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From waste to wealth: Diverse preparation methods for *kunapa jala*– A review

Sreelakshmi P.R. [1*], Manojkumar N.[2]

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ABSTRACT: The escalating global demand for meat, livestock and poultry has resulted in substantial bio-waste generation, posing severe environmental concerns. Converting biomass into manure and compost offers a viable alternative for bio-waste management. Prepared from animal and plant waste, *kunapa jala* streamlines slaughterhouse waste disposal, reduces environmental pollution and promotes soil health.

Traditional and standardized methods of *kunapa jala* preparation were reviewed, highlighting regional variations and material availability. The fertilizer's composition, including beneficial microorganisms, plant hormones and essential nutrients, were analysed. Integrated approaches combining *kunapa jala* with *pancagavya* demonstrate synergistic effects on vegetable crop productivity.

Kunapajala's significance extends beyond agriculture, showcasing ancient India's emphasis on environmental sustainability and resource efficiency. By converting waste into a valuable resource, *kunapa jala* exemplifies circular economy principles in sustainable agriculture. This review underscores the relevance of ancient Indian knowledge in addressing modern environmental challenges, offering a holistic approach to eco-friendly agriculture and waste management.

Keywords: Kunapajala,Organic fertilizer, Waste management, Sustainable agriculture, Ancient Indian knowledge.

INTRODUCTION

The rising global population drives up demand for meat, livestock and poultry, resulting in massive production levels of 220 million tonnes annually. This production, primarily sourced from buffalo (31%), cattle (31%), poultry (11%), goat (10%), pig (10%) and sheep (5%), generates colossal amounts of bio-waste, posing severe environmental concerns that necessitate urgent and effective management solutions.[1] However, this waste also contains valuable resources that can replace commercially available products. To address this issue, effective waste management practices, technologies and policies that prioritize environmental protection and public health are crucial.[2]

Converting biomass into manure and compost offers a viable alternative for bio-waste management, with promising agricultural applications. Research has shown that organic waste, including crop residues and animal waste, is rich in essential nutrients (Nitrogen, Phosphorus, Potassium) and biostimulants (beneficial microbes, phytohormones, protein hydrolysates) that can be recycled back into agricultural ecosystems.[3]

Technologies that convert crop residues and animal waste into valuable agricultural inputs offer sustainable solutions for recycling biodegradable solid wastes.[4] These technologies promote waste recycling, alternative nutrient cycling and soil health, ultimately reducing dependence on synthetic fertilizers and pesticides in sustainable agriculture.

The significance of ancient Indian agricultural sciences, such as *Vrkshaayurveda*, is highlighted

1. *MD Scholar, *Corresponding author; Email: srilaxmipr@gmail.com*
2. *Professor & Head, Dept of Dravyaguna, Vaidyaratnam P.S Varier Ayurveda College, Kottakkal*

in this context. The Indian subcontinent has a venerable tradition of agricultural innovation, evidenced by ancient texts such as *Krshi-Paraasara* (400 BCE). This legacy includes the fermented liquid manures, utilizing diverse organic materials, including meat, which have left an indelible mark on world history. *Kunapajala,* a millennia-old preparation, being a notable example. *Kunapajala,* derived from Sanskrit, literally means "decaying corpse water" or "putrid liquid manure" reflects its organic composition.[5] Varaahamihira's *Brhat Samhita* (505-587 CE) shows *Vrkshaayurveda*'s early stages,[6] while Surapaala's 10th-century Sanskrit text provided the first comprehensive treatment of the subject.[7] The *Vrkshaayurveda* canon expanded with texts like *Visvavallabha* and *Upavanavinoda*, contributing to the evolution of Indian agricultural knowledge.[8,9]

Surapaala introduced fermented liquid manures - *kunapajala/ kunapaambu* from organic wastes, revolutionizing agriculture. His process involved cooking, storing and mixing animal waste with additives, creating a rapidly absorbed, nutrient-rich fertilizer. The fermented ingredients in *kunapajala* break down complex molecules into simple, easily absorbed nutrients, making them readily available to the plants.[10]

Kunapajala, used singly or in conjunction with *pancagavya*, proved beneficial in augmenting growth and yield attributes of vegetable crops.[11]Analysis of *kunapajala* revealed the presence of beneficial microorganisms, including Azotobacter, Azospirillum, Pseudomonas, Rhizobium and Phosphate-solubilizing bacteria (PSB), along with significant amounts of organic carbon, plant hormones like gibberellic acid (GA), and indole acetic acid (IAA).[12,13]

Kunapajala's preparation methods are extensively reviewed in this article, demonstrating the flexibility and effectiveness of this ancient Indian fermented liquid fertilizer in contemporary farming systems.

VARIOUS METHODS OF PREPARATION OF *KUNAPAJALA*

Kunapajala preparation methods vary depending on regional practices and availability of materials.

Traditional Methods

Definition and method of preparation of *Kunapajala*

1.Surapaala - A mixture of certain substances, including excreta, bone marrow, brain, flesh, blood and body parts, along with pig excreta, should be combined with water and stored underground for 15 days. This preparation is referred to as '*kunapajala'* or *kunapaambu*' and it is highly nutritious for plants.

The methodology employed in the preparation of *kunapajala* is described as follows. Procure animal fat and flesh from horses, parrots, fish, goats, sheep and other horned animals. Combine the ingredients and cook them in water over an open flame. Once the mixture reaches the desired consistency, transfer it to a ghee coated container. Then, mix it with adequate amount of paddy husk. Alternatively, transfer the mixture to an iron container and roast it. To potentiate the preparation, incorporate sesame oil cake (*Sesamum indicum* L.), honey, soaked black gram (*Vigna mungo* (L.) Hepper) and ghee and stored underground for 15 days.[7] While Surapaala outlines the ingredients, the exact ratios and quantities are left to the discretion of the practitioner.

2. Saarngadhara - Saarngadhara's "*Saarnga-dhara-paddhati*" (written around 300 years after Surapaala's work) mentions *kunapajala* in its "*Upavanavinoda*" chapter. The procedure is as follows.

Prepare *kunapajala,* by cooking the fat, marrow and meat of deer, pig, fish, goat, sheep and rhinoceros in plain water. Transfer the mixture to a vessel and add milk, powdered sesame seeds(*Sesamum indicum* L.), honey, cooked black gram (*Vigna mungo* (L.) Hepper) with

gravy, ghee and hot water. Allow the blend to mature in a warm place for 15 days, harnessing its nutrient-rich potential to promote robust plant growth and health. The original text did not provide specific amount of ingredients.[14]

3. Kaasyapa - According to Kaasyapa the preparation of *kunapajala* is by mixing one *prastha* (768 g) each of dried and powdered goat and sheep excreta, one *aadhaka*(3.072 kg) of sesame seeds(*Sesamum indicum* L.), and one *prastha* (768g) of *saktu* (powdered rice corn) with 100 *prastha* (76.8kg) of cow's meat in 1.5 *vaha*(73.7 L) water. Allow the mixture to steep for 7 days. This solution, when used as a fertilizer, promotes growth, abundant flowers and fruit production in trees, ensuring vibrant and thriving vegetation.[14]

4. Cakrapaani - Cakrapani's "*Visvavallabha*" (1577 AD) provides a *kunapajala* recipe akin to Saarngadhara's, differentiated only by the inclusion of animal skin[8]

Standardized protocols

1.Non herbal Kunapajala

Narayanan *et al.* (2006), developed a SOP for preparing Rat *kunapa*, commences with collecting a few pieces of dead rats from fields or houses. Place these in a vessel and mix with 5 kg of dung and 3 litres of urine from indigenous cow breeds, 500 g of sugar, 250 g of black gram (*Vigna mungo* (L.), and 250 g of sesame seeds (*Sesamum indicum* L.). Allow the mixture to undergo aerobic fermentation for at least 2 weeks. After fermentation, add 1 litre of cow's milk and 100 ml of honey to the mixture. Finally, sieve the mixture to obtain a liquid, known as Rat *Kunapa*.[15]

SOP developed by Ali *et al.* (2012) is delineated below. To prepare the formulation, combine 1 kg of animal-derived raw materials (waste/bones/fish meal), 1 kg of indigenous cow dung, 1 litre of urine from indigenous cow breeds and 2 litres of water in a suitable vessel. Mix the ingredients thoroughly by rotation. Then, allow the mixture to undergo aerobic fermentation for at least 25 days, stirring repeatedly during this period. After fermentation, sieve the resulting solution using a net or a clean cloth.[12]

The preparation of *kunapajala* adhered to the procedures outlined by Sarkar *et al.* (2014), comprised 10 kg of Bombay duck fish (*Harpadonne hereus*), selected for its cost-effectiveness and decomposition properties, combined with 4 kg sesame seeds oil cake (*Sesamum indicum* L.), 4 kg rice husk (*Oryza sativa* L.), 4 kg molasses and 30 litres fresh cow's urine. Following 60 days aerobic fermentation in shaded conditions, the mixture was then filtered and stored.[11]

Another SOP developed by Jani *et al.* (2017) is delineated as - A 3 kg mixture of fish and mutton was boiled in 12 litres of water to extract 6 litres of meat juice, which was then cooled and divided into three equal batches. The batches were then added to three 5-litre porcelain jars that had been fumigated with dried *guggulu* (*Commiphora wightii* (Arn.) Bhandari), *marica* (*Piper nigrum* L.) and *jataamaansi* (*Nardostachys jatamansi* (D.Don) DC.). Each jar was added with 2 litres of meat juice, 2 litres of milk, 833 grams of honey, and 167 grams each of *tila*(*Sesamum indicum* L.) and *maasha* (*Vigna mungo* (L.) Hepper). The jars were sealed with mud-smeared cloth for 15days anaerobic fermentation. After fermentation, the jars were opened, and the liquid was filtered, stored in air tight glass bottles, allowed to settle, and then decanted through cotton cloth to remove solid contents. The *kunapajala* preparation resulted in a 36.4% yield, producing 5.46 litres. The physicochemical parameters showed a 4% v/v alcohol content and pH 3.5, indicating stability and preservation. Furthermore, the analysis revealed vital micronutrients, including Sulphur-123.61%, Iron-44.53 ppm and Zinc-15.24 ppm, which promote plant growth and physiological functions.

Overall, the preparation demonstrates potential benefits for plant development.[16]

Standard Operating Procedure (SOP) developed by Kavya *et al.* (2023) is detailed as follows. To prepare non-herbal, *kunapajala*,a mixture of 2 kg fish (*Sardinella longiceps*), 1 kg bone meal, 1 kg rice husk(*Oryza sativa* L.), 1 kg coconut oil cake (*Cocos nucifera* L.) and 500 g sprouted black gram (*Vigna mungo* (L.) Hepper)was boiled in 10 litres of water until it became viscous and semi-solid. This mixture was then transferred to a plastic barrel and combined with 10 kg cow dung, 10 litres cow's urine, 250 g honey, 250 g ghee, 2 kg jaggery, 1 litre milk, and 75 litres water. The barrel was then sealed and stored in a warm location for 15 days, with regular stirring in both clockwise and anticlockwise directions. After fermentation, the contents were filtered to yield non-herbal *kunapajala,* a nutrient-rich liquid fertilizer containing 1.28% Nitrogen, 0.11% Phosphorus, 0.44% Potassium, 340 mg/L Calcium, 324 mg/L Magnesium,and 1.80% Sulphur.[17]

2. Herbal *kunapajala*

Herbal *kunapajala* is a plant-based, organic fertilizer derived from accessible leafy materials, widely adopted by farmers for sustainable farming practices.

According to Naik *et al.* (2022), three herbal *kunapajala* variants were developed, including formulations based on nettle plants (*Urtica dioica* L.), weeds and a combination of both.[18]

To prepare nettle plant based *kunapajala,* combine 20 kg of indigenous cow dung, 20 litres of cow's urine, 2 kg of sprouted black gram (*Vigna mungo* (L.) Hepper), 2 kg of mustard oil cake (*Brassica juncea* (L.) Czern.), 2 kg of crushed jaggery, and 20 litres of water in a 200-litre plastic container. Add freshly chopped nettle plants 20 kg, boiled - filtered paddy husk (*Oryza sativa* L.), mixed with one litre of indigenous cow's milk and one litre of buttermilk. Stir the mixture systematically with a wooden stick, fill to the brim, and seal. Ferment for 20-25 days, stirring twice daily, until bubbles disappear, indicating completion. Finally, sieve the mixture and store in an appropriate location.

3. Weed based kunapajala

Weed-based *kunapajala* is made by the following method- Combine 20 kg of indigenous cow dung, 20 litres of cow's urine, 2 kg of sprouted black gram (*Vigna mungo* (L.) Hepper), 2 kg of mustard oil cake (*Brassica juncea* (L.) Czern.), 2 kg of crushed jaggery and 20 litres of water. Add 2 kg each of leaves of neem (*Azadirachta indica* A.Juss.), wild jasmine (*Jasminum angustifolium* (L.) Willd.), *beal* (*Aegle marmelos* (L.) Corrêa), *datura* (*Datura metel* L.), lantana (*Lantana camara* L.), mango (*Mangifera indica* L.), guava (*Psidium guajava* L.), calotropis (*Calotropis procera* (Aiton) W.T.Aiton), castor (*Ricinus communis* L.), and Billy Goat Weed (*Ageratum conyzoides* L.) .Also, include boiled and filtered paddy husk (*Oryza sativa* L.), one litre of indigenous cow's milk and 1 litre of buttermilk. Mix thoroughly with a wooden stick, seal in a 200-litre container and ferment for 20-25 days, stirring twice daily. The fermentation process is complete when bubbles cease to appear. Finally, sieve the mixture to obtain the weed-based *kunapajala* liquid.

Combine nettle plants and weeds in equal quantity to prepare the integrated herbal *kunapajala,* following the same preparation and methodology as before.

The SOP, as outlined by Kavya *et al.* (2023) for making herbal *kunapajala,* incorporates leaves from a targeted selection of ten plants; *Justicia adhatoda* L., *Vitex negundo* L., *Azadirachta* A.Juss., *Ocimum tenuiflorum* L., *Clerodendrum infortunatum* L., *Chromolaena odorata* (L.) R.M.King&H.Rob., *Cassia fistula* L., *Gliricidia maculata* (Kunth)Steud., *Mimusops elengi* L. and *Pongamia pinnata* (L.) Pierre. To prepare th *kunapajala,* 2 kg of each plant's leaves were chopped and mixed with 10 kg of cow dung, 2 kg

of sprouted black gram (*Vigna mungo* (L.), 2 kg of jaggery, and 15 litres of cow's urine, all dissolved in 80 litres of water. The mixture should stir thoroughly with a bamboo pole twice daily for 3 minutes in both directions over 15 days. After fermentation, the liquid filtered to yield *kunapajala,* which contains 1.09% Nitrogen, 0.10% Phosphorus, 0.33% Potassium, 340 mg/L Calcium, 240 mg/L Magnesium and 1.40% Sulphur.[17]

4. Keralagro kunapajala(Jeevani)

Keralagro's *kunapajala*– 'Jeevani' is a revolutionary liquid plant growth promoter developed at the State Seed Farm, Aluva. By harnessing the power of cow dung, urine, honey, nutrient-rich black gram powder (*Vigna mungo* (L.) Hepper), egg, bone meal, rice husk (*Oryza sativa* L.) and coconut oil cake (*Cocos nucifera* L.), this unique blend promotes robust plant development. This commercialization has made it easily accessible to farmers, enabling them to adopt eco-friendly practices and boost productivity.

5. Integrated approaches

Combining *kunapajala* with p*anca-gavya*: blend *Kunapajala* with *Panca-gavya* for synergistic effects;

Sarkar *et al.*'s (2014) research revealed that *pancagavya* (an ancient Indian organic solution, containing five cow derived products - dung, urine, milk, curd and ghee) and *kunapajala,* individually and collectively, boost vegetable crop productivity. The combined application of *pancagavya* and *kunapajala* yielded remarkable results, maximizing nitrogen utilization, enhancing photosynthesis and increasing yields.[11]

DISCUSSION

The traditional methods of *kunapajala* preparation, as outlined in ancient texts such as Surapaala, Saarngadhara and Kaasyapa, reveal significant variations in ingredients and ratios. These differences reflect regional influences and cultural practices, highlighting the adaptability and diversity of *kunapajala* preparation. Furthermore, the evolution of recipes over time demonstrates the ongoing refinement and innovation in *kunapajala* preparation, incorporating new ingredients and techniques.

In recent years, efforts have been made to standardize *kunapajala* preparation methods, resulting in both non-herbal and herbal protocols. Notably, the non-herbal method developed by Kavya *et al.* (2023) and Jani *et al.* (2017) provides a detailed and replicable process. In contrast, herbal *kunapajala* preparation offers a plant-based alternative, utilizing accessible leafy materials. The commercialization of *kunapajala,* exemplified by Keralagro's Jeevani, has made this organic fertilizer more accessible to farmers, promoting eco-friendly practices and boosting productivity.

Combining *kunapajala* with other organic solutions, such as *pancagavya*, has been shown to yield synergistic effects, maximizing nitrogen utilization, enhancing photosynthesis and increasing crop yields.

From the ayurvedic perspective, *kunapajala*'s ingredients predominantly exhibit *madhura- rasa*, *guru-guna*, *madhura-vipaaka*, and *brmhana* (nourishing), *balya* (strengthening) and *jeevaneeya* (vitalizing) properties, associating it with *prthvi* and *jala mahaa-bhoota*. The fermentation process, akin to *ayurveda aasava-arishta* preparation, transforms heavy ingredients into light, leveraging *vaayu* and *agni mahaabhoota*. This enhancement fosters rapid spread, deep penetration and swift action, characterized by *vyavaayi*, *teekshna*, *sookshma* and *aashukaari* properties.[19]

Nutrient analysis reveals that *kunapajala* preparations contain significant amounts of Nitrogen, Phosphorus, Potassium, Calcium, Magnesium and Sulphur, making them valuable organic fertilizers. The eco-friendly aspects of *kunapajala,* including reduced chemical usage and waste management, contribute to its sustainability. Moreover, research has demonstrated the positive impact of *kunapajala*

on crop yields, quality and overall agricultural productivity.

CONCLUSION

The use of animal waste as fertilizer has been practised across cultures, with variations in methods and materials. *Kunapajala,* a versatile organic fertilizer, represents an early example of converting waste into a valuable resource, showcasing ancient India's emphasis on environmental sustainability and resource efficiency. Prepared through various traditional and standardized methods utilizing animal and plant waste, *kunapajala* streamlines slaughterhouse waste disposal, reduces environmental pollution and promotes soil health. By converting waste into a valuable resource, *kunapajala* demonstrates the potential of circular economy approaches in sustainable agriculture, underscoring the significance of ancient Indian knowledge in addressing modern environmental challenges. To further develop *kunapajala,* research should focus on optimizing ingredient ratios, exploring new ingredients and investigating its effects on different crop types. Standardization and regulation are crucial to ensure quality in *kunapajala* production. To promote mainstream adoption, education, training and policy support are necessary. As the world shifts towards more sustainable and environmentally conscious practices, *kunapajala* is poised to play a vital role in shaping the future of agriculture.

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