EXTRACTION OF ESSENTIAL OIL FROM ROSA DAMASCENA

Ms. Varsha A. Dighe[1], Mr. Abrar Raju Sayyed[2], Mr. Omkar Shrikant Gavi[3], Mr. Omkar Somnath Sathe[4].

Author's Description :

[1]AAEMF'S Delight College Of Pharmacy, Dept. Of Pharmaceutical Chemistry, India.

[2]AAEMF'S Delight College Of Pharmacy, India.

[3]AAEMF'S Delight College Of Pharmacy, India.

[4]AAEMF'S Delight College Of Pharmacy, India.

Abstract

Rosa damascena, also referred to as the Damask rose, has captivated people's attention with its alluring scent for generations. Beyond its enticing perfume, the essential oil buried inside its exquisite petals has a plethora of bioactive chemicals with interesting therapeutic and commercial applications. This project dives into the complexities of extracting and analyzing this valuable essence, resulting in a thorough grasp of its unique composition and varied significance.

Keywords: *Rosa damascena, rose oil, essential oil, pharmacological properties, antibacterial activity, antioxidant activity, neuroprotective activity, anti-diabetic effect, anti-inflammatory effect, anti-cancer effect, gastrointestinal effect, respiratory effect, anti-HIV activity, anti-depression, analgesic activity, anti-ageing effect, cosmetic properties, traditional medicine, Ayurveda, unani medicine.*

I. INTRODUCTION:

Herbal medicine is one of the most commonly used ancient methods of treating diseases, and it has been studied scientifically. The rose (Rosa damascena) is more famous than any other flower in the world. It is part of the Rosaceae family. Its natural habitat is India, but due of its beauty and aroma, it is grown all over the world [1]. This shrub is known as the Damask rose since it originated in Damascus. It is a perennial shrub of one or two meters in height and is cultivated in Turkey, Bulgaria, Iran, India, Morocco, South France, China, South Italy, Libya, South Russia, and Ukraine.[2], [3].

Roses have been utilized for centuries in rituals, cosmetics, fragrances, medications, and aromatherapy [2, 3]. It has been used as an ethnomedicine in our culture from ancient times, in addition to being a symbol of love and beauty. It has been employed in the Ayurvedic and Unani systems of medicine since antiquity. Rosa damascena is becoming increasingly popular worldwide due to its therapeutic characteristics and health advantages [4]. Rose species have been used for a variety of important pharmacological properties, including astringency, mild laxativeness, antibacterial, antifungal, anti-HIV, antidiabetic, antidepressant, analgesics, hypnotics, anti-hepatitis, anticancer, anti-aging, antioxidant, antitussive, anti-inflammatory, neuroprotective, and respiratory effects [4], [5].

According to pharmacological and phytochemical research, the presence of polyphenolic chemicals, essential oils, flavonoids, glycosides, terpenes, and anthocyanins is primarily responsible for the Rose plant's numerous health advantages [6], [7].

II. BOTANICAL DESCRIPTION:

Rosa damascena is a shrubby perennial plant with uneven sharp prickles [10] that grows to a height of 1 to 2 meters and produces enormous, brilliant blooms. The leaves are imparipinnate with 5-7 leaflets [10], and the sepals are deflexed after flowering, revealing an open pulpy calyx and peduncle. Fruits are round and turn crimson when mature [11]. Stems have many thick and hooked prickles, which are sometimes combined with glandular bristles. Flowers are usually corymbose, double, red, pink, or white, and occasionally striped; pedicels and receptacles are glandular-hispid [11], [12].

III. GEOGRAPHICAL DESCRIPTION:

Rose petals have been utilized for flooring since ancient times, and they were also used to fill baths and scatter roses at feasts and under chariot wheels. Rosa damascena, the most significant species, is a hybrid of Rosa gallica and Rosa phoenicia [8]. This plant is grown all over the world, especially in India, Turkey, and Bulgaria. In Iran, Kashan, Fars, and Azerbaijan are the main Rosa damascena cultivation regions [9]. There is ample proof that Iran is one of the countries that first introduced rose culture to the world, with a lengthy history of cultivation. According to research, Iran was the primary producer of rose oil in the 16th century [9], [10].

IV. TRADITIONAL USES:

Rosa damascena was believed to have the greatest medicinal benefits in ancient medicine when it came to treating digestive issues, menstrual flow, chest and stomach pain, and reducing inflammation, particularly in the neck [12]. Rose oils aid in the treatment of tension, stress, and depression. It also aids in the healing of chronic coughs, women's specific concerns, wound healing, and skin health [12]. Certain headaches, migraines, and allergies can all be relieved with rose oil [12], [13].

Rosa damascena is an Indian herb widely used in Ayurvedic medicine as gulk and for treating blood abnormalities and stomach issues. It prevents depressive effects and uplifts mood.

It helps in digestion and increases bile production [13], [14]. Rose tea helps to prevent infection of the digestive system. It treats uncomfortable and irregular menstruation. It relieves pain and heavy bleeding caused by uterine congestion, *Rosa damascena* is also used in cosmetics, creams, hand lotions, and perfumes [14], [50]. Rose water was used to sanitize the lips and wash the eyes since it is an antiseptic agent. It was also used to treat pulmonary and chest area congestions because it has antispasmodic properties.

Rosa damascena flowers are the main element in many compound formulations used in Unani medicine;

Jawarish Tabasheer, Jawarish Tamer Hindi, Gulqand Gulab, Majun Dabeedulvard and Sherbat Vard Mukarrer, Anooshdaru Sada [15]. The Unani formulation is used to strengthen the liver (muqawwi-e- jigar), stomach, and intestines (ama), as well as to relieve palpitations (khafqan), syncope (ghashi), and cardiac debility (zof-e-qalb). Additionally, it is utilized as a general tonic (muqawi-e-badan) and a vital organ tonic (muqawi-e-aza-e-raeesa) [15].

V. PHYTOCHEMICAL COMPOSITION:

Citronellol, geraniol, and nerol are among the essential oils that are present in Rosa damascena Mill throughout the research articles [15], [16]. In addition, there are phenyl ethyl alcohol, linalool, geranyl acetate, eugenol, αpinene, and β-pinene [15], [16]. Apart from these oxygenated terpenes, Rosa damascena also included hydrocarbons such Tricosane, Pentacosane, Heptacosane, Heneicosane, Eicosane, Heptadecane, and Nonadecane. Rose oil's waxy nature is caused by these hydrocarbons. Rose oil is thought to include three main ingredients: phenol-ethyl alcohol, citronellol, and geraniol [16].

Damascenone is a potently scented ketone found in trace amounts in rose oil.Methanol, ethanol, hexanol, heptanol, octanol, nonanol, linalool, Terpinen-4-ol, farnesol, acetaldehyde, cinnam Aldehyde, salicylaldehyde, hexylactate, linalyl Acetate, carvone, tran-damascenone, methylheptenone, eugenol, methyleugenol, alpha and Beta-pinene, camphene, myrcene, and propionic Additionally, there are caproic, valeric, and butyric acids. Many components were extracted from Rosa Damascena flowers, petals, hips (seed pot), leaves, stalks, and roots [18].

Betadamascone, betadione, and beta-damascenone are flavoring chemicals found in R. Damascena essential oil. These molecules are often derived from the decomposition of carotenoid compounds. R. Damascena contains the following minerals: phosphorus, calcium, sodium, potassium, magnesium, iron, manganese, boron, and zinc. The majority of Rosaceae's therapeutic properties are attributed to phenolic chemicals, which are abundant in the family [18].

VI. PHARMACOLOGICAL PROPERRTIES:

a) Antimicrobial effects: Wide-spectrum antibacterial activity of Rosa damascena has been demonstrated. Hydrosol, absolute, and essential oils are significant products that exhibited antibacterial action against strains of Pseudomonas aeruginosa, Bacillus subtilis, Escherichia coli, and Staphyloccocus aureus. The most susceptible bacteria to rose essential oils were Escherichia coli [19]. While rose hydrosol exhibited no antimicrobial action against any of the pathogens, rose absolute demonstrated antibacterial activity against both gram-positive and gram-negative bacteria as well. Fresh flowers and leftover/used flower extracts from Rosa damascena were found to have antibacterial activity against bacteria such as B. cereus, Escherichia coli, Enterobacter aerogenes, Klebsiella pneumoniae, Myco-Bacterium smegmatis, Proteus vulgaris, Pseudo-Monas aeruginosa, Pseudomonas fluorescens, Salmonella enteritidis, Salmonella typhimurium, and Staphyloccocus aureus. Fresh floral extracts outperformed wasted or dried flower extracts [20], [21].

b) Anti-oxidant activity: Rosa damascena has antioxidant qualities, just as a lot of other fragrant and medicinal plants. Natural antioxidants can be obtained from phenolic compounds, which are present in all plant components, including fruits, vegetables, seeds, leaves, roots, and bark [22], [23]. Research has shown that Rosa damascena fresh flower extracts had a higher phenolic content and stronger antioxidant properties than spent or used flowers. The presence of flavonoid components and quercetin in the extract may be the cause of the impact [23], [24].

c) Neuroprotective effect: To assess Rosa damascena's effects on the central nervous system (CNS), pharmacological investigations have been conducted. Rosa damascena is said to have a wide range of effects on the central nervous system [25], [26]. It has been demonstrated that ethanol extracts of fresh flowers have strong depressive effects on mice [26]. Other effects shown by this plant include hypnotic, analgesic, anticonvulsant, and anti-anxiety properties [26].

d) Anti-diabetic effect: Research has demonstrated the anti-diabetic properties of Rosa damascena. When normal and diabetic rats were given an oral dose of Rosa damascena methanolic extract, their blood glucose levels significantly decreased [26]. It is possible that the plant's antidiabetic properties stem from its inhibition of α-glucosidase, which inhibits the absorption of carbohydrates from the small intestine and lowers postprandial glucose levels [27].

e) Anti-inflammatory effect: It has also been demonstrated that this herb contains anti-inflammatory properties [27]. Edema is significantly reduced when Rosa damascena hydroalcoholic extract is used. Essential oils did not exhibit any anti-inflammatory properties; nonetheless, flower extracts have the ability to decrease edema [28], [49].

f) Anti-cancer effect: Rose oils and the methanolic extract of R. damascena have been shown in numerous studies to have significant anti-cancer properties. Oils and extracts both demonstrated anti-cancer cell line effects [28], [29]. Additionally, studies have shown that modest concentrations of oils and extracts have harmless effects on human lymphocyte cells and have effective anti-cancer action [28], [30], and [49].

g) Gastrointestinal effect: It has been determined that R. damascena hydro-alcoholic extracts had effects on the gastrointestinal system. The contraction of the ileum's smooth muscle was stimulated by hydro-alcoholic extracts [31]. Furthermore, significant ileum relaxing activity was seen in the isolated geraniol and citronellol. Additionally, β-adrenergic and opioid receptors were stimulated for the inhibition of ileum contractions in guinea pigs and muscarinic receptors for the activation of ileum movements in rats by hydro-alcoholic extracts.

h) Effect on respiratory system: The respiratory system is impacted by Rosa damascena. Citric acid-induced cough in guinea pigs is greatly reduced by ethanolic and aqueous extracts of R. damascena, according to research [31]. Another study examined the effects of essential oil and ethanolic extract on the tracheal smooth muscle of guinea pigs that were constricted with methacholine and KCl. The findings demonstrated that the extract and essential oil had a strong relaxing effect similar to that of theophylline. It is unknown what mechanism the relaxing activity is based on [32].

i) The laxative effect: Rosa damascena's boiling extract shown a strong laxative effect in the Ayurvedic medical system. Both the frequency of defecation and the water content of the feces are increased [32].

j) Anti-HIV activity: Aqueous and methanolic extracts of R. damascena were shown to have anti-HIV properties by researchers. It was demonstrated that 2-phenylethanol-O-(6-O-galloyl)-β-Dglucopyranoside, a novel chemical found in Rosa damascena, is what gives it its anti-HIV properties. Kaempferol is very effective against HIV-infected C8166 cells. Viral protease is slowed down, which lessens the development of infectious offspring viruses. Kaempferol derivatives prevent gp120 from attaching to CD4 to prevent HIV infection [31], [32].

k) Anti-depression and sexual effect: In one study, it was demonstrated that giving depressed men with sexual dysfunction 2 milliliters of rose oil orally every day for two months lowers their feelings of depression and dramatically improves their sexual function [31]. Rose oil has also been demonstrated to have a minimally positive impact on women's sexual function but no effect on depression [33], [34].

l) Analgesic activity: Six investigations looked into Rosa damascena Mill.'s analgesic properties, and 50 patients with extensive burn wounds were treated with essential oil inhalation therapy. After 15 to 30 minutes of wound dressing, patients who received aromatherapy reported experiencing significant pain reduction [35].

m) Anti-hyperlipidemic effect: 50 patients with severe burn wounds received essential oil inhalation therapy as part of six studies that examined Rosa damascena Mill.'s analgesic qualities. Patients who received aromatherapy reported much less discomfort after treating their wounds for 15 to 30 minutes [35].

n) Hypnotic effect: In comparison to diazepam, Rosa damascena's ethanolic and aqueous extracts lengthen sleep duration [37].

o) Anti-ageing effect: The anti-aging properties of Rosa damascena rose flower extract were demonstrated in an experiment. The findings revealed a noteworthy decline in mortality [38].

p) Cosmetic properties: UV light is effectively absorbed by Rosa damascena hydro-alcoholic and ethyl acetate extracts [38], [39]. There have been reports on the antibacterial properties of essential oils against Propioni bacterium acne and their antiacne impact [34], [35].

q) Culinary uses: Rose petals from damask are used as a spice or seasoning in food. Middle Eastern recipes use powdered rose petals and rosewater. For the most part, rose powder is added to sauces, and rosewater is sprinkled over meat meals. The most common use is in the flavoring of delicacies such ice cream, jam, Turkish delights, rice pudding, and yogurt in other Middle Eastern nations. It was and is a flavor found in traditional desserts, where it was most frequently employed [39].

VII. CONCLUSION:

Rosa damascena is an important species in the Rosaceae family, known mostly for its fragrance characteristics. Rose blooms have been used for centuries to treat a variety of ailments. The entire review has been centered on understanding the significance of Rosa damascena as not only an ornamental plant or its beauty, but also for its therapeutic properties. Its main products are essential oils and rose water, which are utilized in cosmetics and pharmaceutical formulations on the market. Terpenes, glycosides, flavonoids, anthocyanins, polyphenols, tannins, and other chemicals are responsible for the plant's pharmacological properties.

According to the literature, this plant possesses antibacterial, antifungal, and antioxidant properties, as well as a high vitamin and mineral content. Other effects of this plant include respiratory and gastrointestinal tract infections, laxative, neuroprotective, antiinflammatory, hepatoprotective, and anti-diabetic properties. The majority of traditional medicine's claims have been supported by scientific studies. However, more extensive

clinical trials appear to be required to fully investigate the plant's therapeutic potential and establish it as a conventional medicine.

VIII. REFERNCES:

1. Shaiqua A and Fahmeeda Z: Therapeutics and pharmacology of Gul-e-Surkh (Rosa damascena Mill)-An important Unani drug. International Journal of Advances in Pharmacy Med and Bioallied Sci 2017: 5(3): 195-205.
2. Esha T and Gotmare SR: Study of variation and identification of chemical composition in Rosa Species oil collected from different countries. IOSR Journal of Applied Chemistry 2016; 9(11): 11-18.
3. Priti SP, Pratima AT and Satish YG: In-vitro antioxidant and free radical scavenging activity of extracts of Rosa damascena flower petals. American Journal of Phytomedicine and Clinical Therapeutics 2015; 3(09): 589-601.
4. Kamran JN and Ansari SH: Volatile oil composition of Rosa damascena Mill. (Rosaceae). Journal of Pharmacognosy and Phytochemistry 2014; 2(5): 177 -81.
5. Nezihe K, Rafet S and Ebru K: Determination of volatile compounds of the first rose oil and the first rose water by HS-SPME/GC/MS techniques. African Journal of Traditional Complement Alternative Medicine 2015; 12(4): 145-50.
6. Neda N, Nahid K and Mohammad K: A systematic review of the efficacy and safety of Rosa damascena Mill. with an overview on its phytopharmacological properties. Complementary Therapies in Medicine 2017; 34: 129-40
7. Davoodi I, Rahimi R and Abdollahi M: Promising effect of Rosa damascena extract on high-fat diet-induced nonalcoholic fatty liver. Journal of Traditional Complement Medicine 2017; 7(4): 508-14.
8. Mark PW: History and utilization of Rosa damascena, Journal of Economic Botany 1981; 35: 42-58.
9. Mohammad HB and Mohammad NS: Pharmacological Effects of Rosa damascena. Iran Journal of Basic Medical Science 2011; 14(4): 295-307
10. Nikbakht A and Kafi MA: Study on the Relationships between Iranian People and Damask Rose (Rosa damascena) and its Therapeutic and Healing Properties ActaHort (ISHS) 2008; 790: 251-54.
11. Thakare P.A. Deshbhratar K and Suryawanshi MN: A brief review on therapeutic effects of – ornamental plant rose. International Journal of Ayurveda and Pharma Research 2017; 5(12): 46-52.
12. Mohammad HB and Mohammad NS: Pharmacological Effects of Rosa damascena. Iran, Journal of Basic Medical Science 2011; 14(4): 295-307.
13. Widerlechner MP: History and utilization of Rosa damascena. Journal of Economic Botany 1981; 35: 42-58.
14. Dolati K and Rakhshandeh H: Evaluation of antidepressant effect of ethanolic extract of Rosa damascena using forced swimming test. Avicenna Journal of Phytomedecine 2011; 2: 46-51.
15. Haider AQ and Naquibul I: Medicinal properties of Gul-esurkh in perspective of unani medicine: a review study. International Research Journal of Biological Sciences 2019; 8(3): 37-41
16. Nazargi M, Jayashree M and Surya G: Uses of Medicinal values of Rosa damacena Mill in Dentistry– A Review. World Journal of Pharmaceutical and Medical Research 2018; 4(2): 92-94.
17. Nanda S and Das PK: Medicinal Efficacy of Rose Plant: A Mini Review,PharmaTutor 2015; 3(10): 23-26.
18. Muhammad A and Muhammad R: Chemical constituents, experimental and clinical pharmacology of Rosa damascena: a literature review. Journal of Pharmacy and Pharmacology 2019; 1-14.
19. Mohammad HB and Mohammad NS: Pharmacological Effects of Rosa damascena. Iran Journal of Basic Medical Science 2011; 14(4): 295-307.
20. Esha T and Gotmare SR: Study of variation and identification of chemical composition in Rosa species oil collected from different countries. Journal of Applied Chemistry 2016; 9(11): 11-18.
21. Mariana P and Marilena R: Rose essential oil extraction from fresh petals using synergetic microwave & ultrasound energy-chemical composition and antioxidant activity assessment. Journal of Chemical and Chemistry Engineering 2016; 10: 136-42.
22. Mohammad HB and Mohammad NS: Pharmacological Effects of Rosa damascena. Iran, Journal of Basic Medical Science 2011; 14(4): 295-307.

23. Adnan Y and Muhammad A K: Effect of different extraction methods on yield and quality of essential oil from Rosa species. Floriculture and Ornamental Biotechnology 2007; 1(1): 73-76.
24. Eman MH: Antimicrobial activity of Rosa damascena petals extracts and chemical composition by gas chromatography-mass spectrometry (GC/MS) analysis. African Journal of Microbiology Research 2014; 8(24): 2359-67
25. Neda N, Nahid K, Mohammad K and Majid E: A systematic review of the efficacy and safety of Rosa damascena Mill. with an overview on its phytopharmacological properties. Complementary Therapies in Medicine 2017; 34: 129-40.
26. Irfan A, Masroor AQ and Humaira B: Pharmacological Effects of Rosa Damascena Mill and its various isolated constituents from Flowers an Important Drug of Unani Medicine- A Review. Journal of Emerging Technologies and Innovative Research 2018; 5(12): 1301-11.
27. Shahriari S, Yasa N and Mohammadirad A: In-vitro antioxidant potential of Rosa damascena extract from guilan, Iran comparable to α-tocopherol. International Journal of Pharmacology 2007; 3: 187-90.
28. Neda N, Nahid K and Mohammad K: A systematic review of the efficacy and safety of Rosa damascena Mill. with an overview on its phytopharmacological properties. Complementary Therapies in Medicine 2017; 34: 129-40.
29. Artun FT and Karagoz A: In-vitro anticancer and cytotoxic activities of some plant extracts on Hela and Vero cell lines. Journal of the Balkan Union of Oncology 2016; 21(3): 720-25.
30. Hagag HA and Bazaid SA: Cytogenetic, cytotoxic and GC–MS studies on concrete and absolute oils from Taif rose. Saudi Arabia Cytotechnology 2014; 66(6): 913-23.
31. Shafei MN, Saberi Z and Amini S: Pharmacological effects of Rosa damascena. Iran Journal of Basic Medical Science 2011; 14(4): 295-307.
32. Neda N and Nahid K: A systematic review of the efficacy and safety of Rosa damascena Mill. with an overview on its phytopharmacological properties. Complementary Therapies in Medicine 2017; 34: 129-40.
33. Farnia V: Rosa damascena oil improves SSRI-induced sexual dysfunction in male patients suffering from major depressive disorders: results from a double-blind, randomized, and placebo-controlled clinical trial.
34. Farnia V and Hojatitabar S: Adjuvant Rosa Damascena has a small effect on SSRI-induced sexual dysfunction in female patients suffering from MDD. Pharmacopsychiatry 2015; 48(4/5): 156-63.
35. Bikmoradi A and Harorani M: The effect of inhalation aromatherapy with damask rose (Rosa damascena) essence on the pain intensity after dressing in patients with burns: a clinical randomized trial. Iran Journal of Nursing and Midwifery Research 2016; 21(3): 247.
36. Joukar S and Askarzadeh M: Assessment of safety and therapeutic efficacy of Rosa damascena and quercus infectoria on cardiovascular performance of normal and hyperlipidemic rabbits: physiologically based approach. Journal of Toxicology 2013; 1-6.
37. Rakhshandah H and Hosseini M: Potentiation of pentobarbital hypnosis by Rosa damascena in mice. Indian Journal of Experimental Biology 2006; 44(11): 910.
38. Tabrizi H, Mortazavi S and Kamalinejad M: An in-vitro evaluation of various Rosa damascena flower extracts as a natural antisolar agent. International Journal of Cosmetic Science 2003; 25(6): 259-65.
39. Louay L and Nasser T: The medicinal and pharmacological properties of Damascene Rose (Rosa damascena)-A review. International Journal of Herbal Medicine 2020; 8(2): 33-37.
40. Wedler J and Weston A: In-vitro modulation of inflammatory target gene expression by a polyphenolenriched fraction of rose oil distillation waste water. Fitoterapia Journal Elsevier 2016; 114: 56-62.
41. Artun FT, Karagoz A and Ozcan G: In-vitro anticancer and cytotoxic activities of some plant extracts on Hela and Vero cell lines. Journal of the Balkan Union of Oncology 2016; 21(3): 720-25.
42. Neda N, Nahid K and Mohammad K: A systematic review of the efficacy and safety of Rosa damascena Mill. with an overview on its phytopharmacological properties. ComplementaryTherapies in Medicine 2017; 34: 129-40.
43. Dolati K and Rakhshandeh H: Effect of aqueous fraction of Rosa damascena on ileum contractile response of guinea pigs. Avicenna Journal of Phytomedicine 2013; 3(3): 248-53.
44. Muhammad A and Muhammad R: Chemical constituents, experimental and clinical pharmacology of Rosa damascena: a literature review. Journal of Pharmacy and Pharmacology 2019; 1-14.

45. Pratt DE and Hudson JE: Natural antioxidants not exploited commercially. In: Hudson BJF, editor, Food Antioxidant Amsterdam UK: Elsevier 1990: 171-92.
46. Hagag HA and Bazaid SA: Cytogenetic, cytotoxic and GC–MS studies on concrete and absolute oils from Taif rose. Saudi Arabia. Journal of Cytotechnology 2014; 66(6): 913-23.
47. Galina N: Reducing oxidative toxicity of L-dopa in combination with two different antioxidants: an essential oil isolated from Rosa Damascena Mill, and vitamin C. Toxicology Reports 2019; 6: 267-71.
48. Abolfazl A and Nasrin B: Effect of aromatherapy on postoperative pain. Journal of Nursing and Midwifery Studies 2020; 9(3): 117-23.
49. Hadian Z and Maleki M: Health aspects of geraniol as a main bioactive compound of Rosa damascena Mill: a systematic review. Electronic Physician 2020; 12(3): 7724-35
50. Kendir G and Köroğlu A: Morphological and anatomical evaluation of herbal drugs sold under the name of Gül (Rosa damascena Mill.) in Turkey. Journal of Research in Pharmacy 2021; 25(1): 63-71.