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Adulteration and Substitution in Ayurvedic Proprietary Medicines: Challenges and Implications

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Abstract:

The Ayurvedic pharmaceutical industry, deeply rooted in ancient traditions, is currently facing a significant challenge in maintaining the efficacy, safety, and authenticity of herbal formulations due to rampant issues of adulteration and substitution. Adulteration refers to the deliberate or accidental incorporation of inferior, toxic, or spurious substances, while substitution involves the replacement of genuine ingredients with morphologically similar but pharmacologically less effective or more readily available alternatives. These practices not only compromise therapeutic outcomes but also pose potential health risks and erode public confidence in Ayurvedic medicines.The growing demand for herbal products, combined with the scarcity of authenticated raw materials and a lack of stringent quality control mechanisms, further aggravates the situation. Additionally, the unregulated exploitation of medicinal plants, inadequate identification techniques, and the extinction or endangerment of key plant species contribute to the proliferation of adulterated and substituted crude drugs in the market.

Keywords: Authentication, substitution, extinct species, crude drug, raw material, etc.

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INTRODUCTION:

Ayurveda an ancient system of medicine describes a various type of herb for a wide range of diseases. Ayurvedic patent medicines are becoming more and more popular in the 21st century due to the growing use of synthetic pharmaceuticals that have mild to moderate or occasionally serious negative effects. The adulteration and substitution of herbal remedies is currently a major problem in the Ayurvedic medicinal sector. The extinction of numerous plant species and inaccurate identification of numerous plant species are just two of the numerous causes of the adulteration and substitution of raw herbal medications. In classical period Vaidyas or Ayurvedic practioners used to prepare the medicines for the patients by themselves but in today's era this got vanished since the production and sale of Ayurvedic drugs have become formalized into a booming industry on a commercial scale. The burning problem faced by the herbal industry since most of the raw materials are derived from plant sources and due to adulteration in raw materials and lack of proper standardization techniques for manufacturing, the worldwide acceptance of Ayurveda is becoming problematic. Adulteration and substitution pose a significant threat to the Ayurvedic system of medicine, and can lead to inconsistencies in the composition and efficacy of Ayurvedic products, making standardization and reliability difficult. This article aims to provide all the important aspects of Adulteration and Substitution thereby aiming at systematic strategy to identify the herbal medicinal drugs correctly.

Aims and Objectives:

This study aims to ensure that consumers receive safe and effective Ayurvedic products by identifying and preventing adulteration and inappropriate substitution, which pose a serious threat to the Ayurvedic medicinal system and can result in inconsistent composition and efficacy of Ayurvedic products, making standardization and reliability challenging.

Materials and Methods:

Adulteration Definition: Adulteration is a practice of substituting the original crude drug partially or fully with other substances which is either free from or inferior in therapeutic and chemical properties or addition of low grade or spoiled drugs or entirely different drug similar to that of original drug substituted with an intention of enhancement of profits. [1,2]

Adulteration may also be defined as mixing or substituting the original drug material with other spurious, inferior, defective, spoiled, useless other parts of the same plant or different plant or harmful substances or drug which do not confirm with the official standards.[3]

Types of Adulterants: -

a) Substitution with substandard commercial varieties: - Adulterants resemble the original crude drug morphologically, chemically, therapeutically but substandard in nature and cheaper in cost. This is the most common type of adulteration.[4]

b) Substitution with superficially similar inferior drugs: - Inferior drugs may or may not have any chemical or therapeutic value. They resemble only morphologically, so due to its resemblance they are used as adulterants.[4] Ex. *Kuchala (Strychnos nux vomica)* is adulterated with *Kataka (Stychnos potatorum), Adraka (Zingiber officinalis)* is adulterated with Japanese Ginger.[5]

c) Substitution with artificially manufactured substance: - The drug is adulterated with the substance which has been prepared

artificially. The artificially manufactured substance resembles the original drug. This method is followed for the costlier drugs.[4] Ex. Paraffin wax after yellow colouration substituted for bee's wax.[5]

d) Substitution with exhausted drugs: - The same drug is admixed but that drug is devoid of medicinally active substance as it has been extracted already. Mainly volatile oil containing drugs like clove, coriander, fennel, caraway are adulterated by this method. As it is devoid of colour and taste due to extraction, natural colour and taste is manipulated with additives. [4,5]

e) Substitution with synthetic chemicals to enhance natural character: - Synthetic chemicals are used to enhance natural character of the exhausted drug.[4] Ex. Citral oil is mineral oil added to the natural citrus oil present in lemon or orange.[6]

f) Presence of Vegetative Matter of Same Plant: - Along with the useful part other vegetative parts of same plant or other plant is added to the original one. It can occur due to negligence or carelessness during collection of plants. Ex. Stem portion of plant *Bala (Sida cordifoilia)* is added along with leaf. Clove is mixed along with leaf and petioles.[1]

g) Harmful Adulterants: - Sometimes waste form of drug which may be harmful for health is added to authentic drug. Ex. White oil in coconut oil. Argemone seed in Mustard seed.[5]

h) Adulteration of Powders: - This type of adulteration is commonly done in powder form of drug to decrease its cost by increasing weight. Ex. Brick powder mixed with *Kampillaka* powder; Wheat flour mixed with *Shunthi* powder.[5]

Types of Adulteration (On the Basis of Motive): -

a) Direct/Intentional Adulteration- Mainly done for commercial benefits.[7]

b) Indirect/Accidental Adultertation-[7]

Methods of Adulteration: -

a) Deterioration- Intentional impairment in the quality of drug is Deterioration.[1]

b) Admixture- Addition or mixing one substance to another accidentally or carelessly or due to ignorance is Admixture.[1]

c) Sophistication- It is an intentional or deliberate type of adulteration in which some totally different substance is added in place of genuine drug.[1]

d) Inferiority- It refers to adding of any substandard drug. [1]

e) Spoilage- It is due to the attack of microorganisms or parasitic infestation.[1]

Reason for Adulteration:

a) Intentional adulteration is done mainly due to commercial benefits, where there is high demand but less availability of drugs. [8,9]

b) Unintentional adulteration is done due to following reasons: -

1) Confusion in vernacular names- More than one plant having same synonyms and confusion in vernacular name will result into adulteration. Ex. *Amruta* is common synonym for *Guduchi (Tinospora cordifolia)* and Haritaki (*Terminalia chebula). Samanga* is synonym of both *Lajjalu* and *Manjishtha (Rubia cordifolia)*[4]

2) Lack of knowledge about authentic source- Drugs that are used extensively as medicinal agent in folk but do not have description in authenticated books are considered as *Anukta Dravya.* Due to lack of knowledge and authentic sources of such drugs result into adulteration. Ex. *Somalatha (Sarcostemma acidum)*[4]

3) Similarity in morphology- Drugs which look morphologically similar are commonly adulterated. Ex. Seeds of *Vruddhadaru* is adulterated with seeds of *Plaksha.* Bark of *Arjuna* is adulterated with bark of *Ashoka.*[4]

4) Unscientific collection- Raw material required for big pharmacy or drug retailer is generally collected by local and uneducated

person from field and forest. These persons are not qualified Botanist or Taxonomist who can identify and authenticate correct species of herb. This careless collection usually admixed the plants. Ex. *Desmodium triquetrum* is collected in place of *Desmodium gangaticum.* Useful part of *Bhrungaraj, Bharangi* is root but in market whole plant parts are found.[4]

5) High price of the drug in the market- Drugs having higher cost are commonly adulterated with relatively low-cost drug for more profit. Ex. Stamens of *Nagakeshara* is adulterated with stamens of *Punnaga* and *Surangi.*[4]
6) Careless collection/Improper collection- Definite part of herb should be collected in particular season, particular place and particular part of plant should be collected but ignorance of these things during collection and drugs collected carelessly may cause adulteration. [8,9]
7) Improper storage- Due to improper storage physical factors such as air (oxygen), humidity, light and temperature can bring about deterioration directly or indirectly and use of such type of drug acts as adulterant. [8,9]
8) Imperfect preparation- Some of crude drugs should be processed before marketing, during such processing improper technique may destroy active constituents e.g. over drying of crude drugs, removal of cork from zinger, etc. [8,9]
9) Absence of Regulation- A breeding ground for adulteration and substitution is provided by the loose implementation of quality control standards and regulations in the herbal medication sector in many places. [8,9]
10) Insufficient Awareness of Quality- The lack of understanding among consumers and certain practitioners may make it difficult to differentiate genuine herbs from adulterants or replacements, which could unintentionally encourage these practices through demand. [8,9]

List of Few Commonly Used Adulterants in Ayurveda: - [8,9]

Sr. No.	Genuine Grugs	Adulterants
1	*Mussabar (Aloe barbadensis)*	Black catechu *(Acacia catechu)*
2	*Nagakeshara (Mesua ferrea)*	Buds of *Mannea suriga* and *Calophyllum inophyllum*
3	*Punarnawa (Boerhavia diffusa)*	*Trianthema portuulachastrum*
4	*Ashoka (Saraca indica)*	*Polyalthia Longifoia*
5	*Kutaja(Holarrhena antidysenterica)*	*Wrightia tinctoria, Wrightia tomentosa*

Disadvantages of Adulteration: - [10]

1) Adulteration is one of the greatest drawbacks in promotion of herbal products.
2) Adulteration can cause deterioration and degradation of products.
3) It can cause denaturation of product and may destroy the active constituents of drugs
4) Efficacy of drug is reduced or it may take longer time to show its action.
5) It can alter the dosage form and nature of drugs.
6) It can produce adverse effects.

Measures to Overcome Adulteration: -

1) Morphological or Organoleptic test- It is quantitative type of evaluation by studying macroscopic character of drugs. The morphological and organoleptic evaluation can be done with the help of sense organ. Drug can be identified by colour, odour, size, shape, fracture and texture.
   Ex. Granular fracture over the bark of *Kutaja (Holarrhoena antidysentrica),* Aromatic odour of *Umbeliferous* fruits.[11]
2) Microcsopic evaluation- Identification of drug with the help of microscope by taking

transverse and longitudinal sections to examine their histological characters like stomata, calcium oxalate crystals, starch gain, etc. It is quantitative evaluation of crude drugs in entire form and powder form. Ex. Starch and hemicellulose is identified by blue colour with iodine solution.[11]

3) Chemical evaluation- Active chemical constituents can be identified by chemical evaluation with the help of chemical tests and chromatography. Chemical evaluation is helpful for isolation, purification, identification of active constituents.[11]

4) Physical evaluation- Physical properties of drug are helpful for detection of active components in plants.
Ex. Moisture content, specific gravity, ash value, viscosity, etc. [11]

5) Biological evaluation- Medicinal plants contain active constituents by which they show specific biological and pharmacological activity. Their pharmacological activities can be utilised for their evaluation. It is also helpful to carry out In-vitro and In-vivo studies.
Ex. Anticancer activity, anti-microbial activity, hepato-protective activity, etc. [11]

Substitution Definition: In simple terms, Substitution involves the replacement of analogous drugs having equivalent pharmacological effects and therapeutic activities instead of original drugs. In Ayurveda Substitution is discussed under the term *Abhava Pratinidhi Dravya. Acharya Vagbhata* gave the concept in later periods, as this concept did not exist during Samhita period. He stated that one should get another drug having similar essential characteristics as that of the original one if there is unavailability or lack of the latter. The principles to select substitute drugs are based on equivalency of five basic tenets, namely, *Rasa* (taste), *Guna* (characteristics), *Veerya* (potency), *Vipaka* and most importantly *Karma* (therapeutic action). [5,12] A detailed account of *Pratinidhi Dravyas* can be obtained from ancient textbooks such as *Bhavaprakasha, Yogaratnakara* and *Bhaishajya ratnavali.* (ref A comprehensive review on adulteration and substitution of crude drugs, princy Agarwal, anju goyal). [5,12]

Types of Substitution: -

a) Substitution with totally different drug- Use of *Danti (Baliospermum montanum)* as a substitute of *Chitraka (Plumbago zelenycum).* [6,9,13,14,15,16]

b) Substitution of species belonging in same family- *Datura metal* is substituted by *Datura stramonium.* [9,17]

c) Substitution using different species having common Sanskrit name- Two types of *Gokshura* are used, they are *Tribulus terrestris (Laghu Gokshur)* and *Padalium murex (Brihut Gokshura).* [9,17]

d) Substitution using different parts of same plant- Instead of root of *Sida cordifolia* whole plants of *Sida cordifolia* is used. [9,17]

e) Substitution due to similar action- *Amalaki (Embelica officinalis)* is taken instead of *Bhallatak (Semicarpus anacardium)* for *Rasayan Karma* (Rejuvinative action). [9,17]

Need for Substitution:

1) Individuality is not sure- Sometimes botanical individuality of medicinal plant is not emphasized properly so they are substituted easily. *Shankhapushpi* is example of it. Different species such as *Convolvulus pluricolius, C. microphyllus* and *Clitorea ternatia* are considered as *Shankhapushpi.*[18]

2) Prize of plant- Because of highly accurate environment during cultivation and proper processing sometimes medicinal plants are very much costly. In Indian market *Kesar* is very much rich in prize. *Crocus sativus*- Saffron Kesar that is often substituted with *Carthamus tinctorius* which is commonly Known as *Kusumbha.*[18]

3) Non-availability of the drug- some drugs mentioned in Ayurvedic lexicon are not available now a days, so those drugs are substituted by other drugs having similar therapeutic value. For example, most of drugs from *Ashtavarga* are not easily available so those drugs are substituted by other ones e.g. *Meda* and *Mahameda* are substituted by *Shatavari.* [6,9,13,14,15]
4) Uncertain identity of the drug- The drugs which are mentioned in Ayurvedic classics but their botanical identity is not clear those are substituted by known one e.g. for the herb *Lakshamana,* different species such as *Arlia quinquefolia, Ipomea sepiaria* etc are considered. [6,9,13,14,15]
5) Geographical distribution of the drug- *Rasna (Pluchea lanceolata)* is used in Northern India while in Southern part *Alpinia galanga* is used as *Rasana* and *Vanada roxburghii* is considered as source in Bengal. [6,9,13,14,15]
6) The adverse reaction of the drug- *Vasa (Adhatoda vasica)* is good *Rakta-pittahara (antihaemorrhagic)* drug but having abortifacient activity, so instead of this drug *Laksha (Lacifer lacca), Ashoka (Saraca asoka)* etc. are used in pregnant women for the same purpose. [6,9,13,14,15]
7) Seasonal availability of drug- *Punarnawa (Boerhavia diffusa)* is commonly not found throughout the year so for that *Trianthema portulacastrum (Varshabhu)* can be used as substitute, which is found throughout the year. [6,9,13,14,15]
8) Shelf life of the drug- Shelf life of the drug is also another reason for substitution. For example, in case of non-availability of old jaggery, new jaggery can be used after heating in sun rays for four hours. [12,19]

Criteria for Substitution:

1) When the drug mentioned in a formulation is not available, then a drug with similar bioequivalent *(Rasa, Guna, Veerya, Vipaka, Karma)* is to be selected and used.[20]
2) Major ingredient of formulation should never be substituted with another similar bioequivalent drug.[20]
   Ex. While preparing *Kutajaghana Vati* one should not substitute *Kutaja* with any other drug.[20]
3) Substituted drug should have same therapeutic effect as that of the original drug. Ex. *Ativisha* and *Musta.*[20]

Medicinally Important main plant substituted with other Plant: - [21]

Main medicinal plant	Common name	Substituted plant	Common name
Beliospermum monatum	*Danti*	*Croton oblongifolius*	*Nagdanti*
Mesua ferrea	*Nagkesar*	*Ochrocarpus longifolius*	*Raktapushpa*
Myristica fragrances	*Jatiphala*	*Syzygium aromaticum*	*Lavang*
Clerodendron serratum	*Bharangi*	*Solanum xenthocarpum*	*Kantakari*

Factors to be considered for selection of *pratinidhi dravya* i.e. Substitution: -

1) Uncertain Identity- In Ayurvedic classics, certain drugs were unidentified, for these drugs the nearest matching characteristics i.e., *Nama* (nomenclature), *Rupa* (morphological and other organoleptic characteristics), *Guna* (properties of the drugs) and *Karma* (action of the drug) were taken into consideration.[22]
   For example-
a) *Soma- Ephedra gerardiana (Wall) Stapf-Gnetaceae*
b) *Trayamana- Gentiana kurroo Roylr Bx Benth-Scrophulariaaceae*
c) Substituion for *Ashtavarga Dravyas* –

1) *Jivaka, Rushabhaka- Vidarikanda (Pueraria tuberosa DC- Leguminoseae)*[22]
2) *Meda, Mahameda- Shatavari (Asparagus racemosus Willd- Liliaceae)*[22]
3) *Kakoli, Kshirkakoli- Ashwagandha (Withania somnifera Dunal- Solanaceae)*[22]
4) *Ruddhi, Vriddhi- Varahikanda (Discorea bulbifera Linn. - Discoreaceae)*[22]

2) Regional substitutes- Under one name, various drugs were used in various regions as there are changes in vernaculars, misidentification or adulteration practices, traditional practice of Vaidya community and specific drug action on the available source may be the cause of introduction of regional substitute.[23]

a) Rasna[23]

-Pluchea Lanceolata Oliver and *Hiren- Asteraceae*- Punjab and Gujarat

-Alpinia galanga Willd- Zinziberaceae- South India

-Vanda roxburghii R. Br. Orchidaceae- Bengal

b) *Shankhapushpi*[23] *-Clitoria ternatea Linn. - Papilionaceae*- Kerala *-Evolvulus alsinoides Linn. - Convolvulaceae*- North India *-Canscora decussata Schult- Gentianaceae*- In some other regions.

b) Non-availability of the drug- In case of the non-availability of *Talisa patra* i.e., *Abies webiana Lindl- Pinaceae* leaf of the *Taxus baccata Linn. - Taxaceae* are used.[24]

c) Seasonal availability of the part- Certain part of drugs are available seasonally, in these cases other drugs can be introduced, which is having the same action. *Rakta Punarnava (Boerhavia diffusa Linn. - Nyctaginaceae)* can be substituted for *Shweta Punarnava (Trianthema portulacastrum Linn. - Ficoidaceae)* in case of non-availability.[25]

d) Shelf life of the drug- *Dravyas* like *Ativisha (Aconitum heterophyllum Wall- Ranunculaceae)* which get infected easily by cankers thus may be substituted by drugs like *Musta (Cyperus rotundus Linn. - Cyperaceae).* If *Purana Guda* (old jaggery) is not available then *Guda* (jaggery) should be taken by heating it in sun rays for 4 hours.[26,27]

e) Ambiguity due to synonyms and homonyms- *Jivanti* is a homonym of several other drugs such as *Guduchi, Abhaya, Meda, Kakoli* and *Vrikshadanti* resulting a lot of confusion in identity of the drug thus one should always depend on the source plant.[23]

f) Cost of the drug-*Rasna Moola* value in the market is near about 700 Rs per kg instead of that pharmacies are using leaf of *Rasna.* Though here it is mentioned as substitute rather; the drugs used as adulterant in which *Guna Karmas* will not match.[25]

g) Preparation form of the drug-Ayurvedic classics like *Yogaratnakara* suggests that substitution can be done in the form of preparation in case of unavailable prepared material and which can be used in emergency conditions. For example, in case of unavailability of *Guduchi sattva* extract of *Guduchi Swarasa* can be used.[28]

h) Geographical distribution of the drug- Though India is one among the richest bio-diversity all over the world, geographical variations are always there as some plants like *Vatsanabha (Aconitu ferox wall)* are available in Himalaya, which are not found in Southern parts of India.[23]

i) Conclusive aspects for regional substitution- To avoid the controversy of drugs, *Raj Nighantu* finds midway, as he mentioned *Moola, Patra* and *Truna* as varieties of *Rasna.*[29]

j) On the basis of similar properties- Although *Dhamasa* and *Yavasa* are identified with *Fagonia cretica Linn.* and *Alhagi pseudalhagi (Beib.) Desv.*, respectively; and they belong to different families, they are considered to be almost identical in their properties and have been used as substitute.[30]

k) Indications and contra indications of the drug- When it is found that different drugs having similar nomenclature are mentioned in a single formulation then the purpose, the

context, the treatise, and the reasoning should be taken into consideration for their proper usage. For example, *Vasa* is a well-known *Rakta Pittahara* drug, but due to its abortifacient activity its utility in pregnant women is limited, instead drugs such as *Laksha* and *Ashoka* can be substituted. Instead of *Bhallataka (Semicarpus anacardium Linn.) Godambi* i.e., *Phalashti* is indicated in *Narsimha Churna* in case of *Pitta Prakruti.* [6,31]

l) Usage of synthetic material- As procurement of these drugs in natural sources is difficult and are easily available in synthetic form, such forms can be substituted in case of unavailability.[32]

Advantage of Substitution: [20]

1) Higher Accessibility- Substitution allows pharmaceutical manufacture to continue when certain raw materials are scarce.
2) Quality Consistency- When alternative components are used, the final product is guaranteed to have an even degree of potency and quality.
3) Reduced Contamination- Contamination risk is decreased by using carefully selected substitude ingredients.

Reasons for Substitution:[20]

1) Confusion in Vernacular Names
2) The deforestation and extinction of many species
3) Lack of Knowledge about authentic source
4) Similarity in Morphology
5) Similarity in Colour
6) Careless Collections
7) Need for substitution

Understanding the risks and consequences of adulteration and substitution: - [20]

1) Risk to Health- The use of hazardous substances and unsuitable ingredients in Ayurvedic medicines might result in negative health effects that range from minor allergic reactions to serious toxicities. These problems pose significant hazards for customers searching for safe and natural solutions.
2) Loss of Trust- When consumers encounter counterfeit drugs, their faith in Ayurveda as a whole is gradually eroded. Such circumstances harm respectable manufacturers and practitioners who adhere to conventional methods.
3) Impact on Law and Economy- In addition to the detrimental impacts on health, adulteration and substitution can result in severe legal repercussions for individuals involved and financial losses for respectable businesses due to unfair competition and diminished consumer trust.
4) Cultural Harm- In addition to being a medical system, Ayurveda is a cultural legacy. Priceless cultural wisdom is at risk due to the prevalence of adulteration and substitution, which also threatens the preservation of this outdated information.
5) Compromised recovery- When ayurvedic drugs are tampered with, their therapeutic effects are often diminished. Patients do not receive the intended health benefits, and the therapeutic power of genuine Ayurvedic substances is somewhat diminished.
6) Unforeseen Allergic Reactions- The safety of patients may be jeopardized due to the unforeseen interactions between active herbal ingredients and adulterants, which might exacerbate pre-existing medical conditions or result in unexpected allergic reactions.
7) Prolonged Consequences- Contaminated drugs can result in long-term health issues and even irreparable damage to vital organs and systems when consumed for an extended length of time.

DISCUSSION:

The prevalence of adulteration and substitution in the herbal drug market poses

a significant threat to the credibility and effectiveness of Ayurvedic medicine. Various types of adulterants are commonly encountered, including substandard, inferior, artificial, or exhausted drugs. In certain cases, synthetic chemicals are added to enhance the appearance or perceived potency of the product, while in others, vegetative matter from the same or different plant species is used to mimic the original. Among all dosage forms, powdered drugs are the most vulnerable to adulteration due to the difficulty in identifying individual constituents.Several factors contribute to the rise of adulteration, including confusion caused by vernacular naming systems, lack of proper botanical knowledge, morphological similarities between species, and the unavailability of authentic plants. More often than not, the primary motivation behind adulteration is economic gain.

On the other hand, substitution may occasionally be necessary, especially in situations where the original herb is unavailable. In such cases, species from the same botanical family, different parts of the same plant, or herbs with similar therapeutic actions may be used. Importantly, pharmacological activity takes precedence over morphological or chemical similarity in deciding appropriate substitutes. Although substitution introduces certain variabilities, it can help widen the therapeutic scope and make treatment more accessible and cost-effective, especially when practiced with scientific justification and care.

CONCLUSION:

This review underscores the urgent need to address the challenges of adulteration and substitution in Ayurvedic formulations. While substitution can be a scientifically valid strategy when guided by pharmacological principles, adulteration—intentional or otherwise—poses a grave risk to patient safety and the credibility of the Ayurvedic system. Enhancing awareness among drug handlers, manufacturers, and healthcare professionals through targeted training programs can significantly reduce these practices. Moreover, incorporating simple yet effective identification techniques and ensuring strict adherence to quality control measures will go a long way in preserving the authenticity and efficacy of Ayurvedic medicines. A concerted effort from all stakeholders is essential to uphold the integrity of this ancient system in the modern era.

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