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Research Article

In-vitro and randomised pilot clinical study to analyse the impact of *Vijayasara (Pterocarpus Marsupium Roxb.) and Vrikshamla (Garcinia Indica Choisy.)* in *Sthoulya* (Obesity)

Aishwarya Gargote[1], Varghese Jibi[2]*, Sanjay Babar[3], Mrudula J[4], Nisha MS[5], Manna Mathew[6]

1. Post Graduate Scholar, Department of Kayachikitsa, Dr. D. Y. Patil College of Ayurveda and Research centre. Dr. D. Y. Patil Vidyapeeth (Deemed to be University), Pimpri, Pune-18, Maharashtra, India.
2. Associate Professor, Dept of Kayachikitsa, Vaidyaratnam Ayurveda College, Ollur, Thrissur. India.
3. Professor & Hod, Department of Shalyatantra, Dr D.Y.Patil College of Ayurveda and Research centre. Dr. D. Y. Patil Vidyapeeth (Deemed to be University), Pimpri, Pune-18, Maharashtra, India.
4. Associate Professor, Santhigiri Ayurveda Medical College, Olassery, Palakkad, Kerala. India.
5. Assistant Professor, Santhigiri Ayurveda Medical College, Olassery, Palakkad, Kerala. India.
6. Ayurveda Practitioner, Kerala. India.

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Abstract

Obesity, a major global health issue, is marked by abnormal fat accumulation and linked to conditions like type 2 diabetes, cardiovascular diseases, and metabolic syndrome. It results from a chronic imbalance between calorie intake and expenditure, commonly caused by sedentary lifestyles, high-fat diets, and stress. In *Ayurveda*, obesity—known as *Sthoulya*—is considered a disorder stemming from an imbalance of *Medo Dhatu*, often associated with aggravated *Kapha* and *Vata doshas*. Factors such as improper diet (*Ahara*), lack of physical activity (*Avyayama*), and impaired digestive fire (*Agnimandya*) contribute to its development. The growing prevalence of obesity correlates strongly with increased risks of lifestyle-related diseases like hypertension, diabetes, cardiovascular disease, and certain cancers. According to NFHS-5 (2019–21), overweight or obesity (BMI ≥25 kg/m²) increased among Indian adults: men from 18.9% to 22.9% and women from 20.6% to 24.0%. (1) A 2021 Indian study showed an overall obesity prevalence of 40.3%, higher in urban populations (about 44%), and more common in women (41.9%) than men (38.7%). (2) This preliminary in-vitro and clinical pilot study explores the potential of *Vijayasara* (Pterocarpus Marsupium) and Vrikshamla (Garcinia Indica) in managing obesity. MTT assay results demonstrated that both extracts effectively reduced adipocyte activity without cellular toxicity. Twenty-four patients with *Sthoulya* were randomized into two groups: Group A received Vijayasara, and Group B received Vrikshamla for six weeks. Both groups showed improvements in body weight, BMI, and waist circumference, with Vrikshamla showing more pronounced benefits. The study suggests that Vrikshamla has stronger anti-lipogenic effects, indicating greater potential in obesity management.

Keywords: *Vrikshamla, Vijayasara,* Gene Expression, 3T3-l1 cell line, MTT assay, Lipid profile.

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Introduction

In *Ayurveda*, obesity is referred as *Sthoulya*, a condition caused by vitiation *of Kapha* and *Medo Dhatu*, and classified as a *Santarpanottha Vyadhi* (disease of over-nutrition). *Acharya Charaka* includes *Sthoulya* among the *Ashtau Nindita Purusha*, indicating its pathological nature. Contributing factors include excessive intake of heavy, sweet, and oily foods, lack of physical activity and day sleeping, leading to *Agni Mandya* (digestive weakness*), Ama accumulation*, and *Medo Dhatu vriddhi* (excess fat tissue). This obstructs the *Medovaha Srotas*, impairs metabolism and promotes fat deposition.

Obesity is a chronic health disorder characterized by an excessive accumulation of body fat that impairs overall well-being. It is typically identified through Body Mass Index (BMI), with a value of 30 kg/m² or higher classified as obese. However, obesity is not just about weight—it is a complex condition involving metabolic, hormonal, and inflammatory changes that affect nearly every system of the body. Modern research recognizes that obesity results from an imbalance between calorie intake and energy expenditure, but this imbalance is influenced by numerous factors including genetics, diet quality, physical inactivity, emotional stress, sleep disturbances and socio-economic conditions. Addressing obesity at both individual and public health levels is essential in reducing its impact on health systems and improving quality of life.

*** Corresponding Author:**
Jibi Varghese
Associate Professor, Department of Kayachikitsa,
Vaidyaratnam Ayurveda College,
Ollur, Thrissur. Kerala. India.
Email Id: vjayu82@gmail.com

At the molecular level, obesity involves enhanced lipogenesis, where excess carbohydrates are converted to fatty acids. Key enzymes such as acetyl-CoA carboxylase (ACC) and fatty acid synthase (FAS) are activated by insulin, promoting triglyceride synthesis. Transcription factors like SREBP-1c and PPAR-γ regulate adipocyte differentiation and fat storage, contributing to increased adiposity. In-vitro study gives an analytical tone to this mechanism through MTT assay, differentiation and gene expression.

Ayurveda advocates a comprehensive approach involving *Shodhana* (detoxification), *Shamana* (herbal therapy), *Pathya-Apathya* (dietary regulation), and *Vyayama* (exercise). Herbs like *Vijayasara* and *Vrikshamla* are known for their *Medohara* (fat reducing) properties. (3,4)

Objectives

- To analyse the effect of *Vijayasara* and *Vrikshamla* in of *Sthoulya* with in-vitro and pilot clinical trial.
- To study the effect of *Vijayasara* and *Vrikshamala* on lipid profile.

Materials and methods

Research design: An in-vitro study and Randomised pilot clinical study.

Ethical aspect: Ethical approval for the study was obtained (DYPCARC/IEC/809/2023) from the Institutional Ethical Committee of Dr. D. Y. Patil College of Ayurveda and Research Centre and successfully registered the trial with the Clinical Trials Registry-India (CTRI/2024/04/065931), ensuring compliance with regulatory guidelines. Following this, patients were enrolled into the study after undertaking written informed consent, confirming their voluntary participation and understanding of the study's objectives, procedures, and potential risks.

Source of data:

In-vitro study: Regenerative laboratory Dr. D. Y. Patil Dental college, Pimpri, Pune-18

Clinical study: Eligible participants, as per the inclusion criteria, were enrolled from the Outpatient and Inpatient Departments of Dr. D. Y. Patil College of Ayurved Hospital and Research Centre, Pimpri, Pune-18.

For Clinical Enrolment:

Sample size: Each group included 12patients excluding dropouts. Following screening, 24 patients who satisfied the inclusion criteria were recruited into the study.

Sampling technique: Computerized Randomization

Drug source: *Vijaysara vati* and *Vrikshamala vati* were prepared at the FDA-approved Suddhatatva pharmacy of the institute Dr. D. Y. Patil College of Ayurved Hospital and Research Centre, Pimpri, Pune-18.

Table 1: Drug Review with Mode of action of drugs: (3,4)

Aspect	*Vijayasara (Pterocarpus marsupium)*	*Vrukshamla (Garcinia indica / cambogia)*
Rasa (Taste)	*Kashaya, Tikta*	*Amla, Kashaya*
Guna (Property)	*Laghu, Ruksha*	*Laghu, Ruksha*
Virya (Potency)	*Sheeta*	*Ushna*
Dosha Action	*Kapha-Pitta Shamana*	*Kapha-Vata Shamana*
Ayurvedic Karma	*Lekhana, Medoghna, Agni Deepana*	*Lekhana, Agni Deepana, Ama Pachana*
Metabolic Effects	↑ Insulin sensitivity, ↑ PPAR-γ, ↑ GLUT-4	↓ ATP-citrate lyase, ↑ Serotonin, ↓ Appetite
Effect on Fat	↓ Adipogenesis, ↓ Lipid accumulation	↓ Lipogenesis, ↑ Fat oxidation
Effect on Appetite	Minimal direct effect	Suppresses appetite via serotonin
Effect on *Agni*	Moderate enhancement	Strong *Deepana* (digestive stimulant)
Overall Outcome	Anti-obesity via glucose regulation & fat reduction	Anti-obesity via appetite suppression & fat inhibition

Figure 1: Showing the ingredients and finished product

Vrikshamla	**Vijayasara**	Vrukshamla Vati	Vijayasara vati
			

Method of preparation

Vijayasara churna and *Vrikshamla churna* are finely sieved and dried separately. Granulation is done to prepare compressible material, thereafter drying is done. Granules are fed into the tablet press machine, where tablets of 250mg are made separately of *Vijaysara* and *Vrikshmala.* Tablets are dried and stored in dry containers.

Table 2: Analytical report of drugs

Sr. no.	Parameters	Observations (Vijayasara vati)	Observations (Vrikshamala vati)
1	Description	Colour- Slightly reddish brown Odour - Pleasant Taste- Bitter Shape- Round Thickness- 0.20 cm Diameter- 0.34 cm	Colour- Light brown Odour - Pleasant Taste- Slightly sour Shape- Round Thickness- 0.25 cm Diameter - 0.38 cm
2	Average weight	247mg+_5%	315mg +_5%
3	pH (10%solution)	5.58	5.32
4	Hardness test	2kg/cm²	2.62kg/cm²
5	Disintegration test	20:00min	18min:40sec
6	Friability test	0.76%	0.15%
7	Loss on drying	6.84%	7.84%
8	Total Ash	14.32%	12.32%
9	Acid insoluble Ash	5.56%	3.56%
10	Water soluble extractive	22.76%	25.84%
11	Alcohol soluble extractive	10.25%	12.03%

Table 3: Intervention

Drug	Dose, Time of intervention	Frequency	*Anupan*
Group A *(Vijayasara vati*)	250mg After food	2-0-2	Lukewarm water
Group B (*Vrikshamla vati)*	250mg After food	2-0-2	Lukewarm water

Duration of the trial: 45 days.

Criteria for the evaluation and scoring pattern

Eligibility Criteria

Inclusion Criteria

Adults aged 18 to 60 years, inclusive of both genders. Body Mass Index (BMI) between >24.9 to 32. Presence of Ayurvedic clinical features of *Sthoulya*, including: *Chala Udara* (flabby or excessively mobile abdomen), *Atikshudda* (increased appetite or frequent hunger), *Chala Stana* (sagging of breast tissue), other signs and symptoms consistent with classical Ayurvedic descriptions. Willingness to receive Ayurvedic treatment only for the duration of the study. Voluntary participation with written informed consent.

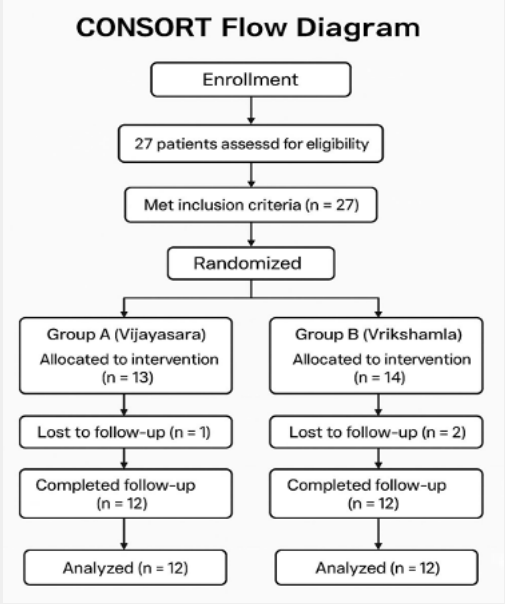
Exclusion Criteria

Individuals undergoing any other weight loss therapies, including modern medicine, surgery, or other traditional systems. Patients with severe systemic illnesses, such as: Heart diseases (e.g., coronary artery disease), Renal disorders (e.g., chronic kidney disease), Malignancies or any diagnosed cancer. Pregnant or lactating women and individuals unable or unwilling to comply with study requirements.

Table 4: Subjective parameters

Symptoms	Gradation				
	0	1	2	3	4
Daurgandhya	Absence of foul smell	Foul smell present from 1-2 feet's	Foul smell present from 2-4 feet's	Foul smell present from 4 feet's	-
Kshudra shwas	Dysnea After heavy workout	Dysnea after moderate workout	Dysnea after little work doesn't relieve	Dysnea after little work relieves soon	Dysnea on resting condition
Angagaurva	No heaviness	Heaviness felt, doesn't hamper work	Heaviness felt, hampers work	Heaviness With flabbiness all over the body	-
Atikshudha	Becomes hungry after 6hrs	Becomes hungry About 4-5hrs	Become hungry about 3hrs	Become hungry about 2hrs	-
Atipipasa	Normal thirst (2-3 litres/ day)	Intake of more than 4-5 litres	Intake more than 5-6litres	Intake of more than 6-7litres	Intake of more than 7-8 0r more
Chala udar	Absence of	Presence of	-	-	-
Chala Stana	Absence of	Presence of	-	-	-
Daurbalya	Feeling of well being	Tired After doing strengthen physical activity	Tired after doing moderate exercise but can do daily activity	Performs daily activity with difficulty	Extremely tired to carry out daily routine activity

Figure 5: CONSORT chart



Objective parameters

- Body weight
- Body mass index
- Girth measurements of following areas
  1. Chest 2. Abdomen 3. Hip 4. Mid-arm 5. Waist
- Lipid Profile

Observations

Most participants in the study were aged 31–40 years (29.17%), followed by 21–30 years (25.00%) and 41–50 years (20.83%), indicating a higher prevalence of obesity in early to mid-adulthood. Students comprised the largest occupational group (45.83%), likely due to sedentary routines, irregular schedules, and unhealthy dietary habits. Homemakers (12.50%) and service workers also showed notable representation. A majority of participants (83.33%) followed a mixed diet, suggesting that consumption of animal products and processed foods may contribute to obesity. Females (54.17%) slightly outnumbered males (45.83%), and marital status was evenly distributed. All individuals belonged to the medium-income group, indicating that lifestyle-related risk factors were prevalent across this socioeconomic category.

Statistical methods

SPSS software version 21 was utilised for all statistical data analyses conducted in the study. ordinal variables (subjective parameters) were assessed using the Friedman test, while binary variables were analysed using Cochran's Q test for within-group comparisons over time. Fisher's exact test was employed to evaluate between-group differences at follow-up intervals. Changes in weight, BMI, lipid profile within each group were analysed using the paired t-test, whereas unpaired t-tests were used to compare weight changes between different groups.

Results

In- vitro study Analysis

In vitro study assessed and compared the anti-adipogenic efficacy of *Garcinia indica (Vrukshamla)* (5) and *Pterocarpus marsupium (Vijayasara)* (4) in 3T3-L1 preadipocyte cells. Both extracts demonstrated excellent cytocompatibility, with MTT assay confirming no cytotoxicity up to 10 µg/mL. Adipogenic inhibition was evaluated through Oil Red O staining, which showed a marked reduction in lipid accumulation in both treatment groups, with *Garcinia indica* exerting a more pronounced effect. Importantly, gene expression analysis revealed significant downregulation of key adipogenic markers—PPAR-γ and GLUT-4—in both groups, indicating suppressed adipocyte differentiation at the molecular level. These results confirm that both plant extracts inhibit adipogenesis via transcriptional regulation of adipogenicity genes, with *Garcinia indica* demonstrating superior potency. This study provides mechanistic support for the traditional Ayurvedic use of these botanicals in the management of *Sthoulya* (obesity) and highlights as natural modulators for adipocyte inhibition.

Pilot clinical analysis statistical outcome

Table 5: comparison of effect of intervention within groups before treatment (BT) and after treatment (AT). Expressed in mean and standard deviation

Parameter	Group	Mean ± Standard deviation		P value
		BT	AT	
Daurgandhya	Group A	2.7500 ± 1.0559	1.0000± 0.60302	< 0.05
	Group B	2.8333p ± 0.71774	0.9167± 0.66856	< 0.05
Kshudra shwas	Group A	0.5833 ± 0.99620	0.0833 ± 0.28868	< 0.05
	Group B	0.4167 ± 0.66856	0.1667 ± 0.38925	< 0.05
Anga Gaurav	Group A	2.5000 ± 0.52223	0.3333 ± 0.49237	< 0.05
	Group B	2.6667 ± 0.49237	0.5833 ± 0.66856	< 0.05
Atikshudha	Group A	2.5833 ± 0.79296	0.8333 ± 0.71774	< 0.05
	Group B	2.4167 ± 0.51493	0.8333 ± 0.93744	< 0.05
Atipipasa	Group A	0.4167 ± 0.79296	0.0833 ± 0.28868	> 0.05
	Group B	0.3333 ± 0.49237	0.0833 ± 0.28868	> 0.05
Chala udara	Group A	0.9167 ± 0.28868	0.3333 ± 0.49237	< 0.05
	Group B	1.0000 ± 0.00000	0.6667 ± 0.49237	< 0.05
Chala sthana	Group A	0.5833 ± 0.51493	0.2500 ± 0.45227	< 0.05
	Group B	0.6667 ± 0.49237	0.3333 ± 0.49237	< 0.05
Daurbalya	Group A	2.0000 ± 1.12815	.2500 ± .45227	< 0.05
	Group B	0.3333 ± 0.49237	0.0833 ± 0.28868	> 0.05
Serum cholesterol	Group A	167.4167 ± 48.63493	152.0833 ± 30.91766	> 0.05
	Group B	187.8333 ± 56.60683	161.4000 ± 35.01989	< 0.05
Serum triglycerides	Group A	121.5667 ± 35.51746	116.7250 ± 31.43533	> 0.05
	Group B	147.5000 ± 35.51746	127.4167 ± 31.43533	< 0.05
Serum HDL	Group A	42.3083 ± 9.85139	42.5000 ± 10.42288	> 0.05
	Group B	44.9500 ± 9.85139	40.9417 ± 10.42288	< 0.05
Serum LDL	Group A	101.2083 ± 47.96795	93.7417 ± 35.72935	> 0.05
	Group B	112.3417 ± 50.94254	107.1667 ± 35.82988	> 0.05

Table 6: Comparison between groups from day 0 to day 45. Expressed in mean rank and percentage effect

Parameter	Group	Mean rank	Percentage effect (%)	P value
Daurgandhya	Group A	12.00	8.33%	< 0.05
	Group B	13.00	7.69%	< 0.05
Kshudra shwas	Group A	10.46	39.21%	< 0.05
	Group B	14.56	28.15%	< 0.05
Anga Gaurav	Group A	12.96	7.10%	< 0.05
	Group B	12.04	7.65%	< 0.05
Atikshudha	Group A	13.50	14.81%	< 0.05
	Group B	11.50	17.39%	< 0.05
Atipipasa	Group A	12.25	4.08%	> 0.05
	Group B	12.75	3.92%	> 0.05
Daurbalya	Group A	11.63	17.19%	< 0.05
	Group B	13.63	14.69%	> 0.05

Table 7a and 7 b: comparison effect of drug on weight and BMI (between groups)

Table 7a: Weight

	N	Mean	Std. Deviation	Std. Mean	t	df	p-value
Group A	12	1.7000	0.55922	0.16143	-0.575	22	0.571
Group B	12	1.8333	0.57735	0.16667			

Table 7b: BMI

	N	Mean	Std. Deviation	Std. Error Mean	t	df	p-value
Group A	12	0.6083	0.21933	0.06332	-0.267	22	0.792
Group B	12	0.6333	0.23868	0.06890			

Pilot Clinical study analysis

Both Group A and Group B showed statistically significant improvement ($p < 0.05$) in all clinical symptoms assessed, including *Daurbalya, Kshudra shwas, Anga gaurav, Atiksudha, Chala udara*, and *Chala sthana.* This suggests that both interventions were effective in reducing symptom severity from baseline (BT) to after treatment (AT).

A statistically significant reduction in total serum cholesterol was observed in Group B ($p < 0.05$), while the change in Group A was not significant ($p > 0.05$).The reduction in serum triglycerides in Group A was not statistically significant ($p > 0.05$).HDL cholesterol showed a significant decrease in Group B ($p < 0.05$), whereas Group A exhibited a non-significant change ($p > 0.05$).Both groups demonstrated reductions in LDL cholesterol, but these were not statistically significant ($p > 0.05$ for both).Overall Group B showed reduction in lipid profile significantly in comparison with Group A.

A comparative analysis of mean ranks between Group A and Group B across six clinical parameters was conducted. The percentage effect was calculated in both directions to evaluate relative group differences. Statistically significant differences ($p < 0.05$) were observed in *Daurgandhya, Kshudrashwas, Anga Gaurav, and Atikshudha.* Among these, *Kshudrashwas* exhibited the highest percentage difference (39.21% from Group A to Group B), suggesting a markedly greater improvement or symptom difference between the groups. *Atikshudha* also showed a moderate effect size (14.81%). Parameters like *Atipipasa* and *Daurbalya* showed percentage differences but were not statistically significant ($p > 0.05$), indicating these variations may be due to chance rather than a consistent effect**.**

The comparison between Group A and Group B showed no statistically significant difference in the reduction of weight ($p = 0.571$) or BMI ($p = 0.792$). Both groups had similar mean reductions in weight (1.70 vs. 1.83 kg) and BMI (0.61 vs. 0.63 kg/m²). The p-values indicate that the observed differences are likely due to chance. Thus, both drugs had comparable effects on weight and BMI.

Discussion

In the present study, the efficacy of two classical Ayurvedic herbs —*Vrikshamla* (*Garcinia indica*) and *Vijayasara* (*Pterocarpus marsupium*)—was evaluated for their anti-obesity potential using both traditional Ayurvedic understanding and In-vitro frameworks.

Sthoulya is primarily a disorder of *Medo Dhatu* (adipose tissue), characterized by an imbalance in Kapha dosha, leading to excessive accumulation of *medo dhatu*, decreased digestive fire (*Agni*), and sluggish metabolism (*Mandagni*) or excessive metabolism leading to over eating (*Atyaagni*). *Vrikshamla* is described in classical texts as having *Amla Rasa* (sour taste), *Laghu* (light) and *Ruksha* (dry) qualities, which help pacify Kapha and stimulate *Agni,* thereby catalyzes in the breakdown of accumulated Medas. On the other hand, *Vijayasara* holds *Tikta* (bitter) and *Kashaya* (astringent) tastes, which are known to reduce *Kapha* and *Medo Dhatu,* promoting *Lekhana* (scraping action), thus supporting weight reduction and improving metabolic efficiency.

In-vitro study reveals, *Vrikshamla* is rich in Hydroxycitric acid (HCA), a compound that inhibits ATP-citrate lyase, a key enzyme involved in lipogenesis. This biochemical action results in decreased conversion of carbohydrates into fat, reduced appetite, and improved lipid metabolism. On the other hand, *Vijayasara* contains bioactive flavonoids and phenolic compounds that enhance insulin sensitivity, regulate blood glucose levels, and modulate lipid profiles. Moreover, both herbs exhibit antioxidant and anti-inflammatory properties, which help mitigate obesity-

induced oxidative stress and low-grade chronic inflammation, factors strongly associated with metabolic syndrome.

Study findings, supported by RT-PCR analysis, revealed upregulation of PPAR-γ and GLUT-4 gene expression, indicating improved adipocyte function and glucose utilization in treated groups. This molecular evidence authenticates the traditional claims of *Lekhana* and *Medoghna* effects of *Pterocarpus marsupium* and *Garicinia indica* mentioned in Ayurvedic texts, thus bringing validation of both biochemical and traditional approach.

Conclusion

Garcinia Indica exhibited superior efficacy compared to *Pterocarpus marsupium*, both in in vitro studies on the 3T3-L1 adipocyte cell line and in clinical evaluations on obese patients. This superiority was evident in objective parameters, strategic anthropometric indices, and lipid profile improvements, highlighting *Garcinia Indica* more pronounced role in reducing adipogenesis and enhancing metabolic balance with dietary and healthy living practices.

Future Scope for studies

This study highlights the importance of in vitro experimentation as a foundational step before progressing to clinical evaluation. Using models like the 3T3-L1 adipocyte cell line enables a better understanding of cellular responses, mechanisms of action, and gene-level interactions in a controlled environment. These early findings help guide safe and effective dose selection for human studies.

Moving forward, further research can focus on:

Investigating precise cellular mechanisms and molecular pathways.

Developing polyherbal formulations or combinations with dietary or lifestyle interventions.

And exploring their role in managing metabolic disorders such as dyslipidaemia, fatty liver, insulin resistance.

Study limitations:

The limited duration of study and pilot sample size were designed were constraints in study.

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