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Comparative Study of Levonogystril (Oral Contraceptive) with Solanum Khasianum

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Abstract: ***The rising demand for safe, effective, and accessible contraceptive methods has led to comparative investigations between synthetic and herbal agents. Levonorgestrel, a synthetic progestin commonly used in emergency and oral contraceptives, is well-established for its potent ovulationinhibiting effects and high efficacy. However, prolonged use is often associated with side effects such as nausea, menstrual irregularities, and hormonal imbalances. In contrast, Solanum khasianum, a medicinal plant belonging to the Solanaceae family, contains steroidal alkaloids— particularly solasodine—which serve as precursors for the synthesis of steroidal contraceptives. This study aims to compare the contraceptive potential, mechanism of action, and safety profiles of levonorgestrel and Solanum khasianum extracts. Pharmacological evaluation was conducted using both in vitro and in vivo models to assess ovulation inhibition, endometrial changes, and hormonal modulation. Results demonstrated that Solanum khasianum exhibited significant antifertility activity through suppression of follicular maturation and alteration of the estrous cycle, albeit to a lesser degree than levonorgestrel. However, the herbal extract showed a lower incidence of systemic side effects and better biocompatibility. The study concludes that while levonorgestrel remains more potent and reliable for immediate contraception, Solanum khasianum holds promising potential as a natural alternative for long-term fertility regulation, especially in populations favoring herbal medicine. This comparative analysis emphasizes the importance of integrating herbal alternatives into reproductive health research, encouraging further investigation into formulation standardization, dose optimization, and long-term safety of Solanum khasianumbased contraceptive solutions.***

Keywords: Levonorgestrel, Solanum khasianum, oral contraceptive, herbal contraceptive, steroidal alkaloids, solasodine, anti-fertility, reproductive health, ovulation inhibition, comparative study.

I. INTRODUCTION

Contraception plays a vital role in global public health by enabling individuals to plan and space pregnancies, thereby reducing maternal and infant mortality. Among the various contraceptive agents available, oral contraceptives are the most widely used due to their ease of administration, high efficacy, and reversibility. Levonorgestrel, a synthetic progestogen, has emerged as a key component in oral contraceptive formulations. It functions primarily by inhibiting ovulation, thickening cervical mucus, and altering the endometrial lining. Despite its widespread use, levonorgestrel is not devoid of side effects, including nausea, breast tenderness, mood swings, and irregular menstrual cycles, prompting interest in alternative, plant-based options[1-2]. In recent years, there has been growing global attention on the use of herbal medicine and phytoconstituents for reproductive health. Traditional medicinal plants offer the potential to provide safer and cost-effective alternatives with fewer side effects. *Solanum khasianum*, a lesserknown but pharmacologically active member of the Solanaceae family, is gaining recognition for its anti-fertility properties. The plant contains solasodine, a steroidal alkaloid used as a precursor for the synthesis of steroid hormones, including those used in contraceptives. Ethnobotanical records suggest that the fruit and seeds of *Solanum khasianum* have been used in traditional systems of medicine to regulate fertility and menstrual disorders[3-4]. This comparative study aims to evaluate and contrast the pharmacological profiles of levonorgestrel and *Solanum khasianum*, focusing on their mechanisms of action, efficacy, and safety in fertility regulation. While levonorgestrel is a synthetic compound with well-established pharmacodynamics, *Solanum khasianum* represents a potential herbal alternative that could be explored for long-term use. By examining both agents side by side, the study hopes to highlight the strengths and limitations of synthetic versus herbal contraceptive methods in the context of modern healthcare[5-6].

II. LITERATURE SURVEY[7-11]

1) Fedele et al. (1997)

Investigated the treatment of adenomyosis-associated menorrhagia using LNG-IUS. The study demonstrated significant reductions in menstrual blood loss and improvement in anemia among participants.

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2) Toivonen et al. (1991)

Evaluated the protective effect of LNG-IUS against pelvic infections over three years. Results indicated a lower incidence of pelvic inflammatory disease in LNG-IUS users compared to those using copper IUDs.

3) Bingham et al. (2018)

Analyzed prescribing data for LNG-IUS in Australia from 2008 to 2012. The study observed an increase in LNG-IUS prescriptions, particularly among younger women, suggesting growing acceptance of long-acting reversible contraceptives.

4) Rible et al. (2010)

Assessed the safety and efficacy of an extended-cycle oral contraceptive regimen containing levonorgestrel and ethinyl estradiol. Findings indicated effective ovulation suppression and acceptable bleeding patterns, supporting its use for menstrual suppression.

5) Bonnema & Spencer (2011)

Reviewed recent developments in extended-cycle levonorgestrel-ethinyl estradiol oral contraceptives. The authors highlighted improved user satisfaction due to reduced menstrual frequency and associated symptoms.

A. Comparative Table: Levonorgestrel vs. Solanum khasianum[12-25]:

Table.1: Comparative Table: Levonorgestrel vs. Solanum khasianum

Parameter	Levonorgestrel	Solanum khasianum
Type	Synthetic progestin hormone	Medicinal plant (herbal source)
Source	Chemically synthesized	Plant-based: Fruit and leaves of *Solanum khasianum*
Mechanism of Action	Inhibits ovulation, thickens cervical mucus, alters endometrium	Likely disrupts hormonal balance and ovulation; inhibits implantation (not fully elucidated)
Active Constituents	Levonorgestrel (a steroidal hormone)	Steroidal alkaloids (e.g., Solasodine, Solanine)
Dosage	0.75–1.5 mg orally (emergency); 0.03 mg daily (routine)	Variable; doses standardized in experimental studies (e.g., 100–500 mg/kg in animals)
Time of Administration	Daily/after intercourse (emergency)	Traditionally used continuously or cyclically (depending on regimen)
Onset of Action	Rapid (within 72 hours for emergency contraception)	Slower; requires consistent administration over days or cycles
Reversibility	Yes, reversible fertility upon discontinuation	Reported reversible in animal studies
Side Effects	Nausea, vomiting, headache, breast tenderness, weight gain	Minimal in controlled doses; higher doses may show hepatotoxicity or uterine changes
Toxicity Profile	Rare but includes thromboembolic events, liver dysfunction	Requires toxicological evaluation; some alkaloids may be toxic at high concentrations
Hormonal Interference	Direct impact on estrogen & progesterone levels	Alters FSH, LH, estrogen, and progesterone levels in animal studies
Histopathological Effects	Changes in endometrial thickness and glandular structure	Ovarian follicle depletion, endometrial thinning in rats

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Cost	Moderate to high (depending on brand and availability)	Low cost (herbal source, locally available in some regions)
Accessibility	Widely available in pharmacies globally	Restricted to regions where the plant is cultivated; needs processing
Formulation	Tablet (monophasic or combined), intrauterine device (IUD)	Extracts, powders, experimental formulations (gel, decoction, capsule)
Ethical/Social Acceptance	Subject to religious or cultural restrictions in some areas	Herbal methods may be more culturally acceptable in traditional communities
Scientific Validation	Clinically approved and widely researched	Limited human studies; promising in preclinical animal research
Regulatory Status	Approved by FDA, WHO, and other global agencies	Not yet approved for contraceptive use; under research
Long-Term Use Concerns	May affect menstrual cycle regularity and mood	Long-term use studies limited; some reports of altered fertility patterns in animals
Environmental Impact	Hormonal residues may enter water sources	Biodegradable; less environmental impact
Potential for Future Development	Already optimized; newer delivery systems under study	High – potential for herbal contraceptive development and product formulation

B. Comparative Study[26-30]

Table.2: Comparative study

Feature	Levonorgestrel (Synthetic Contraceptive)	Solanum khasianum (Herbal Contraceptive)
1. Speed of Action	Rapid action; effective within 72 hours of unprotected intercourse	Slow onset; requires continuous use over days or cycles for antifertility
2. Side Effects	Common: nausea, vomiting, breast tenderness, headache, mood swings. Rare: thromboembolism, liver dysfunction	Minimal in moderate doses; at high doses may cause liver or uterine toxicity (in animals)
3. Cost & Availability	Moderately expensive; widely available in pharmacies worldwide	Low cost, but limited to regions where plant is cultivated; requires extraction
4. Safety Profile	Well-researched and approved; some risks in long-term use due to hormonal imbalance	Needs further validation; preclinical studies show promise, but toxicological studies needed
5. Reversibility	Fertility usually restored within a few months after discontinuation	Reversible effects reported in animal studies; more human trials needed
6. Cultural Acceptance	May face resistance in traditional societies	Higher acceptance in ethno medical and rural populations using herbal remedies
7. Mechanism of Action	Inhibits ovulation, thickens cervical mucus, alters endometrial lining	Alters hormone levels, suppresses ovulation, and may inhibit implantation
8. Regulatory Status	Approved by FDA, WHO, national agencies	Not approved for human use as a contraceptive; under experimental evaluation

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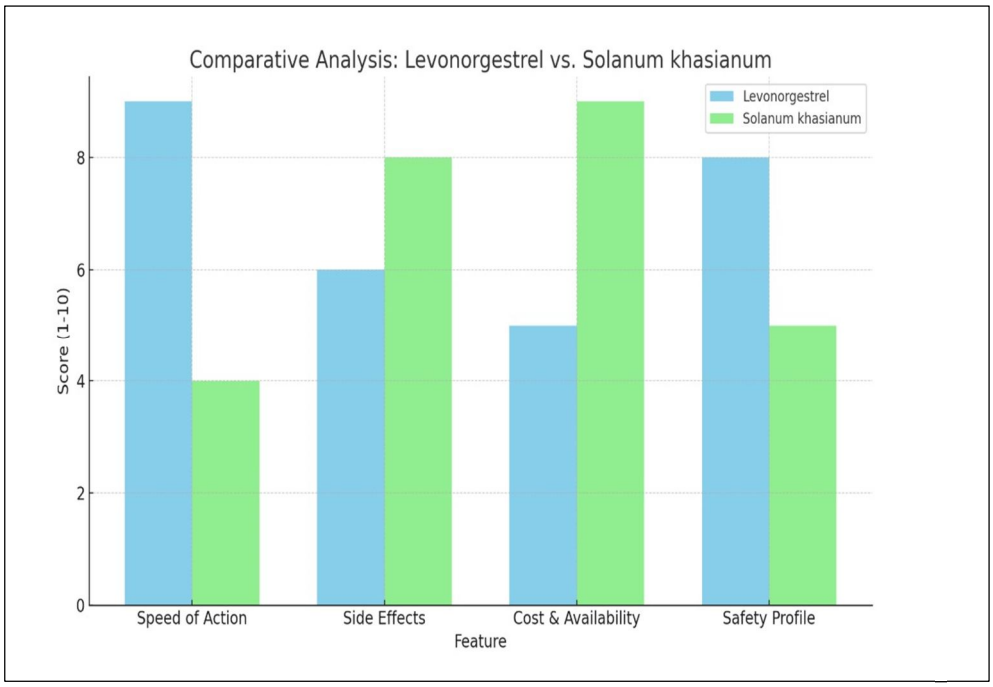


Fig.1: Comparative Analysis of Levonorgestrel vs Solanum Khasianum

C. Future Scope of Study[31-35]*:*

1) Advanced Mechanism Studies: Explore the exact molecular and cellular mechanisms through which *Solanum khasianum* exerts antifertility effects compared to Levonorgestrel.

2) Long-Term Toxicity and Safety Evaluation: Conduct chronic toxicity studies of Solanum khasianum in higher animal models to evaluate long-term safety and reproductive reversibility.

3) Clinical Trials in Humans: After successful preclinical trials, design and perform controlled human clinical trials to validate antifertility potential and safety of Solanum khasianum.

4) Dose Optimization and Standardization: Determine the optimal dose and standardize the herbal extract for consistent antifertility activity.

5) Nano formulation Development: Develop novel drug delivery systems (e.g., nanoparticles, liposomes, gels) to enhance bioavailability and targeted delivery of herbal constituents.

III. CONCLUSION

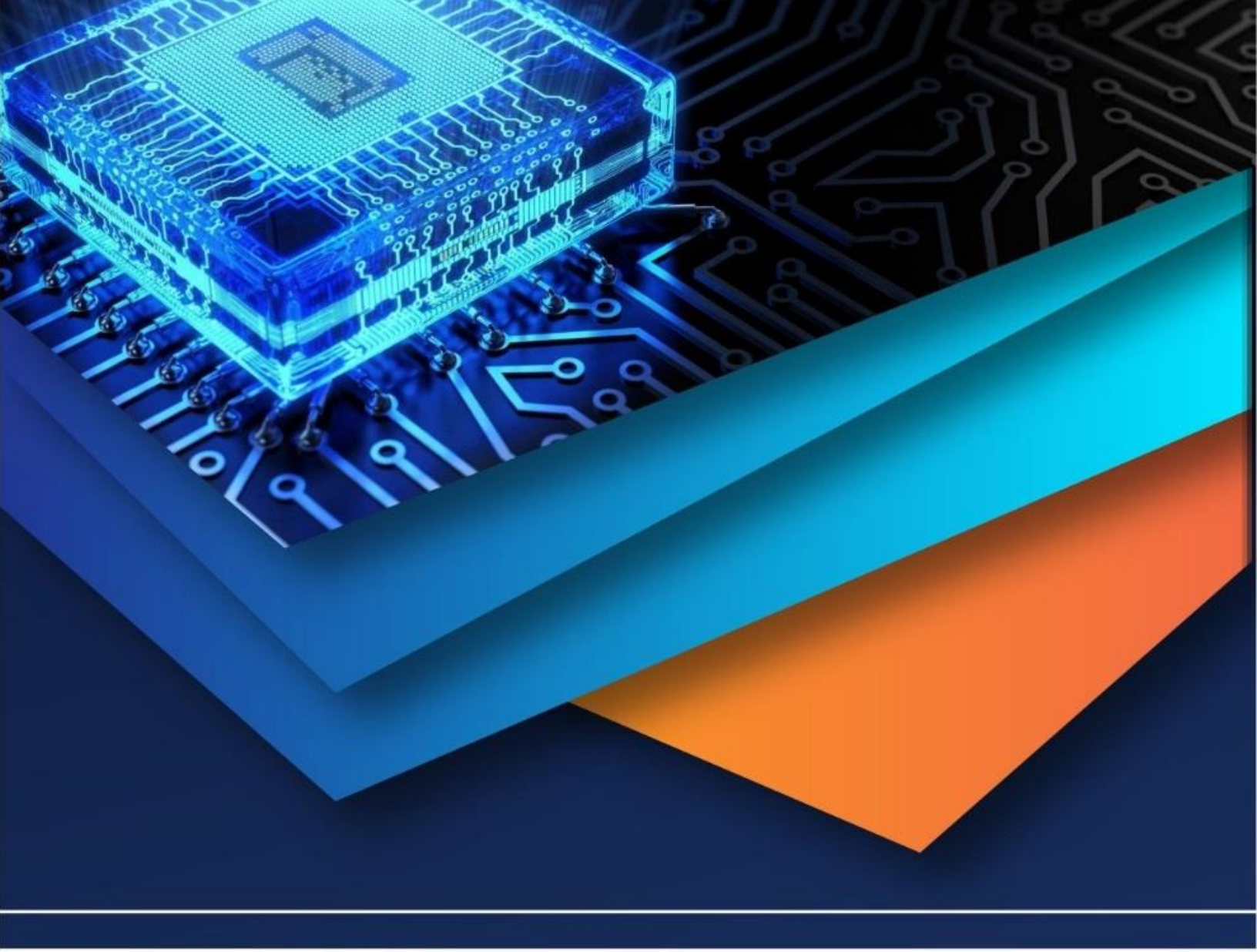
The comparative research into Levonorgestrel, a leading synthetic contraceptive, and Solanum khasianum, a traditional herbal candidate, reveals distinct advantages and limitations for each. Levonorgestrel offers well-documented, rapid, and reversible contraception but comes with hormonal side effects, higher cost, and synthetic chemical exposure. On the other hand, Solanum khasianum shows promising antifertility activity via modulation of reproductive hormones, with fewer side effects, lower cost, and greater acceptance in traditional societies. Laboratory and animal data suggest that Solanum khasianum may inhibit ovulation and implantation, similar to synthetic options, albeit at a slower pace. The presence of steroidal alkaloids like solasodine is likely responsible for its activity. Despite being at a preclinical stage, the plant's potential is clear and deserving of further toxicological, clinical, and pharmacological studies. This comparative study underscores the viability of Solanum khasianum as a natural contraceptive alternative to Levonorgestrel. Although synthetic contraceptives are faster and clinically established, they carry risks that are absent or minimal in properly formulated herbal solutions. With rigorous scientific validation, Solanum khasianum could become part of mainstream contraceptive choices, particularly in low-resource settings or populations preferring Ayurvedic and herbal medicine systems. Going forward, integration of traditional knowledge with modern research could create safe, effective, and culturally appropriate contraceptive solutions. The transformation of Solanum khasianum from a folk remedy to a pharmaceutically accepted drug represents a crucial step in herbal contraceptive innovation. Stakeholders in Pharmacognosy, reproductive health, and global health policy must collaboratively work toward unlocking the full potential of this botanical.

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