



Review Article

Panchgavya: A precious gift to humankindKomal K. Bajaj^a, Vishal Chavhan^a, Nishikant A. Raut^a, Shailendra Gurav^{b,*}^a Department of Pharmaceutical Sciences, RTM Nagpur University, Nagpur, Maharashtra, India^b Department of Pharmacognosy, Goa College of Pharmacy, Panaji, Goa University, Goa, India

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ABSTRACT

Panchgavya represents milk, urine, dung, ghee, and curd, derived from cow and serves irreplaceable medicinal importance in Ayurveda and traditional Indian clinical practices. In Ayurveda, *Panchgavya* treatment is termed as 'Cowpathy'. In India, the cow is worshipped as a god called 'Gaumata,' indicating its nourishing nature like a mother. Ayurveda recommends *Panchgavya* to treat diseases of multiple systems, including severe conditions, with almost no side-effects. It can help build a healthy population, alternative sources of energy, complete nutritional requirements, eradicate poverty, pollution-free environment, organic farming, etc. *Panchgavya* can also give back to mother nature by promoting soil fertility, earthworm production, protecting crops from bacterial and fungal infections, etc. Scientific efforts shall be taken to build evidence for the clinical application of Cowpathy. The present review aims to summarize the health and medicinal benefits of *Panchgavya*.

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1. Introduction

India is the land of traditions with its roots in ancient science directly linking social rituals and scientific reasons behind them. In India, a cow is called 'Gaumata' or 'Kamadhenu' due to its nourishing nature like a mother [1]. *Kamadhenu* is the name of the sacred cow who believed to accomplish desired things. *Panchgavya* is a treasure of health benefits and medicinal properties. The Ayurvedic system of medicine has described the significance of using cow milk, ghee, urine, dung, and curd, each of which is termed 'gavya' (i.e., obtained from 'Gau' means cow) for the treatment of various diseases. Each product possesses different components and uses for human health, agriculture, and other purposes. '*Panchgavya*' has been derived from two words, '*Panch*' meaning five and '*gavya*' meaning obtained from 'Gau' means cow [2], which *in-toto* represents five products obtained from a cow (Fig. 1). Each of the 'gavya' exerts a different medicinal impact against various diseases. *Panchgavya* therapy or treatment is called 'Cowpathy', similar to other pathies (allopathy, homeopathy, and naturopathy). Each 'gavya' can be used as a single therapy or in combination with other products

or with other treatments. Also, all five products can be used alone or combined or any other synthetic, herbal, or mineral origin [3,4].

Panchgavya therapy is recommended for a variety of diseases viz., asthma, flu, allergies, cardiovascular diseases, renal disorders, rheumatoid arthritis, leucoderma, wound healing, leucorrhoea, hepatitis, dietary and gastrointestinal tract disorders, obesity, tuberculosis, ulcer, chemical intoxication, other bacterial, fungal and viral infections. The therapy has also demonstrated its therapeutic potential against severe pathological conditions like cancer, AIDS, and diabetes [2,5,6].

Panchgavya plays a crucial role in organic farming practices as the most favourable organic manure for agricultural fields. Its application ensures zero usage of harmful synthetic fertilizers, pesticides, insecticides, and antibiotics. No other manure can be as cost-effective and beneficial as *Panchgavya*. It can enhance soil fertility, improve the quality of earthworms, and promote crop health by acting as an organic fertilizer. Additionally, cow dung and cow urine are excellent sources of energy to generate biogas and electricity [2,7,8].

Traditional Indian literature cites numerous medicinal effects of *Panchgavya*; however, scientific evidence supporting ancient literature is very little. Scientific Validation and Research on *Panchgavya* (SVAROP) is a national program announced by the Ministry of Science and Technology, Government of India, for scientific validation of *Panchgavya* products. The program includes studies on the activity, efficacy, safety profile, toxicity, and acceptability of

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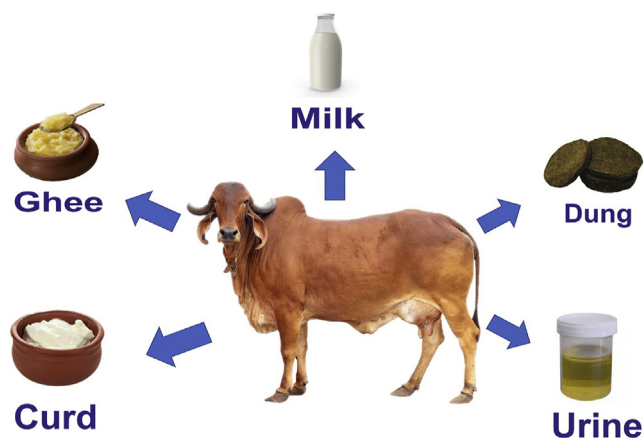


Fig. 1. Components of *Panchgavya*

Panchgavya and other products obtained from the cow. The present review focuses on the composition of each *Panchgavya* product and its health benefits and medicinal properties based on available scientific evidence [9,10].

2. Cow-derived products

2.1. Curd

Curd also called ‘yogurt’ or “*Dahi*”, is consumed worldwide due to its high nutritional value and health benefits. It is prepared by fermenting cow milk using micro-organisms viz., *Streptococcus*, *Acidophilus*, and *Lactobacillus* [11]. Curd is a rich source of probiotics (beneficial living micro-organisms) that exert various beneficial effects upon oral administration. Lactic acid-producing bacteria form metabolites like cyclic dipeptides, phenyl lactic acid, and anti-fungal effects. These bacteria also include proteinous compounds in nature and a 3-hydroxylated fatty acid [2,5]. Ayurveda prescribes certain precautions carefully considering the health of an individual, environmental and climatic conditions for consumption of curd.

Curd contains several nutrients and micronutrients, including water, proteins, vitamins like A, B, D, and E; minerals like calcium, phosphorus, magnesium, zinc, etc. Probiotics present in curd help in strengthening the immune system and digestive system, whereas various minerals, vitamins, and proteins in curd help fight against multiple pathogens, including HIV [11]. It is used to treat digestive ailments as it can resist the growth of harmful micro-organisms and promote good gut flora to improve digestion [5]. Curd also acts as a blood purifier [12] and helps in lowering the total cholesterol, and low-density lipoproteins, thus, preventing the risk of obesity [13], anti-fungal effect for treating dandruff from hair [11], and treating piles [14]. Curd should be taken with green gram or moong for *Vata Prakruti*, sugar for *Pitta Prakruti*, and cumin powder for *Kapha Prakruti* individuals. Curd consumption with all the recommended precautions prescribed by Ayurveda may significantly benefit health [15]. The composition of curd, its health benefits, and its medicinal effects are depicted in Fig. 2.

2.2. Cow dung

Cow dung is rich in several beneficial microbes like *Saccharomyces*, *Lactobacillus*, *Bacillus*, *Streptococcus*, *Candida*, etc. It also contains various nutritional components, including minerals, vitamins, potassium, nitrogen, oxygen, carbon, cellulose, hemicellulose,

mucus, lignin. Cow dung is used to degrade waste generated from the city and hospitals due to the abundance of different micro-organisms beneficial for waste degradation [16].

In rural areas of India, a dried cow dung cake is used as a source of energy for cooking food, decreasing the dependency on other sources of energy and is entirely environment-friendly [17], and ensures air purification by killing the microbes in the surrounding air. ‘*Gobar*’ gas (biogas) plants also serve as a significant energy source. They convert cow dung into methane gas, which is used as a source of energy for cooking and generation of electricity [2]. Furthermore, the remaining residue is the best organic manure after converting most cow dung into methane gas.

Fibrous material obtained from cow dung is used for the preparation of papers [17]. Recently, cow dung-based mosquito repellents have been among the best alternatives for synthetic mosquito repellants [18]. Also, cow dung-based toothpaste protects against oral pathogens and improves oral health. The use of cow dung ensures more environment-friendly and cost-effective human activities [5,19–21].

The use of cow dung in agriculture is essential to maintain soil quality. Cow dung helps increase the population of earthworms, and also promotes and manages fertile soil with the presence of *Eisenia andrei* species of earthworm, showing an enhancement in the nitrification process [22]. Fungal diseases are among the major problem in agricultural fields. The use of cow dung can restrict the development of such fungal issues due to *Fusarium oxysporum*, *Fusarium solani*, and *Sclerotinia sclerotiorum* [23]. The use of pesticides, fertilizers, weedicides, and antibiotics in farming practices is hazardous to humans and animals, and leads to severe diseases such as immunosuppression, hypersensitivity reaction, and autoimmune disorders. Therefore, products obtained from organic farming have more demand as organic farming practices are devoid of harmful chemicals for crop production. High microbial count and nutritional value led the cow dung as manure for farming practices in organic farms. Cow dung serves as the best replacement for these chemicals and ensures human and animal health [24–26].

Cow dung has also demonstrated anti-bacterial and anti-fungal effects [2]. It serves as a skin tonic and is found effective in treating psoriasis and eczema. The mixtures of crushed neem leaves and cow dung helps against boils and heat rashes. Cow dung has demonstrated that it can kill the malarial parasite and *Mycobacterium tuberculosis*. The anti-fungal activity can be observed against *Corprophilous fungi* [20,21]. Smoke liberated on burning of cow dung causes eye irritation and tears, which can help vision enhancement [27]. The composition of cow dung, along with its uses, is summarized in Fig. 3.

2.3. Cow ghee

Cow ghee prepared by traditional method possesses high nutritional value, medicinal benefits, and helps to promote good health. Ghee is prepared by heating the butter obtained from cow milk, and heating must be continued at high temperature until the moisture is completely lost [28].

2.3.1. Traditional methods of ghee preparation

Ghee can be prepared using four different methods and are explained as follows:

2.3.1.1. Method 1: Preparation of creamery butter ghee. In this method, cream from the milk is separated and stored to obtain the desired acidity. This cream is then churned to get the butter. After churning, buttermilk and creamery butter are separated. The butter is then heated at the desired temperature, and molten ghee is obtained. The ghee is then decanted and filled in containers [29].

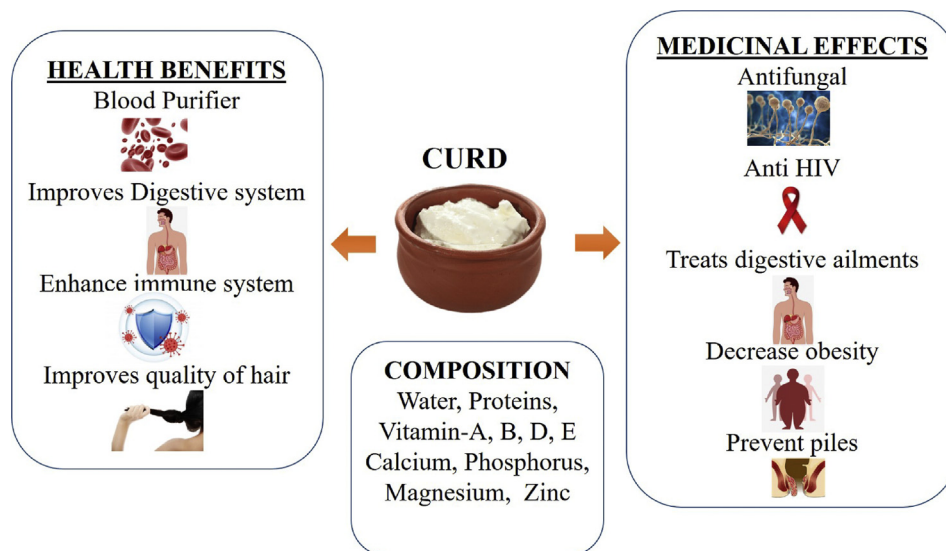


Fig. 2. Composition and uses of cow curd. TB: Tuberculosis; HIV: Human Immunodeficiency Virus.

2.3.1.2. *Method 2: Preparation of desi ghee.* The milk is first boiled, cooled at room temperature, followed by the addition of lactic acid culture and incubation for 10 to 16 h to prepare curd. Water is added to the curd and churned to obtain the butter called 'desi butter'. The butter is heated at the desired temperature, and molten desi ghee is obtained. The ghee must be decanted while hot and filled in a container [30].

2.3.1.3. *Method 3: Preparation of ghee directly from cream.* Cream from milk is separated and heated to remove the moisture by maintaining the desired temperature. Molten ghee is obtained, allowed to settle, further decanted, and stored in containers [29].

2.3.1.4. *Method 4: Preparation of ghee by pre-stratification.* In this method, milk is processed to obtain creamery butter or desi butter. Butter is then heated at about 80 °C and allow to stand for 30 min. The bottom layer is discarded, and the remaining material is heated

at the desired temperature to obtain the ghee. Molten ghee obtained must be decanted hot and filled in a container [31].

Ghee prepared using milk obtained from 'deshi' cow or Indian breed is more beneficial for health than ghee obtained from the milk of other exotic cow species. Due to ghee's high fatty acid content, people believed that ghee consumption could increase the risk of dyslipidemia and cause cardiovascular diseases. Such beliefs were responsible for the widespread avoidance of ghee in India [32]. Even though Ayurveda has given enormous benefits of consuming ghee, various scientific studies were conducted, and ghee's health benefits were re-established [33,34]. In the Ayurvedic system of medicine, ghee plays a vital role, both as a vehicle to deliver the active constituent and a base for incorporating active components to formulate the dosage forms. Ayurveda also supports the co-administration of ghee along with other remedial treatments. Ghee-based formulations, i.e., *Ghrita*, are developed for targeted delivery and enhanced bioavailability of hydrophobic

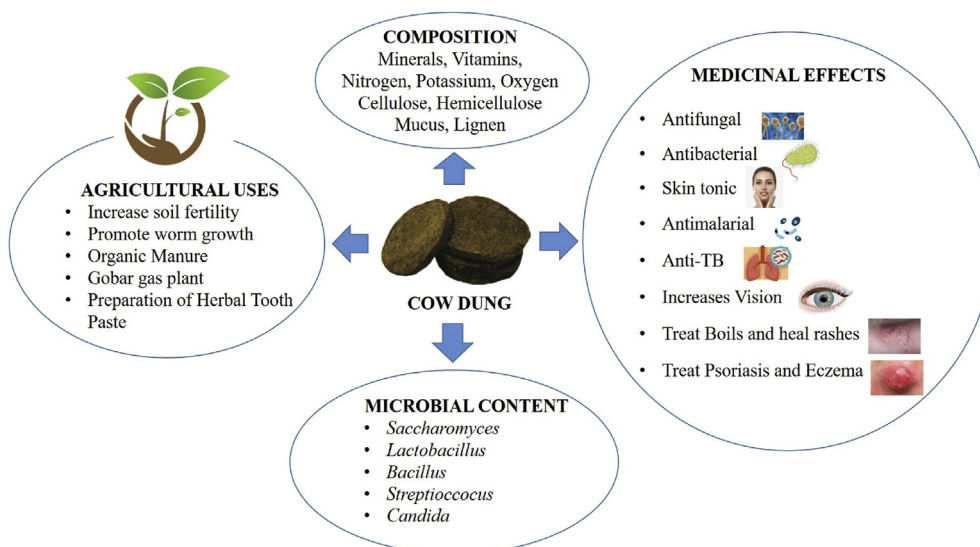


Fig. 3. Composition, health benefits, and medicinal effects of dung.

botanicals. For example, *Brahmi ghrita* for cognitive function; *Vasa ghrita* for the respiratory system; *Shatadhauta ghrita* for skin diseases, *Bhallatakadi ghrita* for wound healing and *Kaamdev ghrita* for sexual disorders, etc. [35–38]. Saleem et al. have performed molecular characterization studies on *desi* ghee. The study revealed that *desi* ghee is a rich source of essential fatty acids (omega 3 and omega 9), vitamins like A, D, E, and K [39]. The health benefits of cow ghee are memory enhancement, lowering bad cholesterol, preventing skin and cardiovascular diseases, promoting skin health, maintaining the digestion process, generating energy, purifying the blood, protecting the liver, etc. [35]. Ghee has demonstrated various medicinal properties such as anti-inflammatory, antineoplastic, vision enhancing, and fasten wound healing [40,41]. It helps treat skin and gastrointestinal diseases and has beneficial effects, including immunostimulant, anti-cholinergic activity, anti-asthmatic effect, helps against paralysis, etc. [12,17]. The composition, health benefits, and medicinal potential of cow ghee are shown in Fig. 4.

2.4. Cow urine

Cow urine or “*Gaumutra*” is a non-toxic liquid waste discharged from the cow. Cow urine or its distillate is known to have several health benefits to improve the quality of life and prolong survival rates in patients with severe diseases [42]. When the Council of Scientific and Industrial Research (CSIR), India, and other scientists in India demonstrated antineoplastic, anti-fungal, antibiotic, and bio-enhancing effects of cow urine distillate, the modern world started to believe in the medicinal properties of cow urine [35,43]. A wide range of medicinal uses of cow urine is already in the public domain, but scientific data is minimal to support its consumption. More such studies shall be carried out to promote the traditional methods of treatment having less severe side-effects.

In the Ayurvedic system of medicine, cow urine is used for the preparation of several formulations. Numerous health benefits and medicinal effects of cow urine are revealed in the textbooks of Ayurveda. Cow urine is known to induce diuretic action and also acts as a nephroprotective agent. It can also help in weight loss, digestive issues, edema, reversal effect against various cardiovascular and kidney diseases [6]. It can also treat diarrhea, GIT infections, jaundice, piles, anemias, and skin diseases like vitiligo.

Indian literature has described numerous benefits of cow urine, but supporting scientific evidence is missing [44,45].

2.4.1. Cow urine composition and their medicinal effects

Cow urine contains 95% water, 2.5% of urea, and the rest 2.5% include components like enzymes, hormones, salts, and minerals [46]. Various components of cow urine and its uses are described in Table 1.

Besides this, cow urine also contains various enzymes to improve the digestive system and build a robust immune system. Vitamins including A, B, C, D, and E are also present in cow urine [43].

2.5. Cow milk

Traditional Indian systems of medicine had described the medicinal effects of cow milk in ancient literature. Milk is used for its health-protecting, health-promoting, and wide range of therapeutic effects [47]. Indian breed of cows delivers A2 type of milk, whereas A1 type of milk is given by crossbreed or exotic cow species. A1 type of milk contains a devil constituent, i.e., b-casomorphin-7 (BCM-7), a seven-membered peptide obtained from *Bos taurus* cow, particularly HeF cows. BCM-7 is a digestive by-product of beta-casein generated due to substituting a proline residue by histidine in polypeptide chains. BCM-7 has several adverse effects on the body. In patients with the leaky gut syndrome, BCM-7 in the bloodstream can cause schizophrenia and atherosclerosis. In nursing infants, it can cause type-1 diabetes and autism due to binding BCM-7 with opioid receptors and inhibiting endorphins' normal binding and function. Endorphins cannot perform their function, leading to autism in infants and schizophrenia in adults. Activation of opioid receptors by BCM-7 also causes damages to the immune system and leads to type-1 diabetes. Consumption of A1 milk also causes asthma, heart diseases, and allergic reactions [48].

On the other hand, milk obtained from the Indian cow breed is an A2 type of milk with numerous benefits on human health and various medicinal activities. In Ayurveda, a traditional practice prescribed cow's milk with medications to enhance the efficacy/toxicity ratio [49,50]. Indian cow milk is rich in nutrients, containing about 4.6% lactose, 4.65% fat, 0.54% minerals, 3.4% proteins, and 86% water. Cow milk proteins contain 27% β-casein, 9% κ-

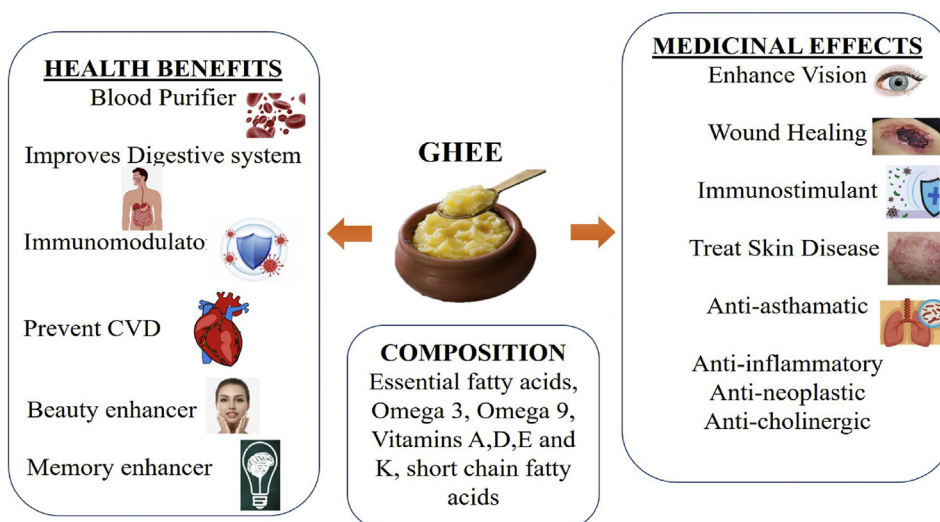


Fig. 4. Composition, health benefits, and medicinal effects of cow ghee. CVD: Cardiovascular diseases.

Table 1
Composition and medicinal effects of cow urine.

Constituent	Formula	Health benefits and medicinal effects
Iron	Fe	Formation of RBCs and hemoglobin
Calcium	Ca	Blood purification; maintains bone strength
Copper	Cu	Prevent deposition of fats
Phosphate	P	Prevent formation of stones in the urinary tract
Manganese	Mn	Germicidal effects; prevent gangrene
Potassium	K	Increase appetite; reduce muscle weakness; cures hereditary rheumatism.
Sulphur	S	Blood cleanser; improve bowel movement
Nitrogen	N ₂ , NH ₂	Regulates kidney function; prevent abnormalities in the blood; diuresis
Sodium	Na	Blood purification; antacid
Ammonia	NH ₃	Enhance blood formation; maintains bile and mucus
Carbolic acid	HCOOH	Germicidal effects; prevent gangrene
Aurum Hydroxide	AuOH	Improves immunity system; antibiotic; anti-toxic
Creatinine	C ₄ H ₉ N ₂ O ₂	Germicidal action
Hipuric acid		Helps in the excretion of toxins in urine
Lactose	C ₆ H ₁₂ O ₆	Reduce nervousness; strengthen the heart
Urea	CO(NH ₂) ₂	Increase urine formation; germicidal effect
Uric Acid	C ₅ H ₄ N ₄ O ₃	Diuretic effect; help to maintain good heart health
Water	H ₂ O	Maintains fluidity of blood and body temperature

casein, 36% α -casein, and 27% peptides [17]. Casein is present in a colloidal state, and it constitutes about 3% of milk, while pigments like xanthophyll, carotene, and riboflavin are also present. Milk also contains essential fatty acids and is a rich source of calcium and phosphorous. Phospholipids including cephalin, lecithin, and sphingomyelin, and vitamins including A, B2, B3, and K are also found in milk [17,51].

Consumption of cow milk shows various health benefits. Cow milk is used as a replacement for breast milk for infants. It is essential for the growth of teeth, bones [52], and heart activities management. The low cholesterol fat of milk is vital for mental and physical development, while milk helps maintain the digestive system, immune system, and brain functions. Lactose serves as an essential source of energy. Milk also enhances vision because of vitamin A whereas vitamin K regulates the blood clotting process.

Milk serves as a gold mine of medicinal effects. Anemia in infants can be treated by consuming milk. Cow milk restricts the growth of harmful gut bacteria and promotes beneficial gut flora [53]. Milk enzymes (xanthine oxidase, lactoperoxidase, and lysozyme) play an anti-bacterial role, whereas peptides (β -casomorphins, exorphin, and serorphin) exert anti-diarrhoeal activity. Regular milk consumption is suggested for patients suffering from gall bladder diseases, diabetes, and hyperlipidemia [54].

Cis-isomer of linoleic acid present in milk has demonstrated antineoplastic activity. It was found to restrict cancerous growth. Milk has anti-cancer activity against skin, colon, and breast cancer [55]. Considering all these beneficial effects of A2 type milk, the Government of India announced the 'Rashtriya Gokul Mission' in 2014 in order to increase the indigenous breeds of cow and get more A2 type of milk [50].

3. Method of preparation of Panchagavya ghrita and its variants

Classic Ayurvedic textbooks (Acharya Charak and Vagbhatacharya) have quoted the traditional methods of preparing Panchagavya Ghrita (PGG). This ancient literature has suggested the preparation of PGG with all five Panchagavya components (Fig. 1) in equal proportion [56].

Recent literature, prepared and published by the Government of India, explained a pre-preparation of cow dung juice. Ayurvedic Formulary of India (AFI) suggested the preparation and filtration of cow dung and cow urine before its use in PGG formulation. Further, all the Panchagavya products should be thoroughly mixed in equal

quantities and heated at a low flame till the formulation achieved all parameters prescribed by AFI [57].

3.1. Variants of PGG

Ayurvedic literature also mentions variants of PGG formulation and revealed that PGG could be used as single or in combination with other herbs. Examples of such combinations and single-use are *Swalpa-Panchgavya ghrita*, PGG, and *Mahapanchgavya ghrita*. Such mixing of herbs in the PGG may increase the therapeutic profile of the formulation. The composition of different variants is shown in Table 2.

4. Therapeutic effects of Panchagavya

4.1. Analgesic effect

Cow urine (2 ml, oral) and its distillate (2 ml, oral) were analyzed for analgesic activity in rats of both sexes (150–200 g) using the rat tail immersion test and Diclofenac Sodium (50 mg/kg, oral) as a reference standard. In the tail immersion test, the time taken for reflex action was recorded at 0th, 30th, 60th, and 90th minute after administration indicated analgesic effect. The intensity of analgesic activity of cow urine (7.63 ± 0.008 , 8.25 ± 0.06 , 8.36 ± 0.37) and distillate (8.36 ± 0.37 , 8.28 ± 0.09 , 9.34 ± 0.09) was observed to be comparable with the group receiving Diclofenac Sodium (9.07 ± 0.02 , 10.55 ± 0.02 , 11.22 ± 0.02) ($P < 0.01$). The analgesic effect was due to steroidal constituents and volatile fatty acids, which were confirmed using sophisticated analytical techniques in other studies. Ayurveda recommends using cow urine in pain relief, and the study served as scientific evidence for its acceptance in the modern world [59].

4.2. Hepatoprotective effect

PGG demonstrated hepatoprotective potential at a dose of 150–300 mg/kg, p.o. against carbon tetrachloride (CCl₄)-induced hepatotoxicity in males albino rats of Sprague Dawley strain. Serum marker enzymes, i.e., serum glutamate oxaloacetate transaminase (SGOT), serum glutamate pyruvate transaminase (SGPT), alkaline phosphatase (ALP), acid phosphatase (ACP) were estimated to assess the liver function by taking Silymarin as a reference standard. PGG formulation was significantly active against CCl₄-induced elevation in SGOT, SGPT, ALP, and ACP, preventing the elevation of

Table 2
The Composition of different *Panchgavya* variants.

Sr. No	Name of Variant	Composition	Reference
1	<i>Swalpa Panchgavya Ghrita</i>	All five <i>Panchgavya</i> components in equal quantities	[58]
2	<i>Maha Panchgavya Ghrita</i>	<i>Kwatha dravya</i> - 24 herbs in 2 <i>pala</i> quantity <i>Kalka dravya</i> - 18 herbs in 1 <i>karsha</i> quantity And each <i>Panchgavya</i> component in equal quantities.	[58]
3	<i>Panchgavya Ghrita</i>	Cow ghee 768 g and other four components are taken in 3.07 kg.	[58]

these enzymes comparable with Silymarin [39]. Phospholipids influence the repair mechanisms with elevated thymidylate synthetase and thymidine kinase levels in the liver, reaching a peak at 72 h demonstrating liver regeneration [60,61].

4.3. Anti-haemorrhoid activity

Hemorrhoids are symptomatic enlargement and distal displacement of the anal mucosa. Treatment of 250 mg of *gaumutra-ghana* (extract of cow urine) along with the water was given twice daily for 30 days to patients of both sexes diagnosed with hemorrhoids of grade I and II. Consumption of cow urine exerted positive effects on the large intestine. Clinical evaluation supported cow urine as oral supplementation to relieve pain, ease defecation, prevent itching, and bleeding [62–64].

4.4. Wound healing activity

Cow ghee has demonstrated potential wound healing activity. High saturated and unsaturated fatty acid content is supposed to have participated in wound healing [65]. A study was conducted to examine the healing ability of cow ghee in combination with *Aegle marmelos* leaves extract and evaluated for the various parameters, i.e., decrease in the area of the wound, wound closure, wound contraction, and tissue regeneration at the damaged area. The combination demonstrated rapid wound healing within eight days [65,66].

Cow ghee was also evaluated with *Aloe vera* for wound healing potential by topical application 0.5 g of formulated gel. Wound contraction ceased between 21 and 24 days, increasing epithelization, providing tensile strength, and promoting collagen formation. The therapeutic intensity of wound healing was comparable with 0.5 g Framycetin sulphate cream (1% w/w) [67].

Cow urine was examined for wound healing activity using the Wistar albino rat's excision wound model of both sexes. Nitrofurazone was used as a reference standard. The experiment revealed the significant wound healing ability of cow urine. External application of cow urine for 14 days on the damaged area exhibited 50% wound healing compared to 50.3% healing of nitrofurazone, showing cow urine was more effective than nitrofurazone [68].

4.5. Effect on eyes

Computer Vision Syndrome (CVS) is a common problem across the globe, characterized by drying of eyes, burning sensation, itching, and redness. Lubricating eye drops are used for the treatment, and their regular use can cause damage to the eyes due to preservatives. Cow ghee has a lubricating property that can be used to treat CVS without any harmful effects. Cow ghee has Vitamin A

which helps maintain moisture in the outer lining of the eyeball and prevents dryness and blindness [69].

4.6. Anti-microbial activity

Anti-microbial activity of cow urine and cow urine distillate was tested against pathogens like *Bacillus subtilis*, *Salmonella typhi*, *Klebsiella pneumonia*, and *Pseudomonas aeruginosa* [70]. Cow urine distillate (at 5, 10 and 15 μ l) demonstrated maximum activity (zone of inhibition) against *P. aeruginosa* (7.06 ± 0.05 , 8.08 ± 0.18 and 10.4 ± 1.23 , mm in diameter, respectively) and *S. typhi* (6.3 ± 1.23 , 8.06 ± 0.17 and 10.4 ± 1.2 , mm in diameter, respectively) [1]. Cow urine and distillate also demonstrated free radical scavenging activity. Fresh cow urine was comparatively more effective than distillate. Ofloxacin was considered the standard, and the anti-microbial activity of fresh cow urine was comparable with Ofloxacin [71].

4.7. Anti-epileptic effect

PGG was examined for anti-epileptic activity using a rat model of maximal electroshock (MES) induced convulsions. PGG demonstrated anti-convulsant activity by increasing the motor activity of rats. The formulation also successfully inhibited the phenobarbitone-induced sleep time. The PGG is recommended as adjuvant therapy in treating epilepsy [72].

4.8. Nootropic effect

PGG was evaluated for nootropic activity using a model of diazepam-induced (1 mg/kg, i.p.) amnesia against piracetam (270 mg/kg) as a reference standard. Elevated Plus Maze (EPM) and Morris Water Maze (MWM) tests considering transfer latency and scape transfer latency as assessment parameters respectively was performed to confirm the activity. The PGG was administered at three different doses 2.5 g/kg, 5 g/kg and 10 g/kg in Swiss albino mice (18-30 g) and 1.75 g/kg, 3.5 g/kg and 7.0 g/kg in Wistar rats (160-200 g). The therapeutic intensity in the group receiving 5 g/kg and 3.5 g/kg of the formulation was comparable to the standard in EPM and MWM tests. PGG demonstrated significant memory-enhancing and memory retention activity [73].

4.9. Anti-cancer effect

A comparative evaluation of cow ghee and soyabean oil in a rat model of 7,12-dimethylbenz(a)-anthracene (DMBA) induced mammary carcinogenesis revealed the anti-cancer potential of cow ghee by expressing cox-2 and peroxisome proliferators activated receptors- γ (PPAR- γ) in mammary glands. The group receiving cow ghee had lower tumour incidences (26.6%), low tumour weight (1.67 g), and volume (1925 mm³) compared to the group receiving

soyabean oil (65.4%, 6.18 g, 6285 mm³) [74]. Cow urine has also demonstrated its potential as an antineoplastic agent [75,76].

5. Role of *Panchgavya* in agriculture

The application of *Panchgavya* in agricultural fields demonstrated several benefits.

5.1. Effect on soil

Panchgavya improves soil fertility by increasing organic matter, macro and micronutrient levels, and the uptake of nutrients in plants, promoting the growth and reproduction of micro-organisms and maintaining good soil health. It also progresses the physical properties of soil by increasing the porosity and balancing the soil aggregate stability, regulating soil pH and the soil's nutrient profile. Beulah, in his study confirmed the application of *Panchgavya* in agricultural fields dramatically influences the growth and crop yield by promoting the beneficial soil microorganisms around the roots [77].

5.2. Effect on different parts of plants and crops

The spraying of *Panchgavya* on leaves results in the production of invariably bigger leaves and denser canopy; enhances photosynthetic material, which results in maximum production of metabolites and photosynthates [78]. It also develops side shoots from the trunk carrying the maximum number of fruits to maturity; rich and high branching; rich and dense roots grow in deeper soil layers. Furthermore, it helps plants and crops remain fresh for a longer time with a high intake of nutrients and water [79].

5.3. Role in organic farming

Panchgavya helps in the production of synthetic pesticide-free food. It also maintains and restores crop production levels when the field changes from inorganic to organic farming practices within a year. It enhances the shelf-life, taste of fruits, grains, and vegetables and yields better and safe quality food products. Moreover, it improves crop harvest by 15 days and reduces crop production costs by decreasing the expenses on chemicals, thereby increasing profit margin.

6. *Panchgavya*-based nanotechnology

Nanoparticles are the fundamental building blocks in nanotechnology, and they consist of macromolecular materials in which drug (active ingredient, biologically active compound) is dissolved, entrapped, encapsulated, adsorbed, or attached. Nanotechnologies have a diverse range of applications and have become one of the functional areas of research in drug delivery due to their capacity to deliver drugs to the right place, at the correct time, and in the proper dosage [80].

Arumugam et al. synthesized *Panchgavya* mediated copper nanoparticles using *Panchgavya* filtrate and copper sulphate solution (25 mM) as substrate. Copper nanoparticles were characterized using various techniques; Ultraviolet spectrophotometer, Fourier transmission infrared spectroscopy, X-ray diffraction analysis, Dynamic light scattering, Scanning electron microscope, High-resolution transmission electron microscope, X-ray fluorescent microscopy. Moreover, they have been evaluated for their antioxidant and cytotoxic potential [81].

Govarathanan et al. synthesized silver nanoparticles using 4 ml of *Panchgavya* filtrate in 96 ml of 1 mM AgNO₃ solution. The prepared nanoparticles were characterized and demonstrated concentration-

dependent anti-microbial activity against antibiotic-resistant bacterial species (sp) such as *Aeromonas* sp., *Acinetobacter* sp., and *Citrobacter* sp [82].

7. Conclusion

Panchgavya has demonstrated its potential to serve humankind and is a promising therapy against various human ailments. The effects of *Panchgavya* must not be limited only to ancient literature although, scientific efforts are needed to validate biological activities and safety and establish the standards. Detailed experiments are required for each product to validate composition, chemical behaviour, pharmacological activity, safety, toxicity profile, and the mechanism of action of the active components. It is equally important to educate the people and promote *Panchgavya* products to seek the world's attention towards India's rich traditional practice and literature.

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Conflict of interest

None.

Author Contributions

Komal Bajaj: Data curation, Resources, Methodology, Roles/Writing- original draft; **Vishal Chavan:** Data curation, Resources, Roles/Writing- original draft; **Nishikant Raut:** Conceptualization, Investigation, Resources, Validation; **Shailendra S. Gurav:** Supervision, Validation, Formal analysis, Writing - review & editing.

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