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Review of the Contemporary Applications of Cow Urine and its Distillate in Agriculture, Medicine, and Electricity Generation for Sustainable Development

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ABSTRACT

Many Indians admire cows for their strength, wealth, and motherliness. As the earthly incarnation of the holy and loving Mother Goddess, it signifies fertility and generosity. They believe that their milk cleanses the body. India has the most significant number of cows. There were 192.49 million cattle in 2019, up 0.8% from the previous census. Female cattle (cows) number 145.12 million, up 18.0% from the last census. India has 43 indigenous cow breeds spread throughout the nation. They exist in typical settings and have different body structures. Cow urine, a dark brown, natural, non-toxic fluid, improves human comprehension, is a worldwide medication, and is readily digestible. The number of Indian Desi cows is quickly declining, affecting our food security, agro-economy, and independence from other nations that need A2 milk. Preserving Indian cow breeds necessitates increased cow milk, urine, and dung use. Every day, an Indian cow produces 2-3 litres of milk, 7-10 litres of cow urine, and 10 kg of dung. Urine is the second most crucial cow product after milk. As a result, cow urine might assist rural farmers and cow sheds gain money. Instead of selling cows for slaughter, individuals who profit from them will retain them for life. It prompted research into the applications of cow urine and distillate. The present research investigates that agricultureconsumes 51.7% of cow urine and distillate. Energy production makes use of it (28.6%). 14.3% of scientists use it medicinally. The most common applications for cow urine and its distillate are found as denitrification of fertiliser, cancer therapy, plant antifungal agents, bio-pesticide, struvite manufacturing origin, production of electricity, and fuel for fuel cell automobiles run on cow urine.

Keywords: Bibliometric analysis; Cancer; Cow urine; Cow urine distillate; Gomutra; Gomutra Arka;

INTRODUCTION

The cow is a well-regarded animal in Hinduism, representing prosperity, power, and motherly affection. It is considered the earthly manifestation of the holy and nurturing Mother Goddess, who signifies fertility and generosity. Their milk is said to have a cleansing impact on human bodies.

Indian cows and milk

India has the world's highest cow population. The overall number of cattle in the nation was 192.49 million in 2019, up 0.8% from the previous Census. Female Cattle (Cows) population is 145.12 million, up 18.0% from the last census (2012)(Government of India, Ministry of Agriculture, 2003). Desi cows are the Indian Subcontinent's native domestic cows. These cows have a hump on their back and a considerable dewlap, which distinguishes them. These cows are used to the tropical and hot Indian weather conditions. As a result, they may live comfortably in India. Water, fat, proteins, lactose (milk sugar), and minerals (salts) are the primary components of milk. Other chemicals found in milk include pigments, enzymes, vitamins, phospholipids (substances having fat-like characteristics), and gases. After removing water and gases, the residue is known as the milk's dry matter (DM) or total solids content. Table 1 shows that cow's milk contains around 87% water and 13% dry material. Water suspends or dissolves the dry material.

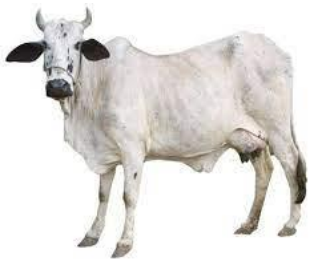
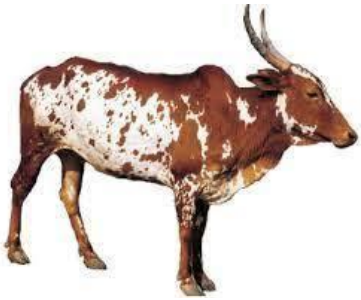
Table 1: Physical-chemical status of cows' milk

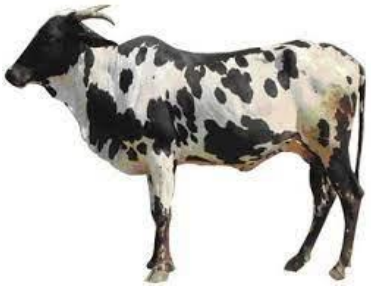
Contents	Average composition %
Moisture	87.5
Fat	3.9
Proteins	3.4
Lactose	4.8
Minerals (Ash)	0.8

Casein is the most abundant protein in milk, accounting for around 80% of total protein content. Milk contains numerous forms of casein. The second most common is beta-casein, which appears in at least 13 distinct forms. A1 and A2 beta-casein are present in regular milk, whereas A2 milk solely includes A2 beta-casein.According to specific research, A1 beta-casein may be hazardous, and A2 beta-casein is a better alternative.As a result, there is considerable public and scientific controversy about these two kinds of milk.The A2 Milk Company manufactures and markets A2 milk with no A1 beta-casein.

The milk of desi cows contains the A2 protein, an essential protein for the human body. The urine and manure of desi cows have various therapeutic characteristics employed in Ayurveda medicine. Indigenous peoples' unique and pure breed Desi Cows in India are reported to have 4-8 litres of milk daily, depending on their lactation cycle. Certain breeds produce just 2 to 3 litres of milk. There will undoubtedly be some exceptions. There have been reports of cows producing 40+ litres of milk daily. Gir cows are reported to make anything from 5 to 12 litres of milk each day. The Sahiwal cow may generate 6 to 11 litres of milk per day. The Rathi cow may produce 3-6 litres of milk each day. There are a total of 43 Indian native cow breeds in India. They are located in different states of the countries. They differ in body structure and survive in the typical environment. Table 2 illustrates the name of cow breeds, their location and photographs. The purpose of this table is to quickly convey the identity of the cow breed to a widespread reader.

Table 2: Different types of Indian cow breeds(Mishra, 2022)

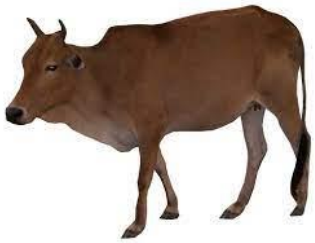
Sn	Breed of Cow	Native	Photo
1	Amritmahal	Karnataka	
2	Bachaur	Bihar	
3	Bargur	Tamilnadu	

4	Dangi	Maharashtra and Madhya Pradesh	
5	Deoni	Maharashtra and Karnataka	
6	Gaolao	Maharashtra and Madhya Pradesh	
7	Gir	Gujrat	
8	Hallikar	Karnataka	
9	Hariana	Haryana, Uttar Pradesh and Rajasthan	

10	Kangayam	Tamilnadu	
11	Kankrej	Gujarat and Rajasthan	
12	Kenkatha	Uttar Pradesh and Madhya Pradesh	
13	Kherigarh	Uttar Pradesh	
14	Khillar	Maharashtra and Karnataka	
15	Krishna Valley	Karnataka	

16	Malvi	Madhya Pradesh	
17	Mewati	Rajasthan, Haryana and Uttar Pradesh	
18	Nagori	Rajasthan	
19	Nimari	Madhya Pradesh	
20	Ongole	Andhra Pradesh	
21	Ponwar	Uttar Pradesh	

22	Punganur	Andhra Pradesh	
23	Rathi	Rajasthan	
24	Red Kandhari	Maharashtra	
25	Red Sindhi	On organised farms, only	
26	Sahiwal	Punjab and Rajasthan	
27	Siri	Sikkim and West Bengal	

28	Tharparkar	Rajasthan	
29	Umblachery	Tamilnadu	
30	Vechur	Kerala	
31	Motu	Orissa,Chhattisgarh and Andhra Pradesh	
32	Ghumusari	Orissa	
33	Binjharpuri	Orissa	

34	Khariar	Orissa	
35	Pulikulam	Tamilnadu	
36	Kosali	Chhattisgarh	
37	MalnadGidda	Karnataka	
38	Belahi	Haryana and Chandigarh	
39	Gangatiri	Uttar Pradesh and Bihar	

40	Badri	Uttarakhand	
41	Lakhimi	Assam	
42	Ladakhi	Jammu and Kashmir	
43	Konkan Kapila	Maharashtra and Goa	

Cow urine and Cow urine distillate

Cow urine is a natural and non-toxic, dark brown substance that enhances the power of wisdom in humans, functions as a universal remedy, and is readily digestible by anyone. The imbalance in specific components is the primary cause of many disorders. Cow urine includes the majority of these components and so aids in the restoration of their equilibrium. Cow urine therapy looked to be an effective alternative to chemotherapy for the treatment of the fatal illness of cancer. The urine of the Indian cow contains 95% water, 2.5% urea, and 2.5% a mixture of various salts, hormones, enzymes, and many vitamins such as vitamins A, B, C, D, and E, nitrogen, sulphur, manganese, iron, silicon, chlorine, magnesium, citric, succinic, calcium salts, carbolic acid, phosphate, lactose, and so on. A lack of these causes a metabolic imbalance, leading to reduced functioning. Internal use of cow urine resulted in repairing these deficiencies and, consequently, the normal function of a specific tissue or organ. Cow urine and cow urine distillate are not chemically comparable since some of the components in cow urine escape as vapour during distillation. Cow urine distillate is pleasant and non-odorous, making it simple for patients or individuals to utilise. Several investigations have shown that cow urine distillate is typically more effective than cow urine. Honey would make it more effective.

Cow urine distillate is often administered at 10-12 mL twice daily. It is efficient mainly at lowering blood cholesterol levels and overall body weight. It may be an effective treatment for variouspediatric disorders, including cough. Regular and long-term usage of Cow urine distillate (often for 3-4 months) produces more outstanding outcomes, particularly in chronic conditions (S. Singh, 2019). Randhawa (Randhawa, 2010) studied cow urine distillate as a bio-enhancer. He mentioned that regular drinkers of cow urine are reported to enjoy a robust life, undisturbed by the changes of old age, even at the age of 90. Furthermore, it has been used as a bio-pesticide in organic farming with cow manure, cow's milk, and other herbal substances.

Motivation behind the present research work

The number of Indian Desi cows is declining at an alarming rate, putting our nation's food security in danger, risking the fundamental foundations of our Agro-Economy, and essentially becoming a slave of foreign powers seeking control of our A2 milk. The truth about the dwindling number of Indian Desi Cows is evident in census statistics obtained in 2012, which revealed that the population of Indian cattle shrunk by 8.94% compared to the population of cross-bred foreign cattle breeds, which surged by 20.18%. Despite this, instead of attempting to increase the population of Desi Cows through crossbreeding, the Animal Husbandry Department appears to be taking the backward step of importing foreign cow breeds and spoiling our Desi breeds. This step will set us back in our efforts to promote our indigenous

cow, its numerous benefits, and the values it represents. Despite the government's prior agreement to cultivate indigenous cows in principle, this reversal does not promise well for our Desi cows or the nation (Agoramoorthy & Hsu, 2012).

Increasing the number of uses of cow milk, urine, and dung is essential to rescue Indian cow breeds from extinction. Every day, an Indian cow generates 2 to 3 litres of milk, 7-10 litres of cow urine, and 10 kg of dung. Apart from milk, another major commodity derived from cows is urine. As a result, cow urine may be utilised to generate additional income for rural people or cow sheds. If individuals make a good living from cows, they will care for and keep them for the rest of their lives rather than sell them to cowslaughter. With this motivation, our research into the uses of cow urine and its distillate has begun.

Specific objectives of the present research work

The specific objectives of the present review work are as follows:

a) Be familiar with the different uses of cow urine and its distillate in agriculture, medicine, and power production for rural communities. So that rural people, if they are unaware of them, would become aware of them and begin these income-generating activities.

b) In addition to this, the present research work rigorously reviews the peer-reviewed articles published on cow urine and its distillate uses to investigate the answer to the following research questions:

   a. Who wrote the first research paper on cow urine and its distillate? And what is its title? How many times has it been cited?
   b. What references were used to write the first research paper on cow urine and its distillate?
   c. What are the first five research papers on cow urine and its distillate?
   d. What are the top ten most cited research papers? Who are the authors of these articles? Where have they been published? So, that literature review would be started from these articles to find the applications of cow urine and its distillate.
   e. What are the essential keywords and index terms in the research area of cow urine and its distillate?
   f. What are the leading countries where research on cow urine and its distillate is undertaken? So that these places may be visited to gather more precise information.

Novelty of the present research work

In the current study endeavour, two developments are novel:

a) This review article illustrates the unique uses of cow urine and its distillate for individuals living in rural areas, including agriculture, therapeutic use, and the creation of energy potential.

b) A bibliographic study of the research articles that have been published on cow urine and its applications and that have been subjected to peer review is also included in this document.

Thus, one may begin the literature review from this analysis accurately without spending time haphazardly completing the literature review so that one can start the literature review there. The authors have determined that no review article of this kind is currently accessible in the literature.

METHODOLOGY USED FOR REVIEW WORK

The following stages were utilised to undertake the review study on the usage of cow urine and its distillate:

- Choosing frequent key phrases for identification and downloading of research papers from the Scopus database; and
- Bibliometric analysis of downloaded articles.
- Review work began based on bibliometric data.
- Reading downloaded articles and drawing meaningful conclusions.
- Separation of collected stuff based on the uses selected.
- Writing a discussion and conclusionsfrom the review work.

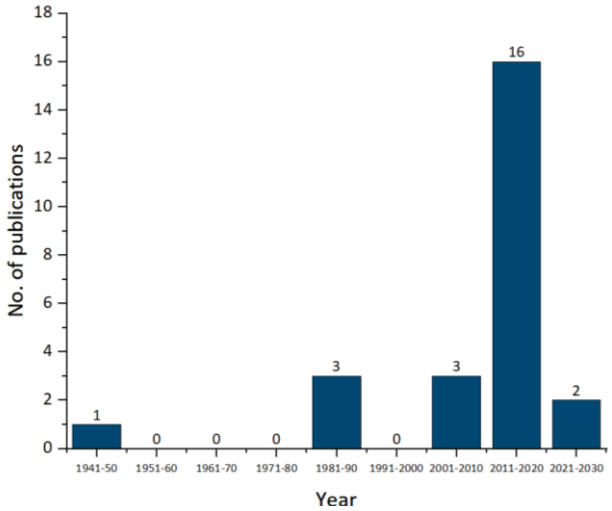


Fig. 1: Year-wise literature on cow urine and its distillate for the present research work.

METHODICAL LITERATURE ANALYSIS OF SCOPUS-INDEXED PAPER

A bibliography is a list of publications on a particular topic or by a specific author used or consulted in preparing a research paper, book, or article. It is also known as a list of works referenced. It is often located after a book, essay, or research paper.

This portion of the article is highly fascinating since it includes a bibliometric study of peer-reviewed research publications published on the usage of cow urine and its distillate. To date, 33 research articles have been found in the Scopus database. Navens et al., published the first research article on cows' urine as a fertiliser for Bluegrass Pastures in 1941. The Journal of Dairy Science has published this paper. Naven conducted the experiments using cow urine and authored his article with the help of various other publications, as indicated in Fig. 2. Fig. 2 shows that research on cow urine and its applications has been ongoing since 1935. And it is still moving slowly since so few individuals are participating in the study on cow urine application. However, as demonstrated in Fig. 3, the initial work authored by Navens is being utilised by investigators today.

Aside from this initial study, knowing the first five research papers published on cow urine and its use is also helpful. The apparent purpose is to determine the next steps in thepublication of research on cow urine applications. Table 3 lists the first five papers published on cow urine and its distillate applications.

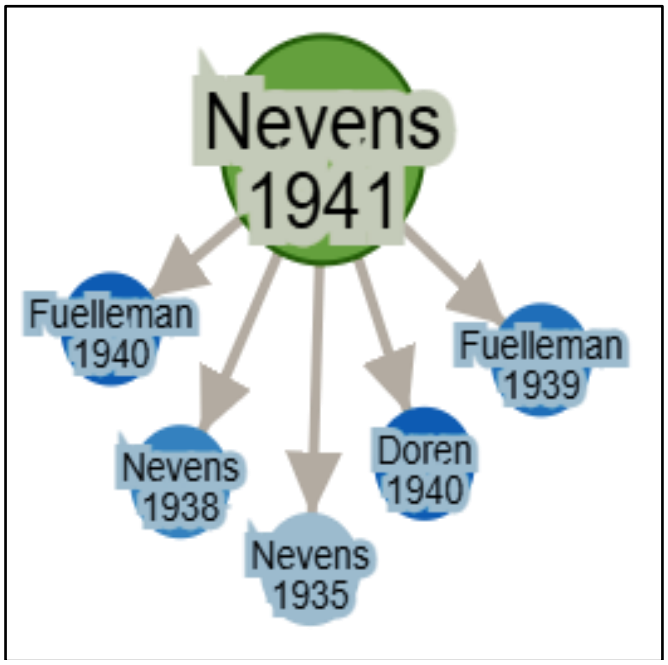


Fig. 2: References used for first publication

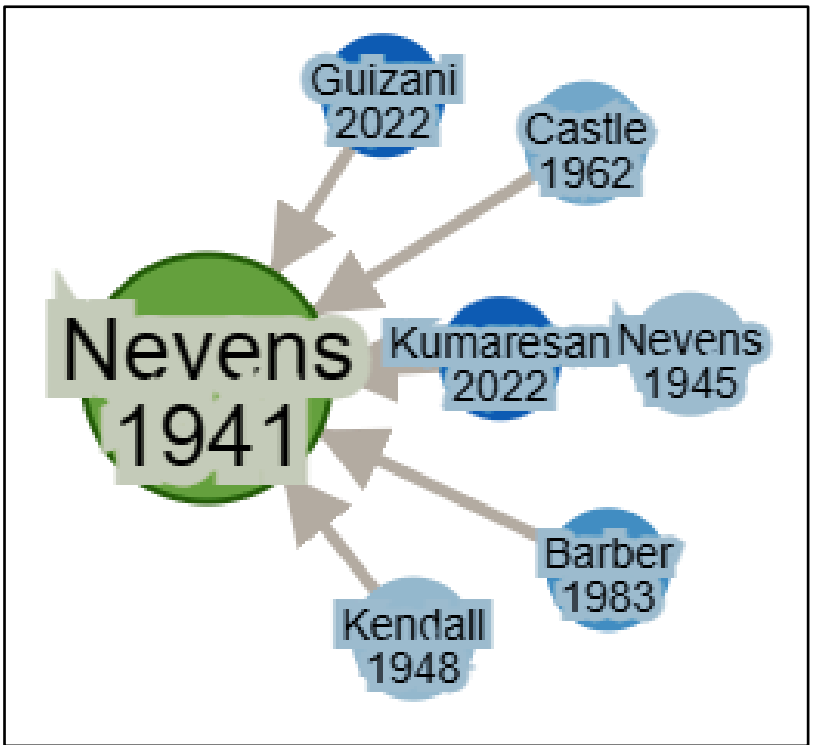


Fig. 3: Paper published based on the first paper

Table 3: ***The first five papers published on cow urine and its applications***

Sn	Authors	Title	Year	Source title	Cited by	DOI
1	Nevens W.B.	Cows' Urine as a Fertiliser for Bluegrass Pastures	1941	Journal of Dairy Science	1	10.3168/jds.S0022-0302(41)95454-1
2	Suemitsu R.; Hiura M.; Nakajima M.	Studies on cow's urine	1955	Nippon	0	10.1271/nogeikagaku1924.29.591
3	Suemitsu R.; Fujita S.; Matsubara H.	Studies on cow's urine	1965	Agricultural and Biological Chemistry	3	10.1080/00021369.1965.10858486
4	Grange A.	Experimental studies on the 'cow's urine mixture.'	1981	Annals of Tropical Paediatrics	1	10.1080/02724936.1981.11748083
5	Ledgard S.F.; Steele K.W.; Saunders W.H.M.	Effects of cow urine and its major constituents on pasture properties	1982	New Zealand Journal of Agricultural Research	88	10.1080/00288233.1982.10423373

Let us identify the most often mentioned authors and publications so that papers may be prominently studied to acquire the most helpful information on cow urine and its distillation use. The Scopus database included 33 peer-reviewed research publications. To determine the top five writers, the minimum citation requirements were 5. Figure 4 shows the top five most referenced authors. The size of the circle represents the number of citations they obtained. Table 4 also includes complete bibliographic information for the top five most cited papers. Table 4 also shows the top ten most referenced research articles on cow urine and their bibliographic information. As a result, these articles were thoroughly researched to acquire the most exact and relevant information. Fig. 5 shows how often other researchers reference the most cited paper written by Ledgardet al., (88 citations to date).

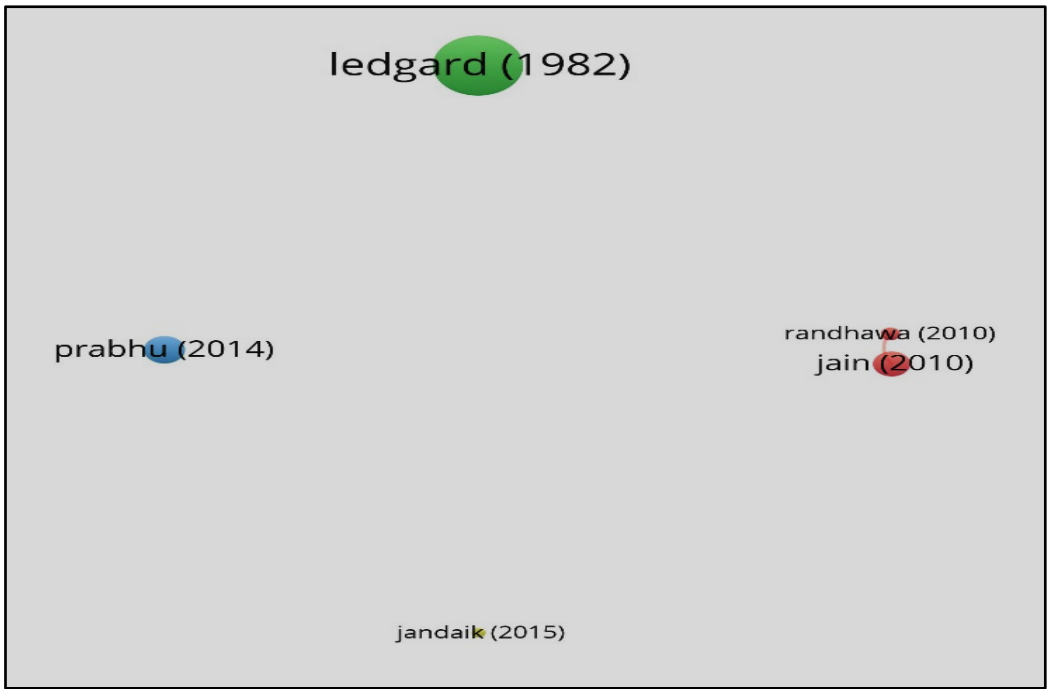


Fig. 4: Citations and documents

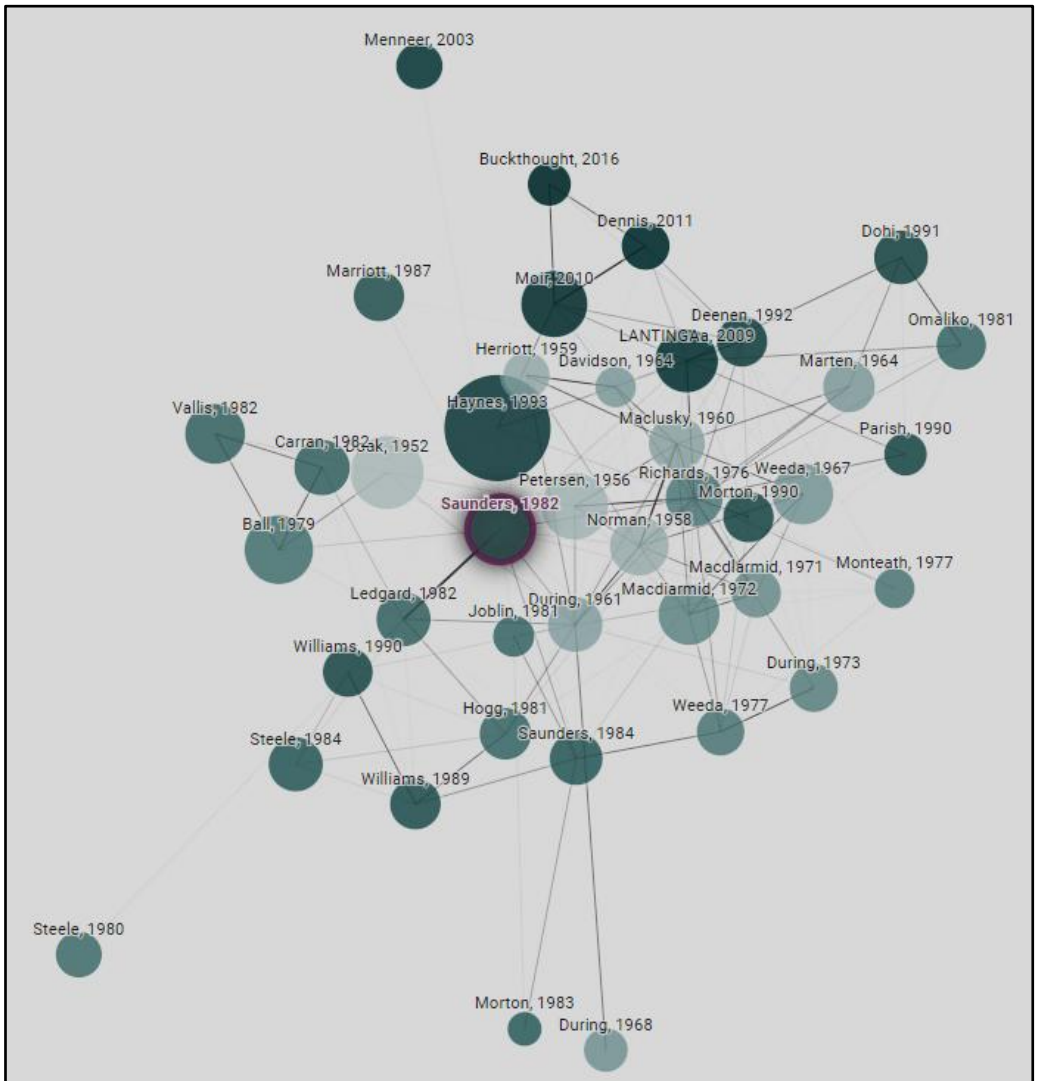


Fig. 5: Citations received by top-cited paper

Table 4: Top-ten cited papers

Sn	Authors	Title	Year	Source title	Cited by	DOI
1	Ledgard S.F.; Steele K.W.; Saunders W.H.M.	Effects of cow urine and its major constituents on pasture properties	1982	New Zealand Journal of Agricultural Research	88	10.1080/00288233.1982.10423373
2	Prabhu M.; Mutnuri S.	Cow urine as a potential source for struvite production	2014	International Journal of Recycling of Organic Waste in Agriculture	41	10.1007/s40093-014-0049-z
3	Jain N.K.; Gupta V.B.; Garg R.; Silawat N.	Efficacy of cow urine therapy on various cancer patients in Mandsaur District, India survey	2010	International Journal of Green Pharmacy	37	10.4103/0973-8258.62163
4	Randhawa G.	Cow urine distillate as bioenhancer	2010	Journal of Ayurveda and Integrative Medicine	20	10.4103/0975-9476.74089
5	Jandaik S.; Thakur P.; Kumar V.	Efficacy of Cow Urine as Plant Growth Enhancer and Antifungal Agent	2015	Advances in Agriculture	15	10.1155/2015/620368
6	Smith G.D.	Cow urine, Indian yellow, and art forgeries: An update	2017	Forensic Science International	10	10.1016/j.forsciint.2017.04.013
7	Hoh J.M.; Dhanashree B.	Antifungal effect of cow's urine distillate on Candida species	2017	Journal of Ayurveda and Integrative Medicine	8	10.1016/j.jaim.2017.04.009
8	Rajapandiyan K.; Shanthi S.; Murugan A.M.; AlaguMuthu G.; Ranjit Singh A.J.A.	Azadirachtaindica-Cow urine extract, a novel controlling agent towards clinically significant multi-drug resistant pathogens	2011	Journal of Applied Pharmaceutical Science	7	
9	Hirapara H.N.; Ghori V.M.; Anovadiya A.P.; Tripathi C.R.	Evaluation of wound healing activity of cow urine ark in diabetic wistar albino rats	2016	Journal of Intercultural Ethnopharmacology	7	10.5455/jice.20160923100135
10	Limmer A.W.; Steele K.W.	Effect of cow urine upon denitrification	1983	Soil Biology and Biochemistry	6	10.1016/0038-0717(83)90004-4

Interestingly, there are barely thirty, if any, publications that are subject to peer review and publish articles on cow urine research.Fig. 6 depicts the top-tier journals (the top-most is the Journal of Ayurveda and Integrative Medicine) that publish research articles on cow urine and its distillation uses.Ninety-eight authors are extensively working on

applying cow urine and its distillate. Fig. 7 depicts the five outstanding investigators doing extensive research and publishing in several prestigious international publications. Professor K. W Steele is the most intriguing researcher on this topic.

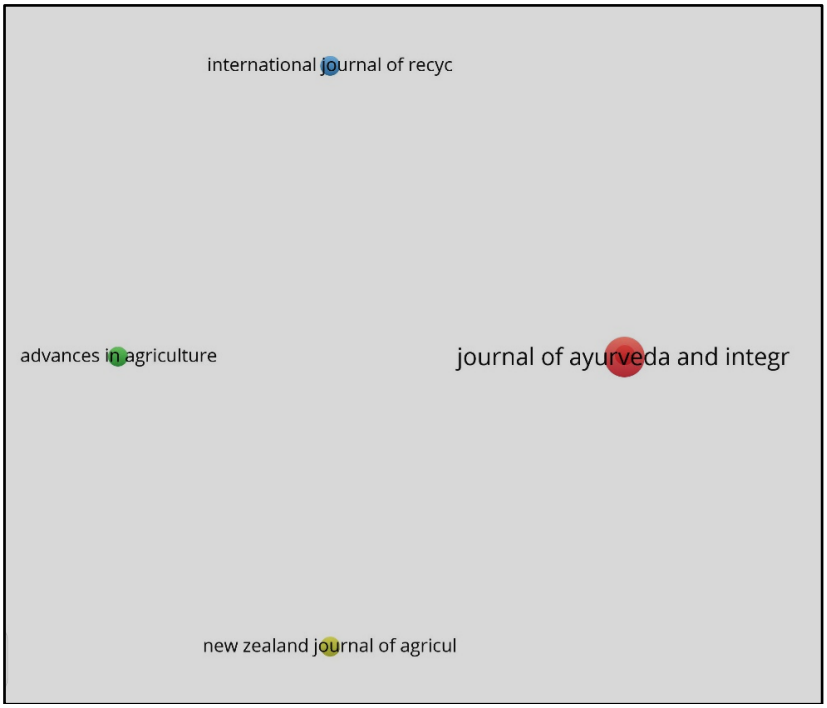


Fig. 6: Citations and sources

Now, we will look at the top countries researching cow urine and its distillate uses. According to the Scopus database, there are a total of 9 nations engaged in this study topic. As shown in Fig. 8, India is the top nation in terms of continuous research effort compared to the rest of the globe. Aside from India, the United States, Japan, and New Zealand are other key nations doing groundbreaking research on cow urine.

Fig. 7: Citations and authors

Fig. 8: Citations and countries

Let's study bibliographic couplings of research papers. Bibliographic coupling happens when two works in their bibliographies refer to the same third work. It indicates that there is a possibility that the two works are on the same topic. Two papers are considered bibliographically connected when referencing one or more other documents.

The top four research articles are linked among the accessible 33 documents, with a minimum citation threshold of 11. Figure 9 depicts them. The top bibliographically related researchers are Prof. Jain, Prof. Jandalik, Prof. Randhawa, and Prof. Prabhu. This inquiry aims to discover who the most collaborative individuals are when working together. So that we may contact them and get their opinions while working on our research ideas on the subject of cow urine and its distillation uses.

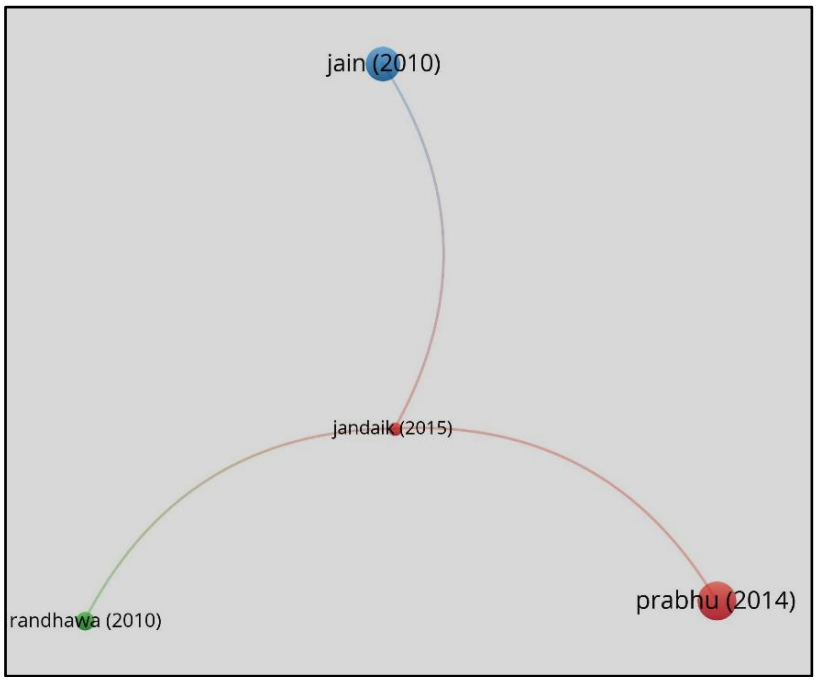


Fig. 9: Bibliographic couplings and documents

Similarly, we shall explore the top bibliographically associated Scopus-indexed peer-reviewed journals. So that these publications might be referred to get further information on our research topic.Fig. 10 illustratesthe top bibliographically connected journals. They are as follows:

- Journal of Ayurveda and Integrative Medicine
- Advances in Agriculture
- International Journal of Green Pharmacy
- International Journal of Recycling of Organic Waste in Agriculture

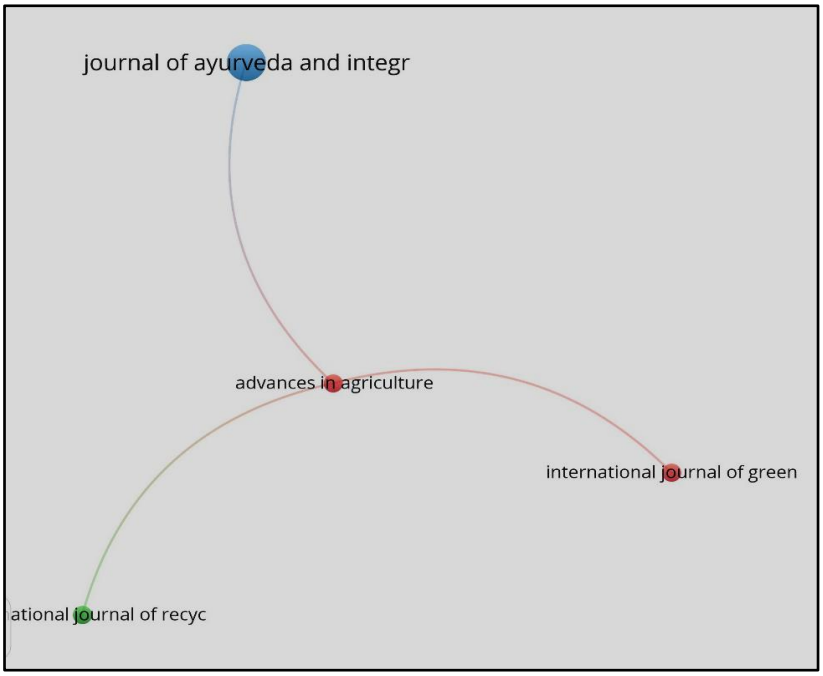


Fig. 10: Bibliographic coupling and sources

Both Fig. 11 and Fig. 12 depict authors and bibliographic couplings and nations and bibliographic couplings. The notion of bibliographic coupling serves as the foundation for author bibliographic coupling analysis, which considers an author's whole body of work as if it were a single publication while conducting the study. After that, it calculates the degree of overlap between the sets of references corresponding to the two authors' respective bodies of work to estimate the bibliographic strength between the two authors under consideration. Similarly, bibliographic coupling is essential for writers, institutions, and nations.

Professors Ledgard, Steele, and Aunders are among the most well-connected authors in terms of their bibliographic connections.Similarly, India, the United States of America, and Soveniya are three nations that link bibliographically and work together in the field of study concerning cow urine and its distillate.

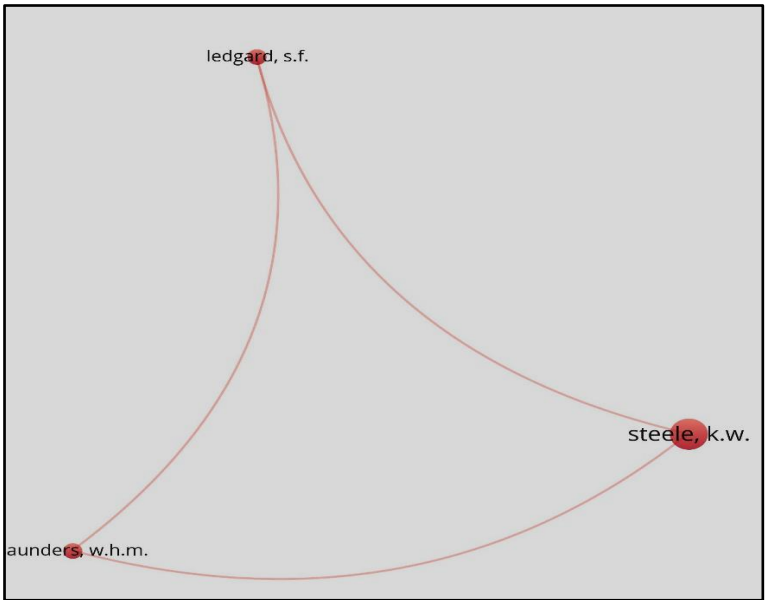


Fig. 11: Bibliographic coupling and authors

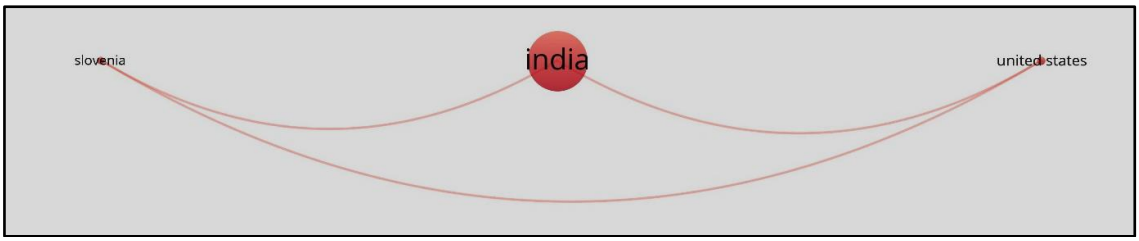


Fig. 12: Bibliographic coupling and countries

Co-citation analysis is a novel approach to investigating the cognitive structure of science. Tracking pairs of publications referenced in the source articles is what co-citation analysis is all about. When many writers mention the same pair of publications, research clusters emerge. Fig. 13 shows co-citations and connected cited authors.

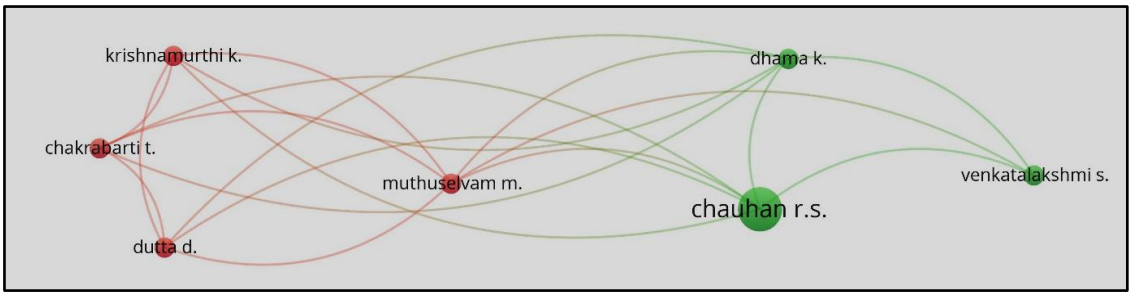


Fig. 13: Co-citation and cited authors.

For most researchers, one common question is: In what ways are keywords significant? The possible answer to this question is that keywords are essential because they give us a better understanding of the literature visitors are looking for and the content we must supply to fulfil their requirements. We may help establish our content strategy and the themes we will feature on the journal website by selecting the keywordswe will use.

Fig. 14, 15 and 16 show the most often used keywords and index terms. An index term is a phrase that encapsulates the core of the subject matter of a document. Regarding information retrieval, an index term is also known as a subject term, subject heading, descriptor, or keyword. Within the context of bibliographic records, index words constitute a regulated vocabulary.The majority of the time, all we will need are keywords. But we cannot locate that article if we cannot identify the phrase the author used to describe your subject matter. No matter what term(s) an author chooses to use (or chooses not to use) in indexed databases, there will always be one subject heading that appears for that particular topic; it is index keywords. Urine, Cow urine, Cow, Human, Non-human, and article are some of the most common keywords identified in research publications.

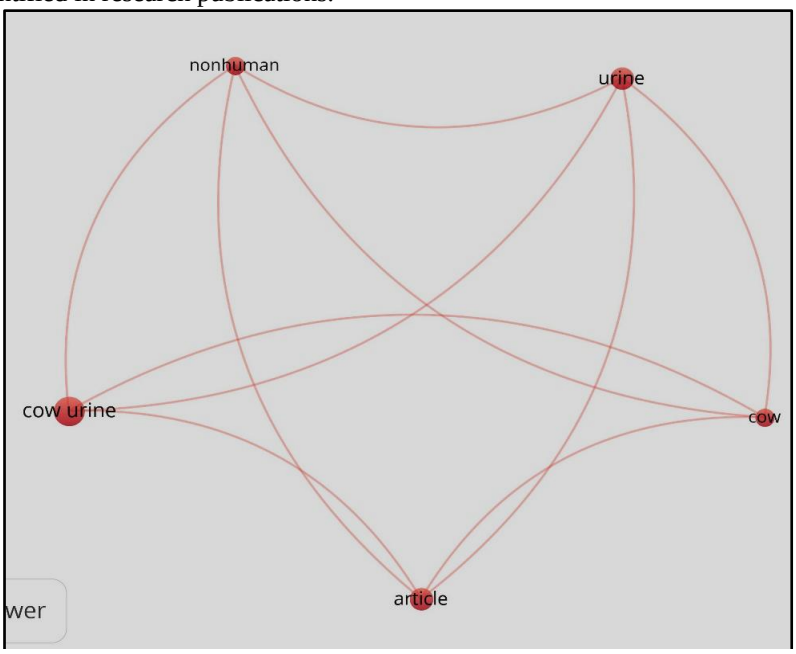


Fig. 14 Co-authors and all keywords

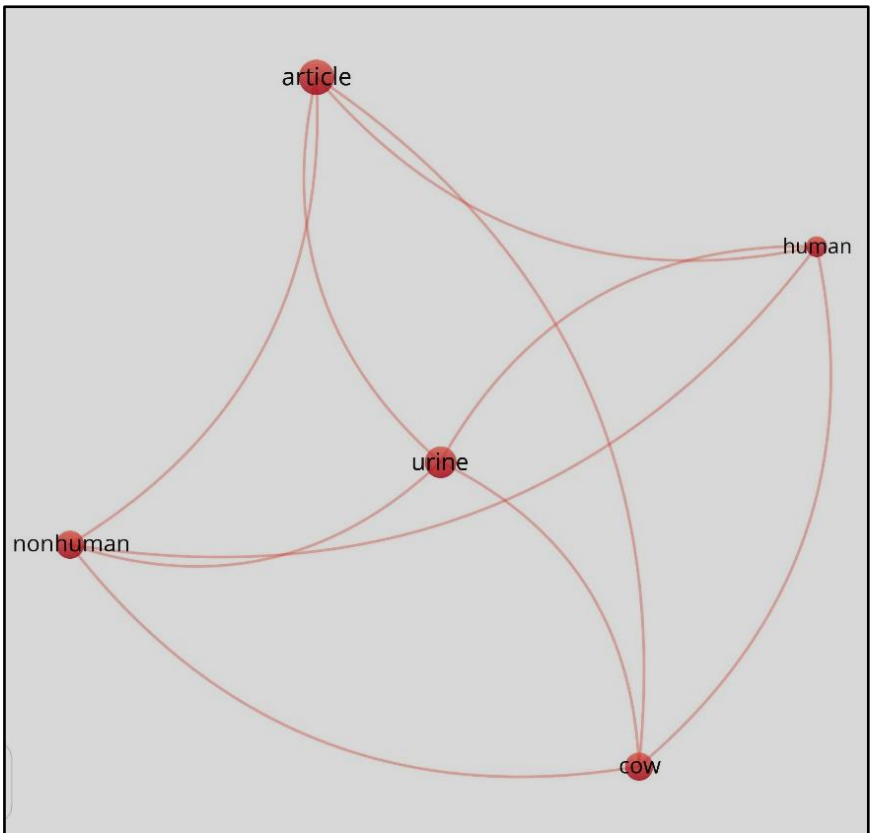


Fig. 15: Co-occurrences and all index terms

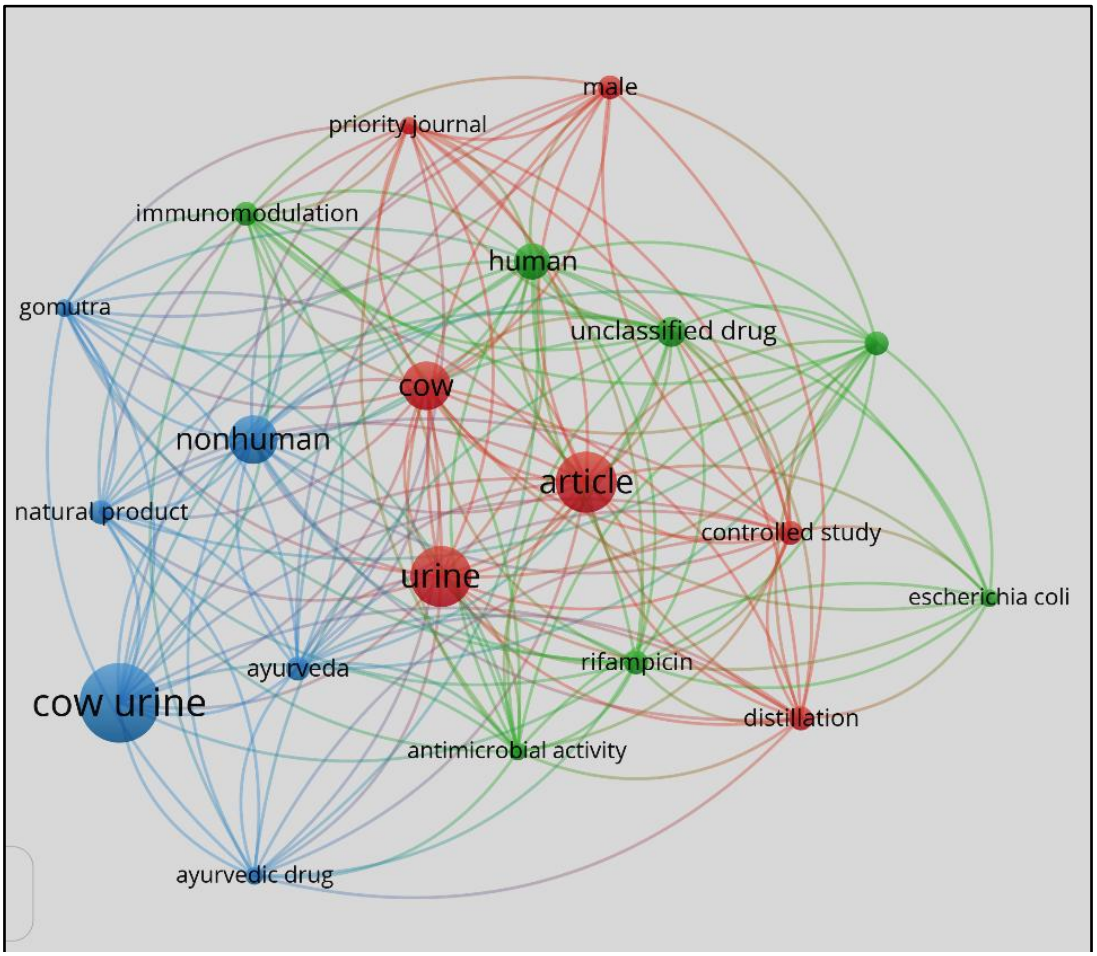


Fig. 16: co-occurrence and all keywords

REVIEW ON VARIOUS APPLICATIONS

Based on bibliographic analysis, a study of the literature was conducted in three categories: uses of cow urine and its distillate in (a) agriculture, (b) medicine, and (c) electrical power production. The following section provides a quick discussion of this literature study.

Applications in the agriculture sector

Neves(Nevens, 1941) studied the efficacy of cows' urine as a fertiliser for bluegrass pastures. Different amounts of cows' urine, ranging from 1250 pounds to 5000 pounds per acre, were used in each application. Grass samples were collected every month from May to September, including both months. The urine, which had a nitrogen content over 1 percent and, in most instances, a potassium content exceeding 1 percent, generally did not cause damage to the fodder when applied in large quantities. The authors stated that the grass on the treated plots had more protein content than the grass in the control area.

Furthermore, in most cases, a higher urine application resulted in a correspondingly higher protein content. The productivity of the plots treated with cow urine was greater than that of the untreated, and there was a trend for even better productivity in the plots that received a larger dosage of urine treatment.

Using a short-term incubation approach, Limmer and Steele (Limmer & Steele, 1983) demonstrated the effect of urine administration on the zone and rate of denitrification of pastoral soil. Denitrification is a microbiological process that involves the reduction of nitrate and nitrite to gaseous forms of nitrogen, primarily nitrous oxide (N_2O) and nitrogen (N_2). The inclusion of cow urine did not affect denitrification activity under complete enzyme induction conditions. At 6 and 90mm depth, the zone of highest denitrification activity was within the top 30 mm and did not change with increasing Carbon and Nitrogen substrate. The authors conclude that adding urine to soil with completely activated denitrifying enzymes did not increase denitrification activity. When the urine was maintained in the top 30 mm of soil by sheltering the experimental plots from rainfall, the only impact detected was a reduction in activity 21 days following treatment. Regardless of increases in Carbon and Nitrogen Oxide substrates at depths of 90mm, the zone of highest denitrification activity remained within the top 30mm of the soil profile. It showedit was safe from dissimilation after nitrogen oxide leaked from the top 30 mm pastoral soils. Significantnitrogen lossesfrom cow urine patches due to denitrification are unlikely to occur when rainfall follows urine deposition. In addition, while applying nitrogen fertiliser, modest watering may be beneficial, especially in hot weather.

Mutnuri and Prabhu(Prabhu & Mutnuri, 2014) used cow urine as a possible struvite manufacturing source (The formation of struvite stones occurs as the urine becomes more alkaline). Cow urine and brine were combined in various proportions to determine the optimal concentration for struvitecrystallisation. Crystallisedstruvite was characterised by X-ray diffraction, thermogravimetric and differential thermal analysis, Fourier transform infrared spectroscopy, scanning electron microscopy, and energy dispersive spectroscopy. At pH 9, a 1:0.5 mixture of cow urine and brine produced the most excellent grade struvite. The phosphate, magnesium, and ammonium ion concentrations in struvite were 5.85, 3.16, and 0.56%, respectively. On the development of Vignaradiata, the fertiliser potential of struvite was examined. The most remarkable growth was seen in pots with struvite applied at 2 g/kg soil concentration. The author mentioned that struvite may be produced from a renewable source, allowing long-term agricultural growth. Theoretically, with a yield of 40 g/L, India could produce 12,176 tonnes of struvite per day for fertiliser application.
Ledgard et al., (Ledgard et al., 1982) studied the effects of cow urine and its crucial constituent components of pasture qualities. Cow urine and its corresponding nitrogen, potassium, and Sulphur botanical composition, herbage chemical composition, pasture yield treatments and nitrogen fixation by clovers were investigated using winter and spring. The nitrogen component increase causes a significant boost in yield.

The efficacy of cow urine as a plant growth enhancer and antifungal agent has been studied by Jandaik et al., (Jandaik et al., 2015). The purpose of their study was to determine the antifungal activity of three different concentrations (5, 10, and 15%) of cow urine against three fungal pathogens (Fusariumoxysporum, Rhizoctoniasolani, and Sclerotiumrolfsii) isolated from infected Methi and Bhindi plants that showed symptoms of damping off and wilting disease using the poison food technique. The authors mentioned that cow urine at 15% concentration was the most efficient of these concentrations. When the three fungal species were evaluated, Fusariumoxysporum (78.57%) showed the most excellent growth inhibition at a 15% concentration of cow urine, followed by Rhizoctoniasolani (78.37%) and Sclerotiumrolfsii (73.84%). Finally, the authors found that cow urine has antifungal properties, and inhibitory action may be employed to control fungus.

Hoh and Dhanashree(Hoh & Dhanashree, 2017) studied the antifungal activity of cow's urine distillate against Candida species. Resistance of Candida species to commonly used antifungal medications has required the search for novel medicines. Few studies have shown that cow's urine may inhibit the development of harmful fungi. Cow's urine distillate inhibits Candida species in a concentration-dependent manner and is effective against isolates that are either resistant or susceptible to commonly used antifungal drugs.

Sadhukhan(Sadhukhan, 2017) presented a study on cow urine as a fertiliser and bio-pesticide that maintains environmental sustainability in agriculture. After regular use of cow urine in the crops, farmers have found that soil microorganisms have increased along with crop production. It has also improved the soil texture and structure. There was no occurrence of any insect pestsor diseases. Cow urine works as a growth promoter.

Tapke(Tapke, 2017) presented zero-budget natural reformation with cow dung and urine. Biological control entails using beneficial organisms, their genes, and products such as metabolites to reduce the adverse effects of plant pathogens and promote positive responses by the plant. This is required to popularise "Jeevamrutha," a mixture of cow dung, cow urine, jaggery, pulse flour, soil, lime, and water that is prepared for free. Chemical formation, which includes pesticide spraying and fertiliser usage, is not only monetarily burdening farmers but also diminishing soil fertility, threatening people's health, and squandering water. Natural farming, which includes Zero-Bugget agriculture practices, is a better option than organic farming production from a genuineTrichoderma culture using solid-state fermentation as well as biofertiliser use in cotton, groundnuts, maise, and caster chillies are all used in Natural Trichodermabiofertilizers. Several farmers who have switched to organic farming are faring better than others who rely on fertilisers.

Applications in medicine

Grange (Grange, 1981) presented research on the "cow's urine mixture." The administration of samples (a traditional medicine for convulsions) intraperitoneally to fasting grey rabbits resulted in a considerable decrease in plasma glucose. A nasogastric injection of cow's urine Mixture had a comparable impact on plasma glucose. These data demonstrate that the combination has a considerable hypoglycemic effect whether administered parenterally, the latter being the preferred method of administration for this concoction. The nature of the hypoglycemic agents included in the combination is addressed.

Jain et al., (Jain et al., 2010) calculated the effectiveness of cow urine treatment on different cancer patients in India's Mandsaur District. This investigation aimed to assess the efficacy of cow urine treatment on various cancer patients from various states in India. From April 8 to April 15, 2007, 68 cancer patients responded to the poll. During the survey, 7.35% of the 68 patients withdrew from treatment, while the remaining 63 (92.64%) patients maintained their treatment. The other most common cancer was breast cancer (14.70%), followed by cervix and uterine cancer (5.88%), buccal cavity cancer and sinus (4.41%), lung cancer, lymphoma and bone cancer (2.94%), both throat and buccal (5.88%) and other cancer (8.82%), respectively. Cancer patients' symptoms (pain, inflammation, burning feeling, trouble swallowing, irritation, and so on) were classified as severe, moderate, or mild. An intensive analysis of cancer patients' data found that the degree of severe, moderate, and mild symptoms was 82.16%, 15.8%, and 1.58% on the first day, respectively, and 7.9%, 55.3%, and 36.34% on the eighth day. According to the findings, patients who had been getting cow urine treatment for at least 2-3 months benefitted the most. As a result, this conventional treatment may be pretty beneficial to cancer patients.

Suemitsu et al. (1965) did a gas chromatography examination of an oil obtained from cow's urine. The main components of the oil produced from cow's urine were identified as phenol and p-cresol.
Mohanvelet al.,(Mohanvel et al., 2017)redistilled cow urine distillate as an anticlastogen agent and cow urine distillate as a bioenhancer for antibacterial and antiproliferative activity. Authors reported that cow urine distillateis a bioenhancer, increasing antibacterial and antiproliferative action. Cow urine distillate exhibited vigorousanticlastogenicexercise towards clastogen. Thus, cow urine has been discovered to contain unique qualities that may be employed with other therapeutic substances to heal illnesses such as TB, leprosy, and cancer. More in vivo and clinical investigations are necessary to establish its therapeutic effectiveness.

Choudhary et al., 2017 (Choudhary et al., 2017) mentioned the indiscriminate use of agrochemicals since the revaluations have harmed soil fertility, crop production, produce quality, and, more precisely, the environmental system. Their present circumstance emphasises the need to adopt eco-friendly farming techniques for food production while keeping soil and environment sustainability in mind. Cow urine is a low-cost agricultural approach that has been utilised widely in traditional agriculture in India for medicinal and agricultural uses since the Vedic era. Cow urine is an excellent source of nitrogen,sulphur, phosphate, potassium, sodium, manganese, carbolic acid, iron, silicon, chlorine, salt, enzymes, and hormones. It's also a natural disinfectant and insect repellant, and it's the critical ingredient in Panchagavya, an organic crop booster created and sprayed by Indian farmers. As a byproduct of ecological sanitation, urine is well suited for fertiliser since it contains critical elements for plant development. Cow urine treatment has improved agricultural yield in various crops, including maise, mustard, and rice.

Safitri and colleagues(Safitri et al., 2019) presented a study to evaluate the quality of fermented cow urine from Ngabab village in Pujon, Kab. Malang. The nitrogen, phosphorus, potassium, and ammonia (as NH3) in fermented urine were measured using commercially available EM-4 and local microbes derived from organic waste. The fermentation was placed in six distinct ratios. They were as follows: (1) urine: EM-4 = 2:1; (2) urine: EM-4 = 4:1; (3) urine: EM-4: organic waste = 4:1:1; (4) urine: table sugar: organic waste = 4:1:1; (5) urine: EM-4 = 10:5:1; and (6) urine alone. The results indicated that composition 1 had the greatest N content, whereas ratio 1 had the highest phosphorus and

potassium values. Surprisingly, the maximum amount of organic carbon was attained in process 6 when urine was fermented without any additions. In summary, these findings revealed that cow urine fermentation may be one of the green approaches for producing ecologically damaging chemical fertilisers and insecticides. Furthermore, using indigenous microorganisms derived from organic waste might be regarded as an alternative to commercially supplied EM-4.

Shalaby and colleagues (Shalaby et al., 2018) conducted a field experiment to evaluate a novel approach as a complementary method to chemical control against Lepidopteran larvae of both Pink bollworms, Pectinophoragossypiella (Saunders) (Fam.Gelechiidae), and Spiny bollworms, Eariasinsulana (Boisduval) (Fam. Noctuidae). They usednatural items such as cow urine-dung extract and crude neem oil. Two different treatments of cow's urine-dung section were prepared in the following ways: (1:1) and (1:4) (cow's urine-dung extract: water) (v:v). In comparison, the other two treatments were prepared with the addition of 50 ml of neem oil to each to produce two treatments of (1:1:50) and (1:4:50) (cow's urine-dung extract: water: neem oil) (v:v:v). The foliar spray was used to apply all treatments to cotton plants. The foliar spraying of cow's urine-dung extract and its combinations with neem oil treatments were evaluated during two successive seasons, from (Mid-June) to (Late-July), and from (Early-Aug.) to (Late-Sept.). The pooled data for both seasons clearly showed that the density of bollworm complexes was significantly lower under all treatments of cow's urine-dung extract and their combination with neem oil than the control, and there were no significant differences between each treatment and others in each season and over the two consecutive periods. Neem oil did not affect the cow's urine-dung extract treatments (1: 1) or (1: 4) (cow's urine-dung extract: water). The findings showed that cow urine-dung extract treatments were more effective against bollworm complexes from mid-June to lateJuly than from earlyAugust to lateSeptember. The results showed that cow urine-dung extract could prevent boll-worm complexes on cotton plants from blooming to boll maturation at a level that may postpone using insecticides and minimise their usage. Current research shows that cow urine-dung extract may be safely and successfully implemented into an integrated pest control programme against the density of bollworm complexes on cotton plants.
Singh et al., (S. N. Singh et al., 2018)studied the effect of cow urine as a nitrogen source on rice growth, yield, and nitrogen absorption. Rice demand is increasing as the world's population continues to expand. Cow urine from the same cow was administered weekly for six weeks after transplantation. The study's findings demonstrated that rice crops reacted positively to varying quantities of nitrogen from fertiliser alone and in combination with cow urine. Nitrogen treatment substantially boosted plant growth (plant height, number of tillers) and yield (grain and straw) compared to the control. Applyingnitrogen at 120 kg/ha and cow urine produced the highest dry matter. Without cow urine, nitrogen treatment at 150 kg/ha yielded a larger yield than the control and 120 kg/ha levels. Nitrogen content and absorption in plants (grain and straw) were likewise found to be highest when nitrogen was given at 120 kg/ha.

Applications in power or electricity generation

Jhalani et al., (Jhalani et al., 2021)evaluated the feasibility of a newly manufactured cow-urine emulsified diesel fuel for CI engines. This research investigated a unique idea of cow-urine emulsification in diesel, in addition to different emission reduction tactics. Cow urine is emulsified to increase brake thermal efficiency. It also contained urea, which acted as a reducing agent and dramatically reduced NOx emissions. According to previous studies, cow urine's sodium, magnesium, calcium, and potassium are likely to improve fuel characteristics. A stationary C.I. engine evaluated emulsions containing 5%, 10%, 15%, and 20% (v/v) cow urine. The 15% emulsion was optimal, with a significant rise in BTE, reaching 24.8% against 21.9% with base diesel. NOx and smoke emissions decreased by up to 31.8% and 36.9%, respectively. CO emissions rose at lower loads but dropped at higher loads. There was no discernible difference in HC emissions. Overall, cow-urine emulsified diesel fuel proved an energy-efficient and cleaner alternative fuel for stationary C.I. engine applications.

Bisen et al., (Bisen et al., 2015) developed a system that generates electricity from cow urine. The authors built tenessential cells from plastic bottles, two electrodes (Zinc and copper), and cow urine as an electrolytic solution. Uric acid was present in cow urine. Copper reacted with Uric acid in the presence of water. When zinc and copper plates came into touch with uric acid, electrons began to travel to produce electricity. Each cell holding 150 mL of cow urine produced 0.87 V. Authors linked them in series to create a battery with an 8.6 V potential difference. The battery's current was determined to be 63 mA. The produced power (VxI) was 0.54 W. The battery was tested for 70 hours, both with and without load.

Hasan et al. (2014) presented a study on electricity generation from cow urine. Energy from cow urine may generate electricity via electrolytic conductions. Fresh cow urine's alkaline composition makes it an excellent electrolyte drink. The system functions similarly to a standard battery system.

On the other hand, a depleted battery must be recharged by electricity to be reactivated. On the other hand, cow urine-based systems must merely replace old urine with new urine to reactivate the system. Because no power was required to charge the device, fresh cow urine from a dairy farm might be a renewable energy source. To assess the practicality of the source, the authors created a car battery-sized prototype capable of holding around five litres of fresh cow urine as an electrolyte. The authors utilised the same number of electrodes as a conventional automobile battery. The authors monitored the source's outputs and tested its performance with loads.

Gidde et al., 2018 (Gidde et al., 2018)tested cow urine and microbial fuel cell (MFC) Based buck converter hybrid electricity generation. This study presented cow urine power, a novel hybrid renewable energy source. Powered Battery and microbial fuel cells have been constructed and suggested for sensor and LED display applications, as well as to compensate for demand at urban village locations to electrify communities that are in darkness using LED. In this hybrid source, we will employ cow urine and organic matter derived from mud, soil, and wastewater treatment facilities as a source of energy extraction. The concept incorporates genuine cow urine and inorganic or organic Bactria as electrolytes.

Biswal et al., 2017 (Biswal et al., 2017)generatedhydrogen from Cow Urine. The authors attempted dairy animal urine management and created a foundation for the future. In the current study, authors constructed ten simple cells made of plastic containers and two cathodes (Zinc and copper) that were immersed in dairy animals' urine to serve as an electrolytic arrangement.The urine of dairy cattle includes uric acid. Copper close to the water will react with Uric corrosive.When zinc and copper plates come into contact with uric caustic, electrons travel to generate electricity. The authors received the majority of our hydrogen from steam-converting gaseous petrol. Thus, it was just another form of petroleum derivative.

Kiran et al., (Kiran et al., 2023)tested cow urine blended with petrol evaluation to reduce emissions. The current investigation is to use cow urine to minimise fuel (petrol) pollution. Cow Urine contains elements such as sodium (Na), magnesium (Mg), calcium (Ca), and potassium (K) that are beneficial to fuel properties.This fuel can cut emissions by using these elements.

RESULTS AND DISCUSSIONS

This review states that cow urine and its distillate have widespread applications in agriculture, medicine, and electricity generation. Table 5 illustrates how cow urine and its distillate applicationsbeganinthe early twentieth century. According to Fig. 17, mostcow urine and its distillate is used in agriculture (51.7%). Then, it is often employed in the production of energy (28.6). And 14.3% of the scientists have utilised it for medicinal purposes. The journey of application of cow urine and its distillate began with the use of cow urine in the agricultural sector in 1922 and continues to this day. Several researchers have recently shown that, in addition to medicine and agriculture, cow urine may be used in energy generators and internal combustion engines for power generation. If this study is successful, the demand for cow urine will skyrocket, and every cow shed will become a fuel pumping station. Furthermore, if cow urine is effective in fuel cells, it will escort a revolution in electric and hybrid automobiles.

The qualities of cow urine are so beneficial that there will come a day when all of these planned advancements will exist.

Trend in applications of cow urine and its distillate

Table 5: The trend in applications of cow urine and its distillate

Sn	Year	Field of application	Specific area of application
1	1941	Agriculture	The use of cow urine as a fertiliser for bluegrass grasslands by farmers
2	1981	Agriculture	Studies were conducted in the laboratory on the cow's urine mixture.
3	1983	Agriculture	Cow urine's influence on the process of denitrification
4	2008	Medical	An investigation of the effectiveness of cow urine treatment on a variety of cancer patients in the “Mandsaur” District of India
5	2010	Agriculture	The distillation of cow urine as a bio-enhancer
6	2014	Agriculture	Cow urine is a possible source of struvite formation.
7	2014	Agriculture	Utilising gas chromatography to conduct an analysis of oil obtained from cow urine
8	2014	Agriculture	The effects of cow urine and the primary components that it contains on the qualities of pastures
9	2015	Agriculture	Evaluation of the effectiveness of cow urine as a growth enhancer and antifungal agent for plants
10	2017	Agriculture	The distillate of cow's urine has an antifungal impact on many types of Candida.
11	2017	Agriculture	Using cow urine in agriculture as a bio-pesticide and bio-fertiliser helps ensure the country's continued environmental sustainability.
12	2017	Medical	The use of cow dung and cow urine to achieve natural reformation

			with no budgetary constraints
13	2017	Medical	The use of cow urine distillate as a bio-enhancer for antibacterial and antiproliferative activity, as well as the use of redistilled cow urine distillate as an anti-inflammatory agent
14	2017	Agriculture	Urine from cows is a boon for environmentally responsible agriculture.
15	2018	Agriculture	Its potential as a liquid fertiliser through the fermentation of cow urine collected from Ngabab Village in Malang
16	2018	Agriculture	Spraying the cotton plant with a foliar spray containing cow's urine and dung extract as a complementary method of pest control against the Boll-Worm Complex
17	2018	Agriculture	An investigation of the impact of cow urine (gomutra) as a source of nitrogen on the growth, yield, and nitrogen uptake of rice (Oryzasativa l.)
18	2018	Agriculture	Its Potential as a Liquid Fertiliser Through the Fermentation of Cow Urine Collected from Ngabab Village in Malang
19	2021	Power generation	A novel cow-urine emulsified diesel fuel recently developed for CI engines is being evaluated for its effectiveness.
20	2015	Power generation	A technology that generates electricity from cow urine
21	2014	Power generation	Utilisation of cow urine in the Production of Electricity
22	2018	Power generation	The use of cow urine and a microbial fuel cell (MFC) based buck converter for the conversion of cow urine into electricity
23	2017	Power generation	The production of hydrogen from the urine of the cow
24	2023	Power generation	An investigation on the viability of combining cow urine with fuel to cut down on emissions

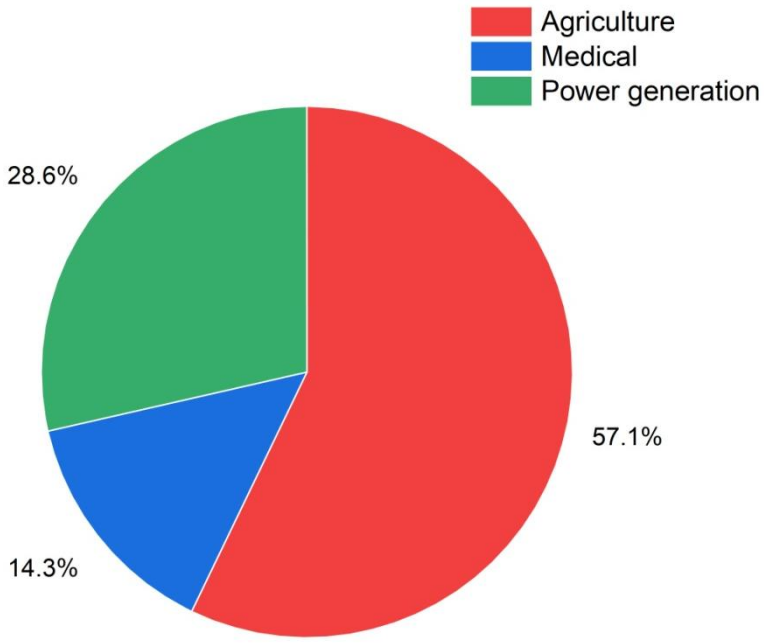


Fig. 17: Applications of cow urine and its distillate

To summarise, cow urine and its distillate are now being utilised for the following specific applications:

- Denitrification process in fertiliser
- Treatment for a wide range of cancer patients
- Bio-enhancer
- The origin of struvite production.
- Plant antifungal agent
- Bio-pesticide
- To produce electric power
- Fuel for fuel cell vehicles for the conversion of cow urine into electricity

CONCLUSIONS

The present work demonstrates a review of the contemporary use of cow urine and its distillate in agriculture, medicine, and electricity generation and makes the following observations:

- Many Indians revere cows for their strength, wealth, and motherliness. It represents fertility and giving as the earthly embodiment of the sacred and loving Mother Goddess. They claim their milk cleanses.
- India has the most cows globally. In 2019, there were 192.49 million cattle, up 0.8% from the previous census. Female cattle (cows) number 145.12 million, increasing 18.0% from the 2012 census.
- India has 43 indigenous cow breeds in various states. They live in usual conditions and vary in bodily structure.
- Cow urine, a dark brown, natural, non-toxic fluid, boosts human understanding, is a global medicine, and is easily edible.
- The number of Indian Desi cows is falling rapidly, threatening our food security, Agro-Economy, and freedom from foreign countries demanding A2 milk.
- Preserving Indian cow breeds requires more cow milk, urine, and dung usage. An Indian cow produces 2–3 litres of milk, 7–10 litres of cow urine, and 10 kilogrammes of manure daily. Urine is another main cow product after milk. Thus, cow urine may help rural farmers and cow sheds make money.
- Instead of selling cows to slaughter, those who earn a livelihood from them will keep them for life. This motivated study on cow urine and distillate uses.
- This review article highlights the many applications of cow urine and its distillate for rural residents, including agriculture, therapy, and energy generation.
- Agriculture uses 51.7% of cow urine and distillate. Energy production uses it (28.6). 14.3% of scientists use it medicinally.
- The following leading applications use cow urine and its distillate: Fertiliser denitrification, Cancer treatment Bio-enhancer, Struvite production origin, Plant antifungal agent, Bio-pesticide, Electric power production, Provides fuel for fuel cell cars that generate power from cow urine.

The present review work also methodically analyses peer-reviewed articles published in international journals indexed in the Scopus database. From this review, the following conclusions are drawn:

- Cow urine studies and uses began in 1935. Since so few people are participating in the cow urine application research, it's proceeding slowly.
- K. W. Steele is the most fascinating researcher in this area.
- India leads the world in ongoing research. Besides India, the US, Japan, and New Zealand are pioneering cow urine research.
- Prof. Jain, Jandalik, Randhawa, and Prabhu are the most bibliographically connected researchers.
- Professors Ledgard, Steele, and Aunders are among the most bibliographically related authors.
- Research articles often include keywords like urine, cow urine, cow, human, non-human, and article.

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