The Pharma Innovation Journal 2023; 12(3): 5203-5208

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(3): 5203-5208

www.thepharmajournal.com
Received: 12-12-2022
Accepted: 16-01-2023

Madhu Vershit CH
M.Sc. Scholar, Department of Agronomy, Lovely Professional University, Phagwara, Punjab, India

Amandeep Kaur
Assistant Professor, Department of Agronomy, Lovely Professional University, Phagwara, Punjab, India

Lomada Vasudha
M.Sc. Scholar, Department of Agronomy, Lovely Professional University, Phagwara, Punjab, India

Corresponding Author:
Madhu Vershit CH
M.Sc. Scholar, Department of Agronomy, Lovely Professional University, Phagwara, Punjab, India

Exploitation of rice husk and ash: A review

Madhu Vershit CH, Amandeep Kaur and Lomada Vasudha

Abstract
Research on agricultural waste management is a natural resource material and beneficial in many technical fields. Easy access and implementation, as well as affordability and environmental friendliness, are all advantages. Humans have long been concerned about making the best use of agricultural wastes, and using them for various uses is a cost-effective method of environmental management [Mohammed Abdullahi *et al.,* 2019]. Some bio-waste ashes, such as rice husk ash, have a high quantity of silica due to their high silica concentration. When compared to typical mechanical methods, these materials have a substantially shorter reaction time and a higher utilisation rate, which has piqued researchers' curiosity. The experimental studies of biomass waste ash as a pozzolanic additive for engineering applications are reviewed in this work. Biomass debris has become progressively crucial as a "green" fuel, allowing waste disposal to have a smaller environmental impact while also reducing the usage of expensive fossil fuels and the production of greenhouse gases. In light of the foregoing, the current work reviews experimental research on harvest residues ash (HRA) as a cementitious material additive for engineering applications [Slobodan Supic *et al*., 2021]. This paper starts with some background information, such as agricultural waste ash preparation procedures and composition, and then goes over the several physical and chemical processing methods. Finally, the article looks at how rice husk ash could be used in a variety of businesses.

Keywords: Rice husk ash (RHA), agricultural waste, parboiled rice husk (PBH)

Introduction
Rice is grown for more than half of the worldwide people. In 17 Asian and Pacific nations, 9 North and South American countries, and 8 African countries, it is the predominant source of dietary energy. Rice hulls are the coats of seeds, or grains, of rice [Ayyappan Palaniappan *et al*., 2017] [30]. The husk protects the seed during the growth season by containing hard components such as opaline silica and lignin. The hull is difficult to eat or swallow due to its high fiber content, and it is mostly indigestible to humans. During times of food scarcity in ancient China, however, a pastry prepared from rice husks, wild veggies, and soybean powder was a typical daily meal. Winnowing is the process of separating the rice from the hulls by placing the whole rice in a pan and throwing it into the air while the wind blows. The light hulls are blown away, leaving the heavier rice in the pan. To remove the hulls, pestles and a basic machine called a rice pounder were invented later. Brazil invented the current rice hulling machine in 1885 (Adeolu A. Awoyale *et al*., 2019) [31]. The hulls are removed from the raw grain during the milling process, revealing complete brown rice, which is then milled further to remove the bran layer, yielding white rice. The biomass of rice husks is composed of three polymers: cellulose, hemicelluloses, and lignin (Anwar Ma'ruf *et al*., 2017) [32].
Rice husk, like other lignocellulosic biomass feedstocks, has been investigated as a low-cost bio-ethanol feedstock. As a waste product from the agriculture sector and forest leftovers, it is essentially free. The use of these wastes could solve the problem of trash disposal while also lowering the cost of waste treatment. Rice husk ash is produced when rice husks are burnt. We will explore the various applications of rice husk and rice husk ash in this review. PBH (parboiled rice husks) is used as a substrate or material for gardening, particularly hydrocultures. Rice hulls have been proven to have no effect on plant growth regulation.

Characteristics of rice husk
Rice husk makes up around 20% of the weight of rice and is made up of the following ingredients: cellulose (50%), lignin (25–30%), silica (15–20%), and moisture (10–15%). The bulk density of rice husk is modest, ranging from 90 to 150 kg/m3 [Hans Henrik Stein *et al*., 2015] [18]. It is the hard outer protective shell that surrounds the paddy grain and makes up 20–25 percent of its weight. During rice milling, it is eliminated.

Approximately 20% of the weight of rice is obtained as husk during milling.

Husked Rice

Rice Husk Ash

Carbonized Rice Husk

Importance of Rice Husk

Rice husk is used for a variety of purposes depending on its physical and chemical qualities, such as ash content and silica concentration (Hanan Ahmed *et al*., 2012) [33]. Rice husk is utilised directly as a good fuel in power plants. It's also utilised as a starting material for the production of silica and silicon compounds. Rice husks are used in a variety of businesses and residential facilities are:

a). Used as toothpaste

In Kerala, India, charcoal from Rice husks were universally used for over centuries in cleaning teeth, before toothpaste replaced it.

b). Utilizing as rice bran oil

Rice bran oil is made from the rice's hard outer brown coating, known as chaff (rice husk). In the Indian subcontinent and East Asian nations, such as India, Nepal, Bangladesh, Indonesia, Japan, Southern China, and Malaysia, it is widely used as a cooking oil.

c). Preparation of Brewing

Rice hulls can be added to boost a mash's lautering ability while brewing beer. Rice husk is also utilized in one phase of the traditional Kaoliang (Sorghum) liquid production method. Rice husk can be added to the wine tank after fermentation to raise the void, which is beneficial for distillation.

d). Rusk husk as Fertilizer and substrate

Although due to their high lignin concentration, the rice hulls are composted but the process might be sluggish. Earthworms are sometimes used to speed up the process. In around four months, hulls may be turned to fertilizer using vermicomposting procedures.

Parboiled rice husks (PBH) are used as a platform or material for gardening, particularly hydrocultures. The hulls deteriorate with time. Rice hulls drain faster and contain less water than growstones. Plant growth regulation has been shown to be unaffected by rice hulls.

e). Used as Fireworks

As the main explosive charge, the fine-grained gunpowder is coated to Rice hulls and used as aerial fireworks shells.

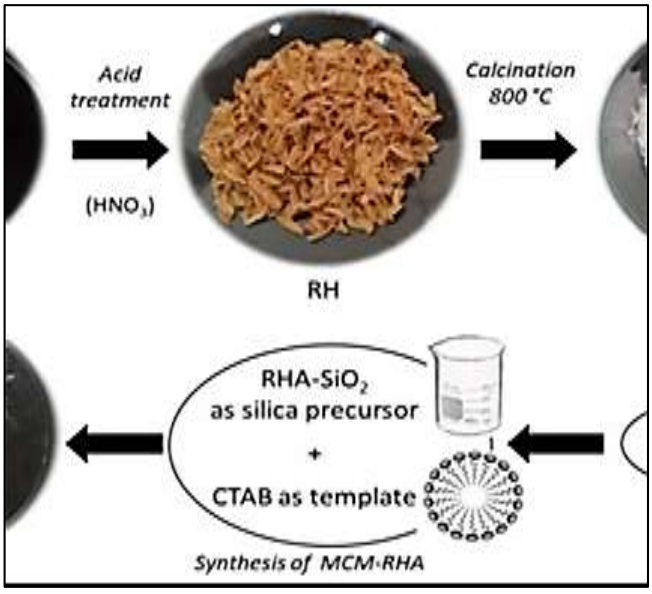
f). Preparation of Fuel

If done correctly, Rice hulls may be burnt and utilized to power steam engines. This is how certain rice mills used to dispose of hulls. The direct burning of rice hulls, unfortunately, creates a lot of smoke. Gasification is an option. In top-lit updraft gasifiers, rice hulls are easily gasified. Rice husk gas generates a blue flame when burned, and rice hull biochar is a useful soil addition.

Traditional brickmaking in are using rice hulls as fuel.

g). Used as Juice extraction

Rice hulls are used as a "press aid" to increase apple pressing extraction efficiency.



h). Pet food fiber

Rice hulls are a low-cost byproduct of human food processing that serve as a source of fiber and are used as a filler in pet meals.

i). Used in Pillow stuffing

The pillows are lightly packed and are said to be therapeutic since they keep the head's form.

j). Used as Insulating material

Because rice hulls are harder to burn and less likely to enable moisture to grow mold or fungus, they are a class A thermal insulating material. It may also be used as a roofing material after being mixed with dirt and water.

k). Used as Particle boards and cardboard

Particle boards and cardboard are also made from rice hulls. Rice husk contains silica, which makes particle boards less appealing to termites.

Applications of RHA

The physical and chemical features of the husk, like as ash content and silica content, determine the suitability of RH for various purposes. Rice husk has been used directly as a fuel in power plants. RH is used as a source raw material for the synthesis and development of novel phases and compounds.

in addition to being used as a fuel. The following is a thorough description of how rice husk is used in industrial and other domains.

As a fuel in power plant: Rice husk is mostly used as fuel in boilers for processing paddy and generation of process steam. Heat energy is produced through direct combustion. Fixed low-capacity boilers are used in small-scale process businesses, and they are manually fired with rice husk as a fuel. Smoke is produced as a result of partial and uneven fuel burning, which reduces fuel efficiency. Because husks are practically free, the efficiency of the boiler and the degree of combustion have been the focus of recent research. Plants with capacity 2-10 MW range can become 9 commercially viable and this biomass resource can be utilized to a much greater extent than at present (Ahmed Mohammed Hassanain *et al*., 2012) [33] It has been determined that 1 tonne of rice husk is required to create 1MWh. As a result, technical and economic criteria determine whether rice husk may be used as a fuel for power generation. Rice husk has also been utilized as a beneficial and renewable source of energy in the home.

Use in ceramic and refractory industry: Rice husk ash is used in the manufacture of refractory bricks because of its insulating properties. Low-cost, lightweight insulating boards have been made with it. RHA has been utilized as a source of silica in the manufacturing of cordierite (S. Kurama *et al*., 2016) [15]. Higher cordierites with a lower crystallize temperature and lower activation energy of crystallization result from replacing kaolinite with rice husk silica in the combination composition.

Insulating fire brick using RH: Using RH to insulate fire brick Due to the burning out of organic material, bricks constructed from rice husk develop a lot of pores during heat treatment.
The higher the amount of rice husk in a brick, the more porous and thermally insulating it is. Pores with entrapped air provide thermal insulating properties, making the porous fire brick construction excellent for backup insulation (E. I. Akpan *et al*., 2014) [34]

RHA in steel industry: RHA is used during the production of high quality flat steel. Ash may also be used as a good insulator because of its outstanding insulating qualities, which include low heat conductivity, a high melting point, low bulk density, and high porosity. It's used as "tundish powder" to keep the tundish container warm, prevent steel from cooling too quickly, and maintain consistent solidification throughout the casting process (Fernanda Andreola *et al*., 2018) [1]. RHA is also utilized as a layer over molten metal in the tundish and ladle, acting as an excellent insulator and preventing the metal from cooling quickly.

Use of RHA as silica source: Due to presence of large silica content in ash, extraction of silica is economical. Silica is also precipitated in a variety of forms to fulfill the needs of diverse applications. Silica is used in the rubber business as a strengthening ingredient, in cosmetics, as a cleaning agent in toothpastes, and in the food industry as an anti-caking agent. Fine amorphous silica is in great demand for high-performance cement and concrete, as well as for usage in bridges and maritime settings.

RHA in cement and construction industries: A novel concept, mixed cement, has partially met the growing need for stronger and more durable building materials. The use of reactive rice husk ash in cement is now nearly universally recommended in international construction regulations **(**Kaffayatullah Khan *et al*., 2020) [10].
The use of RHA as a mineral addition to improve the performance of concrete has been the subject of much investigation.
According to reports, RHA is a highly reactive pozzolana. RHA is mostly utilized as a silica fume substitute or as an additive in the production of low-cost concrete.

Other uses: RH is used as a raw material for production of xylitol, furfural, ethanol, acetic acid, lingo sulphonic acids. It's utilized as a polishing or refining reagent in the metal and machine industries, as well as in the construction industry. RH has been utilized as a raw material in industry. as an insulating board material, fillers in plastics, filling material, building materials, for making panel board, activated carbon etc. Composite goods based on two surface structures of rice husk have received little attention (Qingfa Zhang *et al*., 2018) [27]. Considering so many well-established applications, only a small amount of rice husk produced is actually used; the rest is burned in open mounds or discarded as solid waste. Rice husk ash has a wide range of industrial uses, which are listed below.

Rice husk Ash classification and chemical composition
The chemical composition of rice husk ash is similar to that of many natural fibers. Rice husk ash is composed of the following:

- Cellulose ($C_5H_{10}O_5$)
- Lignin ($C_7H_{10}O_3$)
- Hemicellulose
- SiO_2
- Holocellulose

These are compounds within them in common. The rice husk ash composition varies based on the source and treatment method. The rice husk is treated in the sense that it is burnt to get the desired qualities (L Xiong *et al*., 2009) [24]. As a result, the manner of heating might alter the ash's overall chemical makeup.
One of the key components of rice husk ash is silicates. During the burning process, all of the components that may evaporate are removed, leaving just the silicates. To be more specific, rice husk ash has properties dependent on the components, burning temperature, and burning period. The component that provides rice husk ash its pozzolanic reactivity capability is silicates (Kusbiantoro *et al*., 2012) [11]. In order to do this, the silica must stay non-crystalline. Within their microstructure, they should develop a very porous structure. As a result, it's evident that properly burning rice husk to produce rice husk ash will eliminate the cellulose and rice husk components while retaining the rice husk particles' natural cellular structure (Tiankui Yang *et al*., 2019) [29].

Conclusion
The use of rice husk could solve the problem of garbage disposal while also lowering the cost of waste treatment. Rice husk and ash are directly used in the production and synthesis of new materials (Kumar S *et al*., 2010) [12]. It's utilized as a

fuel, fertilizer, and substrate, and it's also used to make activated carbon, pet food fiber, silica and silicon compounds, and bricks. Among other things, steel, cement, and construction industries used as rice husk ash. Rice husk is used as an adsorbent to remove heavy metals from wastewater (I Nhapi *et al*., 2011) [13]. Rice husk is readily available and inexpensive in rice producing countries, which is an added bonus to its use. As a result, rice husk's abundance and renewability provide a significant advantage over diminishing fossil fuel sources for bioethanol production. Future critical study efforts can realise multiple benefits of rice husk and rice husk ash, providing new momentum for local and regional sustainable development.

References

1. Andreola F, Lancellotti I, Manfredini T, Bondioli F, Barbieri L. Rice husk ash (RHA) recycling in brick manufacture: effects on physical and microstructural properties. Waste and Biomass Valorization. 2018;39(5):5427-5435
2. Basha EA, Hashim R, Mahmud HB, Muntohar AS. Stabilization of residual soil with rice husk ash and cement. Construction and building materials. 2018;19(6):448-453.
3. Chan KY, Van Zwieten L, Meszaros I, Downie A, Joseph S. Agronomic values of greenwaste biochar as a soil amendment. Soil Research. 2007;45(8):629-634.
4. Chiang KY, Chou PH, Hua CR, Chien KL, Cheeseman C. Lightweight bricks manufactured from water treatment sludge and rice husks. Journal of hazardous materials. 2009;171(3):76-82.
5. Chuah TG, Jumasiah A, Katayon S, Choong TSY. Rice husk as a potentially low-cost biosorbent for heavy metal and dye removal: An overview. Desalination. 2005;175(3):305-316.
6. Della VP, Kuhn I, Hotza D. Rice husk ash as an alternate source for active silica production. Mater Lett. 2002;57(4):818-821.
7. Giddel MR, Jivan AP. Waste to wealth, potential of rice husk in India a literature review. In International conference on cleaner technologies and environmental Management PEC, Pondicherry, India. 2007;2(1):4-6.
8. Hossain SS, Mathur L, Majhi MR, Roy PK. Manufacturing of green building brick: Recycling of waste for construction purpose. Journal of Material Cycles and Waste Management. 2019;21(5):281-292.
9. Ke S, Wang Y, Pan Z. Recycling of polished tile waste as a main raw material in porcelain tiles. J Clean Prod. 2016;49(4):238-244.
10. Khan K, Ullah MF, Shahzada K, Amin MN, Bibi T, Wahab N, *et al*. Effective use of micro-silica extracted from rice husk ash for the production of high-performance and sustainable cement mortar. Construction and Building Materials. 2020;25(8):119-589.
11. Kusbiantoro A, Nuruddin MF, Shafiq N, Qazi SA. The effect of microwave incinerated rice husk ash on the compressive and bond strength of fly ash based geopolymer concrete. Construction and Building Materials. 2012;36(2):695-703.
12. Nayak JP, Kumar S, Bera J. Sol–gel synthesis of bioglass-ceramics using rice husk ash as a source for silica and its characterization. J Non Cryst Solids. 2010;35(6):1447-1451.
13. Nhapi I, Banadda N, Murenzi R, Sekomo CB, Wali UG. Removal of heavy metals from industrial wastewater using rice husks. The Open Environmental Engineering Journal. 2011;4(1):170-180.
14. Rabah AB, Oyeleke SB, Manga SB, Hassan LG. Microbial pretreatment of rice husk and groundnut shell for bioethanol production. IRJM. 2011; 2(8):253-258.
15. Kurama S, Sembiring S, Simanjuntak W, Situmeang R. Preparation of refractory cordierite using amorphous rice husk silica for thermal insulation purposes. Ceramics Int. 2016;42(1):8431-8437.
16. Serra MF, Conconi MS, Gauna MR, Suarez G, Aglietti EF, Rendtorff NM. Mullite (3Al2O3· 2SiO2) ceramics obtained by reaction sintering of rice husk ash and alumina, phase evolution, sintering and microstructure. Journal of Asian ceramic societies. 2016;4(1):61-67.
17. Sintharm P, Phisalaphong M. Green natural rubber composites reinforced with black/white rice husk ashes: effects of reinforcing agent on film's mechanical and dielectric properties. Polymers. 2021;13(6):882.
18. Sm N, Hh E-M, Sabed M. Highly porous scaffolds made of nanosized hydroxyapatite powder synthesized from eggshell. J Ceram Sci Technol. 2015;23(6):237-244.
19. Soltani N, Bahrami A, Pech-Canul MI, González LA. Review on the physicochemical treatments of rice husk for production of advanced materials. Chemical engineering journal. 2015;264(1):899-935.
20. Srinivas KR, Naidu SV. A review on removal of heavy metal ions from waste water by rice husk as an adsorbent. Journal of Chemical, Biological and Physical Sciences. 2013;3(2):602-606.
21. Torres LF, McCaffrey Z, Washington W, Williams TG, Wood DF, Orts WJ, *et al*. Torrefied agro-industrial residue as filler in natural rubber compounds. Journal of Applied Polymer Science. 2021;138(28):50684.
22. Ugheoke BI, Onche EO, Namessan ON. Property optimization of kaolin-rice husk insulating fire-bricks. Leonardo Electron J Pract Technol. 2006;5(2):167–178.
23. Vakalova TV, Pogrebenkov VM, Karionova NP. Solid-phase synthesis of wollastonite in natural and technogenic siliceous stock mixtures with varying levels of calcium carbonate component. Ceramics Int. 2016;42(1):16453-16462.
24. Xiong L, Sekiya EH, Sujaridworakun P, Wada S, Saito K. Burning temperature dependence of rice husk ashes in structure and property. Journal of Metals, Materials and Minerals, 2009, 19(2).
25. Yang B, Wyman CE. Pretreatment: The key to unlocking low-cost cellulosic ethanol. Biofpr. 2008;2(1):26-40.
26. Yank A, Ngadi M, Kok R. Physical properties of rice husk and bran briquettes under low pressure densification for rural applications. Biomass Bioenergy. 2016;84(1):22–30.
27. Zhang Q, Yi W. Li Z, Wang L, Cai H.. Mechanical properties of rice husk biochar reinforced high density polyethylene composites. Polymers. 2018;10(3):286.
28. Zhu M, Ji R, Li Z. Preparation of glass ceramic foams for thermal insulation applications from coal fly ash and waste glass. Constr Build Mater. 2016;112(6):398-405.
29. Zou Y, Yang T. Rice husk, rice husk ash and their applications. In Rice bran and rice bran oil. 2019;9(1):207-246.
30. Palaniappan A, Yuvaraj SS, Sonaimuthu S, Antony U.

Characterization of xylan from rice bran and finger millet seed coat for functional food applications. Journal of Cereal Science. 2017 May 1;75:296-305.
31. Awoyale AA, Lokhat D. Harnessing the potential of bio-ethanol production from lignocellulosic biomass in Nigeria–a review. Biofuels, Bioproducts and Biorefining. 2019 Jan;13(1):192-207.
32. Ma'Ruf A, Pramudono B, Aryanti N. Optimization of lignin extraction from rice husk by alkaline hydrogen peroxide using response surface methodology. Rasayan J. Chem. 2017 Apr 1;10(2):407-414.
33. Abdel Aziz MT, El-Asmar MF, El-Ibrashy IN, Rezq AM, Al-Malki AL, Ahmed HH, *et al* Effect of novel water soluble curcumin derivative on experimental type-1 diabetes mellitus (short term study). Diabetology & metabolic syndrome. 2012 Dec;4:1-0.
34. Adeosun SO, Usman MA, Akpan EI, Dibie WI. Characterization of LDPE reinforced with calcium carbonate—fly ash hybrid filler. Journal of Minerals and Materials Characterization and Engineering. 2014 Jun 13;2014.