativum* Linn). The GC-MS analysis of *Twakmustadi yoga Arka* with 12 compounds highlights distillation's efficiency in concentrating bioactive compounds, with 2-Methyl-Z,Z-3,13-octadecadienol (52%) and pentadecanoic acid (21.29%) as major constituents. The presence of volatile aldehydes, monoterpenes, and phenolic acids further underscores its therapeutic potential. The GC-MS analysis of *Twakmustadi yoga Phanta* with 17 compounds demonstrates its efficacy in extracting non-volatile, lipid-based, and phenolic bioactive compounds, with cis-11-Eicosenoic acid (69%) as the major constituent. The presence of fatty acids, sterols, antioxidants like HMF, and nucleobase analogs supports its potential for systemic therapeutic applications.

Comparison of observations of results in Arka and Phanta of Twakmustadi yoga: *Arka* (distillate) is rich in volatile bioactive compounds, including aldehydes, monoterpenes, and phenolic acids, with the highest composition of a terpenoid compound 2-Methyl-Z,Z-3,13-octadecadienol (52%) which contribute to its antimicrobial, anti-inflammatory, and aromatic properties (40) from the essential oil. Also the presence of Pentadecanoic acid (21.29%) will enhance the mitochondrial function and reducing oxidative/metabolic stress, PDA helps limit the triggers of inflammation at the cellular level, leading to broad anti-inflammatory effects. (41) Additionally, the presence of antimicrobial aldehydes (Nonanal, Dodecanal, 2-Decenal, 2,4-Decadienal) and phenolic acids (trans-Cinnamic acid) enhances its natural aromatic properties, antimicrobial and anti-inflammatory as well as antioxidant. (42) monoterpenes like p-Mentha-1,5-dien-8-ol also has role of antimicrobial action. (43) The absence of high-molecular-weight fatty acids into the *Twakmustadi yog arka* suggests that steam distillation selectively extracts low-molecular-weight volatiles, making *Arka* chemically stable and resistant to oxidation.

In contrast, *Phanta* (hot infusion) retains non-volatile and lipid-based bioactives, including long-chain fatty acids (Hexadecanoic acid, cis-11-Eicosenoic acid, 9-Octadecenoic acid) and sterols (3-Bromocholest-5-ene), which contribute to systemic anti-inflammatory and lipid metabolism benefits (44, 45) cis-11-Eicosenoic acid with predominant presence (49.06%) is identified as an immune system stimulator and has potential as a vaccine adjuvant along with being Anti-inflammatory action. (46) Benzyl nitrile (17.46%) is grouped under nitrile compound, through its incorporation into drug molecules can enhance binding affinity, improve pharmacokinetic profiles, and increase metabolic stability. (47) However, the lipid constituents are prone to oxidation and rancidity, reducing *Phanta's* storage stability. The presence of 5-Hydroxymethylfurfural (HMF), a sugar degradation product, indicates potential thermal degradation of organic components, as HMF is formed by the dehydration of reducing sugars like glucose and fructose during heating processes such as caramelisation and the Maillard reaction (48), further compromising long-term stability. Phenolic ketones (3', 5'-Dimethoxyacetophenone (6.55%) pharmacologically act as antioxidants, antimicrobial, and anti-inflammatory properties. (49) The presence of nucleobase analogs 2, 4(1H, 3H)-Pyrimidinedione (1.45%) is the chemical structure foundational to nucleobases such as uracil and thymine, which are integral components of RNA and DNA. This core structure has been

utilized in the development of various pharmacologically active compounds, including antiviral agents. (50) Additionally, as a water-based extract, *Twakmustadi yoga Phanta* is more susceptible to microbial spoilage compared to distillate (*arka*) wherein *Arka* will undergo steam distillation, eliminating non-volatile impurities and microbial contaminants, ensuring greater longevity.

From the above observations of molecular weight it is notably observed that there are no such similar compounds found to be present in distillate and *phanta* but the distillate is having low molecular weight comparing with the *phanta*, Lower molecular weight compounds generally have lower boiling points, making them more volatile because they vaporize easily with steam, these lighter molecules are preferentially extracted.

From an Ayurvedic perspective, *Arka Kalpana* (distillation) offers a longer shelf life and easier administration, making it more palatable for patients who struggle with powders or decoctions. It embodies qualities of *Jala* (water) and *Agni* (fire), which result in characteristics such as *Laghu-paka* (easy digestion), *Vyavayi* (pervasive), and *Vikasi* (quick spreading), enhancing its therapeutic action. (51) This can be scientifically interpreted as the *Twakmustadi Yoga Arka* containing volatile compounds like aldehydes, monoterpenes, and phenolic compounds with lighter molecular weights, reflecting the qualities of easy absorption and rapid dispersion.

Conclusion

The distillation process of *Twakmustadi Yoga's Arka* and *Phanta* is compared. *Arka* is rich in volatile compounds, such as aldehydes, monoterpenes, and phenolic acids, with antimicrobial, anti-inflammatory, and antioxidant properties. It is easier to administer and more palatable, making it suitable for patients with difficulty with other Ayurvedic preparations. *Phanta*, on the other hand, retains non-volatile and lipid-based bioactives but is prone to oxidation and rancidity. Further experimentation is necessary to comprehend how the compounds act in each of their forms.

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References

1. Parasuraman S, Thing GS, Dhanaraj SA. Polyherbal formulation: Concept of ayurveda. *Phcog Rev* 2014; 8:73-80.
2. Chakrapani Datta. *Charaka Samhita: Chikitsa Sthana*, Vol. 3. English translation by Sharma RK, Dash VB. Varanasi (UP): Choukhambha Sanskrit Series Office; Sloka 136-137, p. 396.
3. Angadi R. A Textbook of Bhaishajya Kalpana Vijnana. 1st ed. Varanasi: Chaukhambha Surbharati Prakashan; 2009. p. 83.
4. Haris M.S, Sreeni T.V. Critical Review of Phanta Kalpana and Phytochemical Comparison of Panchakola Phanta with Panchakola Kashaya. *International Journal of Ayurveda and Pharma Research*. 2024;12(1):25-31.
5. Rizwani F, Jain K, Thakkar S. A review on Arka Kalpana. *Int J Pharm Phytopharmacol Res*. 2023;26(3):336-341.

6. Ravindra Angadi. The Textbook of Bhaishajya Kalpana Vijnāna [Pharmaceutical Science]. 2nd rev. ed. Varanasi: Chaukhambha Subharati Prakāśana; 2016 [reprinted 2018]. Chapter 14, Arka Kalpana, p. 115.
7. Asha Kumari, Premanth Tiwari . Śaraṅgadhara Samhitā: Prabodīnī (Hindi commentary). 1st ed. Varanasi: Chaukhambha Bhārati Acad.; 2021. Madhyama Khanda, Chapter 3 (verse 1), p 201.
8. Kokalj Ladan M, Kočevar Glavač N. GC–MS analysis of a *Helichrysum italicum* hydrosol: sensitivity, repeatability and reliability of solvent extraction versus direct hydrosol analysis. *Appl Sci.* 2022;12(19):10040.
9. Haris M.S, Sreeni T.V. Critical Review of Phanta Kalpana and Phytochemical Comparison of Panchakola Phanta with Panchakola Kashaya. *International Journal of Ayurveda and Pharma Research.* 2024;12(1):25-31.
10. National Center for Biotechnology Information. PubChem Compound Summary for CID 31289, Nonanal. <https://pubchem.ncbi.nlm.nih.gov/compound/Nonanal>. Accessed Apr. 10, 2025.
11. National Center for Biotechnology Information. PubChem Compound Summary for CID 5283345, 2-Decenal. <https://pubchem.ncbi.nlm.nih.gov/compound/2-Decenal>. Accessed Apr. 10, 2025.
12. National Center for Biotechnology Information. PubChem Compound Summary for CID 85755, Methyl alpha-terpinyl ether. <https://pubchem.ncbi.nlm.nih.gov/compound/Methyl-alpha-terpinyl-ether>. Accessed Apr. 10, 2025.
13. National Center for Biotechnology Information. PubChem Compound Summary for CID 519323, p-Mentha-1,5-dien-8-ol. https://pubchem.ncbi.nlm.nih.gov/compound/p-Mentha-1_5-dien-8-ol. Accessed Apr. 10, 2025. “Small-Molecule Compounds.” *Smolecule*, <https://www.smolecule.com/>. Accessed 10 Apr. 2025.
14. National Center for Biotechnology Information. PubChem Compound Summary for CID 5283349, 2,4-Decadienal. https://pubchem.ncbi.nlm.nih.gov/compound/2_4-Decadienal. Accessed Apr. 10, 2025.
15. National Center for Biotechnology Information. PubChem Compound Summary for CID 5283361, 2-Dodecenal. <https://pubchem.ncbi.nlm.nih.gov/compound/2-Dodecenal>. Accessed Apr. 10, 2025.
16. National Center for Biotechnology Information. PubChem Compound Summary for CID 444539, Cinnamic Acid. <https://pubchem.ncbi.nlm.nih.gov/compound/Cinnamic-Acid>. Accessed Apr. 10, 2025.
17. National Center for Biotechnology Information. PubChem Compound Summary for CID 13849, Pentadecanoic Acid. <https://pubchem.ncbi.nlm.nih.gov/compound/Pentadecanoic-Acid>. Accessed Apr. 10, 2025.
18. National Center for Biotechnology Information. PubChem Compound Summary for CID 8194, Dodecanal. <https://pubchem.ncbi.nlm.nih.gov/compound/Dodecanal>. Accessed Apr. 10, 2025. DOI 10.5281/zenodo.5794106
19. National Center for Biotechnology Information. PubChem Compound Summary for CID 5364412, 2-Methyl-Z,Z-3,13-octadecadienol. https://pubchem.ncbi.nlm.nih.gov/compound/2-Methyl-Z_Z-3_13-octadecadienol. Accessed Apr. 10, 2025.
20. National Center for Biotechnology Information. PubChem Compound Summary for CID 5364673, Trielaidin. <https://pubchem.ncbi.nlm.nih.gov/compound/Trielaidin>. Accessed Apr. 10, 2025.
21. National Center for Biotechnology Information. PubChem Compound Summary for CID 74409, Undecalactone. <https://pubchem.ncbi.nlm.nih.gov/compound/Undecalactone>. Accessed Apr. 10, 2025.
22. National Center for Biotechnology Information. PubChem Compound Summary for CID 2758, Eucalyptol. <https://pubchem.ncbi.nlm.nih.gov/compound/Eucalyptol>. Accessed Apr. 10, 2025.
23. National Center for Biotechnology Information. PubChem Compound Summary for CID 1135, Thymine. <https://pubchem.ncbi.nlm.nih.gov/compound/Thymine>. Accessed Apr. 10, 2025.
24. National Center for Biotechnology Information. PubChem Compound Summary for CID 8794, Phenylacetone. <https://pubchem.ncbi.nlm.nih.gov/compound/Phenylacetone>. Accessed Apr. 10, 2025.
25. National Center for Biotechnology Information. PubChem Compound Summary for CID 237332, 5-Hydroxymethylfurfural. <https://pubchem.ncbi.nlm.nih.gov/compound/5-Hydroxymethylfurfural>. Accessed Apr. 10, 2025.
26. National Center for Biotechnology Information. PubChem Compound Summary for CID 11469649, alpha-Terpinyl acetate, (+). <https://pubchem.ncbi.nlm.nih.gov/compound/11469649>. Accessed Apr. 10, 2025.
27. National Center for Biotechnology Information. PubChem Compound Summary for CID 757253, Ethyl 4-(((2,2-dimethyl-4,6-dioxo-1,3-dioxan-5-ylidene)methyl)amino)benzoate. <https://pubchem.ncbi.nlm.nih.gov/compound/757253>. Accessed Apr. 10, 2025.
28. National Center for Biotechnology Information. PubChem Compound Summary for CID 95997, 1-(3,5-Dimethoxyphenyl)ethan-1-one. https://pubchem.ncbi.nlm.nih.gov/compound/1_3_5-Dimethoxyphenyl_ethan-1-one. Accessed Apr. 10, 2025.
29. National Center for Biotechnology Information. PubChem Compound Summary for CID 11005, Myristic Acid. <https://pubchem.ncbi.nlm.nih.gov/compound/Myristic-Acid>. Accessed Apr. 11, 2025.
30. National Center for Biotechnology Information. PubChem Compound Summary for CID 985, Palmitic Acid. <https://pubchem.ncbi.nlm.nih.gov/compound/Palmitic-Acid>. Accessed Apr. 10, 2025.
31. National Center for Biotechnology Information. PubChem Compound Summary for CID 5282768, Gondoic Acid. <https://pubchem.ncbi.nlm.nih.gov/compound/Gondoic-Acid>. Accessed Apr. 10, 2025.
32. National Center for Biotechnology Information. PubChem Compound Summary for CID 445639, Oleic Acid. <https://pubchem.ncbi.nlm.nih.gov/compound/Oleic-Acid>. Accessed Apr. 10, 2025.
33. National Center for Biotechnology Information. PubChem Compound Summary for CID 5364495, 11-Hexadecenal, (11Z)-. https://pubchem.ncbi.nlm.nih.gov/compound/11-Hexadecenal_-11Z. Accessed Apr. 11, 2025.
34. National Center for Biotechnology Information. PubChem Compound Summary for CID 10356632, Pbutylbenzoicacidndimethylaminoethylester. <https://pubchem.ncbi.nlm.nih.gov/compound/Pbutylbenzoicacidndimethylaminoethylester>. Accessed Apr. 11, 2025.
35. National Center for Biotechnology Information. PubChem Compound Summary for CID 5364497, 13-Octadecenal, (13Z)-. https://pubchem.ncbi.nlm.nih.gov/compound/13-Octadecenal_-13Z. Accessed Apr. 11, 2025.

36. National Center for Biotechnology Information. PubChem Compound Summary for CID 68149, Glyceryl 1,3-dipalmitate. https://pubchem.ncbi.nlm.nih.gov/compound/Glyceryl-1_3-dipalmitate. Accessed Apr. 11, 2025.
37. National Center for Biotechnology Information. PubChem Compound Summary for CID 5364497, 13-Octadecenal, (13Z)-. https://pubchem.ncbi.nlm.nih.gov/compound/13-Octadecenal_-_13Z. Accessed Apr. 11, 2025.
38. National Center for Biotechnology Information. PubChem Compound Summary for CID 101735, 3beta-Bromocholest-5-ene. <https://pubchem.ncbi.nlm.nih.gov/compound/3beta-Bromocholest-5-ene>. Accessed Apr. 11, 2025.
39. Adeyemi MA, Ekunseitan DA, Abiola SS, Dipeolu MA, Egbeyale LT, Sogunle OM. Phytochemical analysis and GC-MS determination of *Lagenaria breviflora* R. fruit. *Int J Pharmacogn Phytochem Res.* 2017; 9(7):1051-1056. DOI: 10.25258/phyto.v9i07.11178
40. Ciesielski, Vincent, et al. "New Insights on Pentadecanoic Acid with Special Focus on Its Controversial Essentiality: A Mini-Review." *Biochimie*, vol. 227, Dec. 2024, pp. 123–129.
41. Catalano, Alessia, et al. "Aldehydes: What We Should Know About Them." *Organics*, vol. 5, no. 4, Oct. 2024, pp. 395–428.
42. Gavanji, Shahin, et al. "Antimicrobial and Cytotoxic Evaluation of Some Herbal Essential Oils in Comparison with Common Antibiotics in Bioassay Condition." *Integrative Medicine Research*, vol. 3, no. 3, Sept. 2014, pp. 142–52.
43. Aparna V, Dileep KV, Mandal PK, Karthe P, Sadasivan C, Haridas M. Anti-inflammatory property of n-hexadecanoic acid: structural evidence and kinetic assessment. *Chem Biol Drug Des.* 2012 Sep;80(3):434-9.
44. Xie C, Wang S, Cao M, Xiong W, Wu L. (E)-9-Octadecenoic Acid Ethyl Ester Derived from Lotus Seedpod Ameliorates Inflammatory Responses by Regulating MAPKs and NF-κB Signalling Pathways in LPS-Induced RAW264.7 Macrophages. *Evid Based Complement Alternat Med.* 2022 Jan 5; 2022:6731360.
45. Alqarni AM, Dissanayake T, Nelson DJ, Parkinson JA, Dufton MJ, Ferro VA, Watson DG. Metabolomic Profiling of the Immune Stimulatory Effect of Eicosenoids on PMA-Differentiated THP-1 Cells. *Vaccines.* 2019; 7(4):142.
46. Wang X, Wang Y, Li X, Yu Z, Song C, Du Y. Nitrile-containing pharmaceuticals: target, mechanism of action, and their SAR studies. *RSC Med Chem.* 2021 Aug 10;12(10):1650-1671.
47. Shapla, U.M., Solayman, M., Alam, N. *et al.* 5-Hydroxymethylfurfural (HMF) levels in honey and other food products: effects on bees and human health. *Chemistry Central Journal* 12, 35 (2018)
48. Ravikumar S, Gnanadesigan M, Suganthi P, Ramalakshmi A. GC-MS analysis of bio-active components of *Zanthoxylum tetraspermum* stem bark. *Res J Pharm Biol Chem Sci.* 2012;3(4):1137–1143.
49. Buckheit RW Jr, Hartman TL, Watson KM, Kwon HS, Lee SH, Lee JW, Kang DW, Chung SG, Cho EH. The structure–activity relationships of 2,4(1H,3H)-pyrimidinedione derivatives as potent HIV type 1 and type 2 inhibitors. *Antivir Chem Chemother.* 2007;18(6):259–275.
50. Swaranjali R. Kaswa, Sharada N. Chikurte Ayurlog: "Standardization of Arka Kalpana- A Review." *National Journal of Research in Ayurved Science-* 2020; (8) (6):01- 09
51. Jayanta Bag, Neetu Singh. Arka Kalpana - A Review of Traditional and Modern Methods. *AYUSHDHARA,* 2024;11(3):228-238.
