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A feasibility and viability analysis of Biomass combustion products with implied impact on health as well as environment

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ABSTRACT

One of the major sources of energy in developing countries is the bioenergy that comes from Biomass Fuels. Biomass fuels contribute to (1/4) one fourth of the energy consumed in India. These, usually originate from organic materials which make them a sustainable renewable source of energy which can be used in variety of ways, be it production of heat or electricity. Biomass fuels, which are supposed to be environment friendly, come into question as they are not being exploited in a way that their use remains eco-friendly. Use of unprocessed biomass fuels has turned out to be more negative than positive in the recent years which make them a subject of critique as to how viable they actually are in practice. Improper combustion of biomass fuels results in the emission of a complex mixture of air pollutants in the form of trace gases like CO, CH_4, CH_3Cl, NO, HCN, CH_3CN, aerosols and particles (PM) in the air which in turn degrade the quality of both indoor air and outdoor air. Expert data suggest that in developing countries health impact of indoor air pollution is more significant than outdoor pollution. 6% of the death in the developing countries are attributed to indoor pollution. Most of the indoor air pollutants originate from burning of biomass are potentially toxic which makes them a subject of study with respect to their impact on human health and environment..

Keywords: Biomass fuels (BMF), Emission Factor (EF), Fossil Fuels, Green House Gases (GHG), Indoor Air Pollution

Introduction

Almost half of the world's total population and around 90% of the rural households in developing countries still count on unprocessed biomass fuels in the modes of wood, dung and crop residues (Hossain and Meng, 2014). Processed biomass (Pelletizing biomass) fuels have several benefits. A significant amount of moisture can be driven off during the pelletizing process, thereby increasing the calorific value of the fuel. The use of biomass can be environment friendly because the biomass is reduced, recycled and reused. It is also a renewable source because plants that can make biomass can be grown over and over. Biomass is such a widely utilized source of energy, probably due to its low cost and indigenous nature (Kumar and Sharma, 2014), that it accounts for almost 69% of the world's total energy supply (Funabashi. T, 2016). One third of the world's populations combust organic materials (usually biomass fuels) for cooking, heating and lighting. These practices become one of the major sources of indoor air pollution which eventually becomes a cause of respiratory problems like pneumonia, tuberculosis, chronic obstructive pulmonary diseases (Lakra and Gahlawat, 2015) and list goes on. The reason behind these health problems has not ever been thoroughly investigated to know what actually goes behind the pictures. There are various metrics that can be considered while establishing and analyzing the relation between the ailment and its cause (Nashier and Lakra, 2017). Some of the metrics include age, gender, difference in the socio-economic exposure levels and how these account for the impact and vulnerability within each category. Exposure to biomass fuel combustion has accounted for 0.5% of deaths and 0.14% of all disability adjusted life years across South Africa in 2000. This review is aimed at summarizing the previous work on biomass fuels and take the discussion about the feasibility and viability of Biomass combustion products and how they impact the health as well as environment in which we live in. To assess the atmospheric impact of biomass burning quantitative estimation of emission of trace gases and aerosols from biomass burning are highly required (Andreae and Merlet, 2001). Crucial parameters include fuel consumption and the emission factor (EF) (Andreae and Merlet, 2001). However, emission factor (EF)of pollutants varies substantially with time and space, even within a biome. The monitory disadvantage of solid bio fuels is amplified by the lower comparative combustion efficiency during the process of power generation (Kumar P et. al, 2014). In order to make sure that biomass fuels remain sustainable as well as eco-friendly, an initiative needs to be taken up to make sure that there is a change in the way biomass energy generation takes place. Processed forms of Biomass Fuels need to be provided and

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should replace the unprocessed alternatives. Proper mechanisms and precautions need to be taken which would result in reduced amount of damage to both, the people as well as environment, increased fuel efficiency and less harmful byproducts. We face a paradox here, as to convert unprocessed Biomass Fuel to Processed ones, it takes resources and knowledge – the main points which the people using these unprocessed forms are devoid of (Wadhwa nee Dabas and Kaur, 2017). These people are not aware of this, neither are they capable enough to be able to provide for this conversion (Deepshikha, 2014) and they end up using the harmful unprocessed form of biomass fuels which also has a negative impact on their health.

Biomass Fuels

Biomass fuels generate energy from the materials that once were living, like wood products (which comes from a tree), dried vegetation crop residues and it can also include vegetable litter. When the wood was a plant / tree (living entity), they would have consumed Sun's energy to synthesize their own food, which implies that solar energy as converted to chemical energy through the process of photosynthesis. As the plants died, the energy was still stored in the remains. This trapped energy is usually released by combustion of biomass fuels and transition into biomass energy. Combustible materials like wood waste, agricultural waste and other plant by products that die, release stored chemical energy in the form of heat which is used for various chores by humans. The energy can be used for a diversity of purpose. The use of biomass for generation of energy is environment friendly and it seeks to be sustainable renewable source of energy in contrast to the others. But this statement comes with a condition on the process of combustion of biomass.

Studies revealed that solid biomass fuels were the main causes of indoor air pollution. Biomass Smoke caused significantly more respiratory disorders than did cleaner fuels. Categorized data analysis demonstrated significant associations between biomass smoke pollution and respiratory symptoms such as cough, phlegm, breathlessness, whizzing, and chronic respiratory diseases such as COPD and asthma. (Shrestha, 2005). Debate on the benefits of biomass energy in comparison to the other renewable sources of energy has been going on since a long time now. There is still a lot of research and analysis required so as to study how viable and feasible will the Biomass Fuel actually is, while still considering its environmental implications. Algae based biomass fuels are considered to be the most sustainable, renewable, effective and environment friendly response that has the capacity to meet the global demand for fuel in the long run. (Vassilev S, Vassileva C, Vassilev, 2015-16). One of the major upsides of using Biomass over fossil fuels for generating energy is that they emit reduced amount of carbon emissions. Biomass also facilitates climate change by reduction of greenhouse gases and the gas emissions balance for biomass fueled electricity and heat application.

Health Issues related to Biomass Fuel use

Some of the most harmful and observable effects on the health of individuals because of the improper combustion of the biomass fuels have been mentioned below:

1. Respiratory illness in children: Indoor air pollutants release from biomass fuel increase the incidence of respiratory infections, including pneumonia, tuberculosis and chronic obstructive pulmonary disease, low birth weight, cataracts, cardiovascular problems, although mechanism behind these association are not fully understood. Environmental and occupational risk factors contributes to nearly 40% of the national burden of disease in India (Kalpana Balakrishnan, 2011). The world is making progress global death from indoor air pollution have declined by more than one million per year since 1990. Apart from Zimbabwe, death rates from indoor pollution have declined in almost every country in the world since 1990.The impact of air pollution on individuals health actually not because of outdoor concentrations, but to their personal environment in indoors where they spend most of their time.(David. D. Massey et al,2016) Emission from biomass combustion products negatively affect respiratory tract and cardiovascular health problems. (Torben et al,2015). Small children living in household exposed to solid fuels have 2 to 3 times greater risk of developing acute lower respiratory tract infection (ALRI) compared with those living in household using cleaner fuels or suffering less exposure to smoke. (Smith et al, 2000). The first report of indoor cooking smoke associated with childhood pneumonia and bronchitis was in Nigeria (Sofoluwe, 1968) one relatively small cohort study in rural Kenya found that the amount of pollution a child is exposed to directly correlates with the risk of developing pneumonia. (Ezzati and Kammen 2001). Indoor air pollution from burning of biomass is a major cause of acute respiratory infection, which contribute the most important causes of death of young children in developing countries (Xinying Fan et al 2015; Broor Set al., 2001)

2. Respiratory Illness in Adults: Women bear the brunt of the disease burden associated with BMF, primarily because it is women living in rural area who are exposed to high level of smoke. In Nepal, the average M10 level in the kitchen using BMF was 3 times higher than in those using cleaner fuel such as kerosene, liquefied petroleum gas (LPG) and biogas. (Shrestha and Shrestha, 2005)

3. Interstitial Lung Disease: Biomass Fuels (BMF) smoke is associated with an interstitial lung disease called as 'hutlung' (Grobbelaar and Bateman 1991; Gold et al 2000) a form of pneumoconiosis in rural women from developing countries.

4. Chronic Obstructive Lung Disease: An overview chronic obstructive lung disease: Biomass fuel smoke is responsible for COPD in non-smoking women living in rural area (Smith et al. 2003; Ezzati, 2002). In women from rural turkey is estimated that the function of COPD attributed to exposure to biomass smoke.

5. Lung Cancer: Data from China state that domestic coal smoke is a significant risk factor for the development of Lung Cancer (Dai XD et al 1996; Du et al, 1996; Zhao et al. 2006). In studies from India and Mexico, data for non-smoking women exposed to BMF smoke for a number of years suggest that long term exposure to BMF smoke from cooking may contribute to the development of adenocarcinoma of the lung (Wang TJ 1996;Behera and Balamugesh, 2005).

6. Respiratory Tract Infections : Exposure to air born particles and specifically to its fine fractions is of particular importance as these particles have a higher chances of penetration into the deeper parts of the respiratory tract, including trachea, bronchi, bronchioles and alveoli and also contain higher level of trace element and toxins (David D. Massey et al. 2016).

7. Tuberculosis: Evidence is emerging that the cases of Tuberculosis (TB) is increased amongst biomass fuel(BMF)

exposed women. Studies from Mexico and India have suggested a causal role of current BMF smoke exposure and the development of Tuberculosis (TB) overall (Mishra et al. 1999a, b; Perez Padilla et al. 2001).

8. Cardiovascular Disease: Particulate air pollution is statistically and mechanistically linked to increased cardiovascular disease (Brook et al., 2015; Daniel P.Croff et al., 2017). Biomass fuel cause different types of respiratory infection and cardiovascular problem in Adults (Fullerton et al., 2008).

9. Nutritional Deficiency: Biomass fuels (BMF) smoke in young children contributes to chronic nutritional deficiencies including anemia and stunned growth (Mishra and Rutherford, 2000a, b, Lakra and Gahlawat, 2016).

10. Low Birth Weight in children: Carbon monoxide cause low birth rate among children born in between 1989and 1993. (Ritz B,1999)l. Evidence suggest that implicates exposure to Biomass fuels(BMF) smoke in adverse effects on different birth outcomes (Sram et al., 2005) there is a published associated of low birth weight, intrauterine growth retardation and prenatal mortality with air pollution (Dejmek et al., 1999; Mavaanker et al., 1991; Wang et al., 1997; Bobak M ,2000; Boy E et al., 2001). Infant mortality is also caused by the air pollutants in Mexico city (Loomis D et al ,1999)

11. Cataract: Epidemiological studies from Nepal and India have associated indoor cooking using biomass fuels (BMF) with cataract or blindness (Pokhrel et al., 2005; Saha et al., 2005). Smoke induces oxidative stress and droplets plasma, ascorbate, carotenoids and glutathione, which provide antioxidant protection against cataract formation. Cigarette smoking and cooking fuel smoke is reported to increase the risk of cataract (V.K. Shalini et al., 1994).

12. Reproductive Health: Most of indoor air pollutant from biomass fuel burning are potentially toxic which make them a subject of study with respect to their environmental impact. Burning of wood in the kitchen increase the risk of cervical neoplasia in women (Velema,2002)

Control measures to regulate Biomass Fuel generated Pollutants

The combustion efficiency of biomass fuels is very low; thus they produce relatively higher levels of pollutants during incomplete combustion, which are damaging to the health of the population as well as the environment. There are many intervention strategies to reduce the emission of pollutants from biomass fuels, some of which are mentioned below.

1) Using modified cook stoves, which aims to burn fuel more efficiently and therefore produce fewer waste combustion products. Our houses should be modified from traditional smoky and leaky cooking store to the ones which are fuel efficient, smokeless and have an exit for pollutants. The limited studies generally suggest that more advanced stove designs can provide meaningful climate benefit. The advanced biomass stoves generally showed an improvement in black carbon factor (BC) emission factors compared to simple wood and rocket stoves(Charity Garland et al. 2017, Singh et al 2017).The concentrations of aerosol components and gases in the indoor air during the operation of improved cooking stoves(ICS) were found to be lower as compared to traditional cooking stoves(TCS) (Sudha et al., 2014). Alternative stoves reduces the burden of disease associated with exposure to household air pollution (Steve hankey et al., 2015; Lan Q Chapman et al., 2002). Wood burning stoves and fireplaces as well as agricultural fires emit significant quantities of health damaging pollutants, including many carcinogenic compounds (Naeher et al, 2000a, b). Stove design and lowering exposure to smoke emission reduces respiratory diseases.(June et al 2015).

2) Improving Ventilation to avoid air pollution inside the ventilation: Modification in the designs of houses : During construction of a house, importance should be given to adequate ventilation for purely ventilated houses, measures such as a window above the cooking stove and cross ventilation through doors should be installed. Outdoor air pollution remains an important determinant of residential indoor air pollution in Switzerland (Reto Meier et al ,2015).Air pollution transport path is related to human behaviour and building spatial layout (Xinying et al, 2015).

3) Use of clean, safe and drier fuels that end up producing fewer waste and have minimal by products which are comparatively less harmful to the environment (Sardar et al, 2014; Maheshwari and Mathur, 2014). The southeast Asian biomass burning smoke deposits had distinct behaviour from European and USA wood fuels consumption. (Abdus Salam, et al, 2013). Yak dung in Tibet show low average BC/PM2.5 (BC black carbon; Particulate matter) mass ratio from dung combustion. (Qingyyang Xiao et al,2015) found a change in the BC/PM 2.5 ratio before and after a snow event.

4) A change in the routines and cooking methodologies which would help reduce cooking time which in turn will reduce the amount of time an individual spends around a fire / stove which would result in the decrease in exposure to harmful by products.

5) Intersectional coordination and global initiatives: Indoor air pollution can only be controlled with organized and dedicated efforts between different sectors concerned with health, energy, environment, housing and rural development (Ankita Kankaria et al, 2014).

6) Altering regulatory or financial policies, with intent to improve across to advanced cook stoves or fuels and provide in centres for changes within communities or towards community development.

7) Oxy-combustion: Burning biomass is an oxygen enriched environment rather than in air is defined as oxy-biomass combustion. This may result in the production of water vapour and biogenic CO2 with little or no nitrogen.

8) Change in type of fuel : In developing countries, low income families rely only on direct combustion of biomass fuels for cooking needs, as this is the cheapest and easiest source available to them; however this could be replaced by promoting the use of cleaner energy sources such as solar power system or gobar gas (bio gas). Residential solid mass cook stoves are important source of aerosols emission in India. (Apoorva Pandey et al)

Mohit Saxena (2016) determined the emission factor (EF) and estimated the emission of particulate matter (PM), organic carbon, polycyclic aromatic hydrocarbon (PAHs), water soluble inorganic constituents (Singh J, 2014, Singh J, 2013) and trace gases such as SO_3, NO and NO_2 from combination of biomass fuels (Wood and Dung Cake) used in rural sector for cooking in Himachal Pradesh. Average indoor to outdoor ratio for organic carbon (OC) in occupied residences showing that indoor sources, such as cooking, smoking, biomass burning

and movement of people, strongly influenced indoor organic carbon(0C) concentrations. (Danilo Custodio et al,2014)

9) Use of Biomass / Bio Energy / Solar Power :Kenya, is the world leader in the number of solar power system installed per capita, more than 30,000 small solar panel, each producing 12 to 30 watts are sold in Kenya, annually. More Kenyans adopt solar energy power every year than make connections in the country's electric grid. There is a high degree of natural variability in fuel quality depending upon region and reason (Sand et al). Emission factor of SO_2 show high spatial variability and are dependent on fuel types and burning behaviour.

10) Environmental Awareness: One of the most important step in the prevention of indoor air pollution is education, viz., spreading awareness among people about the environment pollution and the serious threat it poses to their health and well-being. People should also be educated about the use of alternative cleaner sources of energy to replace direct combustion of biomass fuel. The Stakeholders must include not only public, but also politician and administrators to ensure their responsibilities and increase their awareness about adverse health effects of indoor air pollution caused by biomass fuels.

11) Check on the size of the emission particle (EF) Emission Factor of Particles: Emission of organic carbon from dung cake are highest (T Saud et al., 2011, 2012) Organic carbon and emission factor that Uttar Pradesh contributes highest emission as compared to Punjab, Haryana and Delhi because of high biomass consumption value. In 1977, the United States Environmental Protection Agency (USEPA) modified the National Ambient Air Quality Standards (NAAQS) for particulate matter (PM) to add a standard for the fine particle fraction of atmospheric aerosols, PM2.5, particles measuring less than 2.5 um in diameter. this new standard was based on epidemological evidence of association between elevated ambient concentrations of PM2.5 and a range of serious health effects. (Melissa M. Linden et al. 2008). EF28p PAHs was identified among different crop residue, indicating considerable underestimation when laboratory derived EFs were used in the inventory. The field measured EFpm. EFoc and EFec were significantly affected by stove age and the EFs of carbonaceous particles for the 15 years-old stove were approximately 2.5 times of those for the 1-year old stove. (Siye wei et al., 2014)

12) Avoid the use of coal: The indoor PM2.5 concentrations in household using coal were significantly higher than in those using gas or electricity. And consequently, the exposure concentration in the group using coal for cooking was significantly higher than those in groups using gas or electricity. The contribution of the indoor micro environments using coal for daily cooking to the overall PM2.5 exposure was 4-7 folds higher than that of the outdoor environment. Changing from coal to gas or electricity would have reduction of PM2.5 in the kitchen by about 40 to 70% and result subsequent reduction in personal inhalation exposure levels (Titanxin et al, 2016).

13) A change in the regulatory and financial policies with the motivation to upgrade to advanced cookstoves and fuels which would eventually lead to the development of the community as a whole. Governments and authorities must work in collaboration to do more analysis and investigation as to what alternative steps can be taken to help mitigate both, indoor as well as outdoor air pollution. A systematic as well as comprehensive study will lead to better mitigation of pollution and do the environment lesser harm.

14) less use of Solid Fuel: Indoor air pollution results from a dependence of solid fuels for cooking is needs to be controlled.Only 60% of the world has access to clean fuels for cooking. But this share has been increasing. The use of solid fuels for cooking has been declining across world regions but it is still high. Tackling indoor pollution and providing universal access to clean household energy is a great opportunity to improve health, reduce poverty and protect our environment (Ankita Kankaria et al., 2014).

Conclusion

Indoor air pollution from biomass fuel generally affect women and children and is the main cause of mortality and morbidity. Emission from burning of biomass fuel negatively affect respiratory and cardiovascular health problems. Incomplete combustion of Biomass Fuels is leading to rise of indoor air pollution and more efforts are required to be put in to regulate the advent of emissions from these combustions. Poverty, inaccessibility to improved cooking fuel, the lack of awareness about the negative impacts of biomass fuelemissions are some of the major factors that affect the environment adversely. The need of the hour is that clean and more efficient fuel is provided to the public for the betterment of the environment with reduced amount of emissions and will also mitigate the negative impact on the health of the masses.

References

Abdus Salam, Mahmodul Hasan, Bilkis A. Begum, Monira Begum, Swapan K. Biswas : Chemical characterization of biomass burning deposits from cooking stoves in Bangladesh; BIOMASS AND BIOENERGY 52(2013) 122-130.

Amod K Pokhrel, Kirk R Smith, Asheena Khalakdina, Amar Deuja, Michael N Bates, Case–control study of indoor cooking smoke exposure and cataract in Nepal and India, International Journal of Epidemiology, Volume 34, Issue 3, June 2005, Pages 702–708

Andreae, M. O., and P. Merlet (2001), Emission of trace gases and aerosols from biomass burning, Global Biogeochem. Cycles, 15(4), 955–966, doi:10.1029/2000GB001382.

Apoorva Pandey, Sameer Patel, Shamsh Pervez, Suresh Tiwari, Gautam Yadama, Judith C. Chow, John G. Watson, Pratim Biswas and Rajan K. Chakrabarty : Aerosol emissions factors from traditional biomass cookstoves in India : insights from field measurements; Atmos, Chem, Phys., 17, 13721-13729, 2017

Balakrishnan, K., Ramaswamy, P., Sambandam, S., Thangavel, G., Ghosh, S., Johnson, P., 589 Mukhopadhyay, K., Venugopal, V., Thanasekaraan, V., 2011. Air pollution from household solid fuel combustion in India: an overview of exposure and health related information to inform health research priorities. Global health action 4:1

Behera D, Balamugesh T. Indoor air pollution as a risk factor for lung cancer in women. J Assoc Physicians India. 2005 Mar;53:190–2.

Behera D, Dash S, Yadav SP (1991) Carboxyhaemoglobin in women exposed to different cooking fuels. Thorax, 46:344-346.

Bobak M (2000) Outdoor air pollution, low birth weight, and prematurity. Envi¬ronmental Health Perspectives, 108:173-176.

Boy E, Bruce N, Delgado H (2002) Birth weight and exposure to kitchen wood smoke during pregnancy in rural Guatemala. Environmental Health Per¬spectives, 110:109-114.

Broor S, Pandey RM, Ghosh M et al. (2001) Risk factors for severe acute lower respiratory infection in under-five children. Indian Pediatrics, 38:1361-1369.

Charity Garland, Samantha Delapena, Rajendra Prasad, Christian L'Organge, Donee Alexander, Michael Johnson, Black carbon cookstove emissions :A field assessment of 19 stove/fuel combinations; Atmospheric Environment 169 (2017) 140-149.

Dai XD, Lin CY, Sun XW, Shi YB, Lin YJ (1996) The etiology of lung cancer in nonsmoking females in Harbin, China. Lung Cancer,14:S85-91.
Danilo Custodio, Isabel Pinho, Mario Cerqueira, Teresa Nunes, CasimiroPio : Indoor and outdoor suspended particulate matter and associated carbonaceous species at residential homes in northwestern Portugal; Science of the Total Environment 473-474 (2014) 72-76.
David D. Massey, Mahima Habil, Ajay Taneja: Particles in different indoor microenvironments - its implications on occupants; Building and Environment 106 (2016) 237-244.
Deepshikha, Chauhan, K. (2014). Chemo-enzymatic conversion of biomass into bio-ethanol. *J. Integr. Sci. Technol.*, *2*(1), 34-36.
Du YX, Cha Q, Chen XW, Chen YZ, Huang LF, Feng ZZ, Wu XF, Wu JM. An epidemiological study of risk factors for lung cancer in Guangzhou, China. Lung Cancer 14:S9–S37 (1996).
Ezzati M, Kammen D (2001) Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study. The Lancet, 358:619-624.
Ezzati M, Kammen DM (2002) Household energy, indoor air pollution and health in developing countries: knowledge base for effective interventions. Annual Review of Energy and the Environment, 27:233-270.
Ezzati M, Kammen D. Indoor air pollution from biomass combustion and acute respiratory infections in Kenya: an exposure-response study [published correction appears in Lancet 2001; 358(9282): 619-624.
Fullerton DG, Bruce N, Gordon SB(2008). Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. Trans R Soc Trop Med Hyg. 2008; 102: 843–851.
Funabashi, T. (2016) Integration of Distributed Energy Resources in Power Systems. Elsevier, Cambridge.First edition
Gaurav Pandey (2011) : Chemical characterisation of Aerosols emitted from Household Biomass Burning of Madhya Pradesh, India.
Grobbelaar JP, Bateman ED. Hut lung: a domestically acquired pneumoconiosis of mixed aetiology in rural women. Thorax. 1991;46(5):334–340.
Gupta S., Kankaria A., and Nongkynrih B., Indoor air pollution in India: Implications on health and its control, Indian J. Community Med. 2014; 39, 4, 203.
Gold JA, Jagirdar J, Hay JG et al. (2000) Hut lung. A domestically acquired par¬ticulate lung disease. Medicine, 79: 310-317.
J Dejmek , S G Selevan, I Benes, I Solanský, R J Srám (1999) : Fetal growth and maternal exposure to particulate matter during pregnancy; Environ Health Perspect 1999 Jun;107(6):475-80.
JYT Po, JM FitzGerald, C Carlsten (2011) : Respiratory disease associated with solid biomass fuel exposure in rural women and children: systematic review and meta-analysis - Thorax, 2011 - thorax.bmj.com
Hossain, M., Meng, L. (2014). A comparative study on energy review among the developed and emerging nations.. *Integr. J. Soc. Sci.*, *1*(1), 1-4.
Ko Y (2000) Chinese food cooking and lung cancer in women nonsmokers. Am. J. Epidemiology, 151: 140-147.
K Pokhrel, Kirk R Smith, Asheena Khalakdina, Amar Deuja, Michael N Bates, Case–control study of indoor cooking smoke exposure and cataract in Nepal and India, International Journal of Epidemiology, Volume 34, Issue 3, June 2005, Pages 702–708.
Kumar, M., Sharma, M. (2014). Status of biofuel production from microalgae in India. *J. Integr. Sci. Technol.*, *2*(2), 72-75.
Kumar, P., Sharma, M., Dwivedi, G. (2014). Impact of biodiesel on Combustion, Performance and Exhaust Emissions of Diesel Engines. *Journal of Integrated Science and Technology*, *2*(2), 57-63.
Lakra, P., Nashier Gahlawat, I. (2015). Prospective Phytochemicals for alleviation of different chronic ailments. Integr. J. Social Sci., 2(1), 36-39.
Lakra, P., Nashier Gahlawat, I. (2016). The role of Nutrition in the Immune system functions. *Integr. J. Social Sci.*, *3*(1), 30-33.
Lan Q, Chapman RS, Schreinemachers DM, Tian L, He X (2002) Household stove improvement and risk of lung cancer in Xuanwei, China. Journal of the National Cancer Institute, 94:826-835.
Loomis D, Castillejos M, Gold DR, McDonnell W, Borja-Aburto VH (1999) Air pollution and infant mortality in Mexico City. Epidemiology, 10: 118-123.
Maheshwari, P., Mathur, R. (2014). Development of Energy Efficient Carbon Fiber based Convective Heater. *J. Integr. Sci. Technol.*, *2*(2), 76-79.
Masako Morishita, Kathryn C. Thompson, and Robert D. Brook (2015) : Understanding Air Pollution and Cardiovascular Diseases: Is It Preventable ; Curr Cardiovasc Risk Rep. 2015 Jun; 9(6): 30.
Mavalankar DV, Trivedi CR, Grah RH (1991) Levels and risk factors for peri¬natal mortality in Ahmedabad, India. Bulletin of the World Health Organi¬zation, 69:435-442.
Melissa M. Lunden, Thomas W. Kirchstetter, Tracy L. Thatcher, Susanne V. Hering, Nancy J. Brown : Factors affecting the indoor concentrations of carbonaceous aerosols of outdoor origin; Atmospheric Environment 42 (2008) 5660-5671.
Mishra VI, Retherford RD, Smith KR (1999a) Biomass cooking fuels and prevalence of blindness in India. Journal of Environmental Medicine, 1: 189-199.
Mishra VK, Retherford RD, Smith KR (1999b) Biomass cooking fuels and preva¬lence of tuberculosis in India. International Journal of Infectious Diseases, 3:119-129.
Mohit Saxena, Sudhir Kumar Sharma, Nidhi Tomar, Humaira Ghayas, Avirup Sen, Rohtash Singh Garhwal, Naresh Chandra Gupta, Tuhin Kumar Mandal : Residential Biomass Burning Emissions over Northwestern Himalayan Region of India : Chemical Characterization and Budget Estimation; Aerosol and Air Quality Research, 16; 504-518, 2016.
Naeher LP, LeadererBP, Smith KR (2000a) Particulate matter and carbon monoxide in highland Guatemala: indoor and outdoor levels from traditional and improved wood stoves and gas stoves. Indoor Air, 10:200-205.
Naeher LP, Smith KR, Leaderer BP, Mage D, Grajeda R (2000b) Indoor and outdoor PM2.5 and CO in high- and low-density Guatemalan villages. Journal of Exposure Analysis and Environmental Epidemiology, 10: 544-551.
Nashier Gahlawat, I., Lakra, P. (2017). Contextual implicit role of PROBIOTICS in improving the Human Health. *J. Integr. Sci. Technol.*, *5*(2), 50-53.
Perez-Padilla R, Perez-Guzman C, Baez-Saldana R, Torres-Cruz A (2001) Cooking with biomass stoves and tuberculosis: a case control study. Interna¬tional Journal of Tuberculosis and Lung Disease, 5:1-7.
Perez-Padilla R, Regalado J, Vedal S et al. (1996) Exposure to biomass smoke and chronic airway disease in Mexican women a case-control study. American Journal of Respiratory Critical Care Medicine, 154: 701-706.
Qingyang Xiao, Eri Saikawa, Robert J. Yokelson, Pengfei Chen, Chaoliu Li, ShichangKang : Indoor air pollution from burning yak dung as a household fuel in Tibet; Atmospheric Environment 102 (2005) 406-412.
Ritz B, Yu F (1999) The effect of ambient carbon monoxide on low birth weight among children born in southern California between 1989 and 1993. Envi¬ronmental Health Perspectives, 107: 17-25.
Reto Meier, Christian Schindler, Marloes Eeftens, Inmaculada Aguilera, Regina E. Ducret-Stich, Alex Ineichen, Mark Davey, Harish C. Phuleria, Nicole Probst-Hensch, Ming-Yi Tsai, Nino Kunzli : Modeling indoor air pollution of outdoor origin in homes of SAPALDIA subjects in Switzerland; Environment International 82 (2015) 85-91.
Saha A, Kulkarni P, Shah A, Patel M, Saiyed H. Ocular morbidity and fuel use: an experience from India. Occupational Environ Med. 2005; 62(1): 66-9.
Sardar, S., Kar, P., & Pal, S. (2014). The Impact of Central Metal Ions in Porphyrin Functionalized ZnO/TiO2 for Enhanced Solar Energy Conversion. *J. Mater. NanoSci.*, *1*(1), 12-30.
Sehgal M, Rizwan SA, Krishnan A (2014). Disease burden due to biomass cooking-fuel-related household air pollution among women in India. Glob Health Action. 2014; 7: 25326.
Shalini V, Lothra M, Srinivas L (1994) Oxidative damage to the eye lens caused by cigarette smoke and fuel smoke condensates. Indian Journal of Biochem¬istry and Biophysics, 31:261-266.
Shrestha IL, Shrestha SL. Indoor air pollution from biomass fuels and respiratory health of the exposed population in Nepalese households. Int J Occup Med Environ Health 11: 150–160, 2005.
Sigsgaard T, Forsberg B, Annesi-Maesano I, et al. 2015 : Health impacts of anthropogenic biomass burning in the developed world. Eur Respir J. 2015; 46(6): 1577-1588.
Singh, N., Balomajumder, C. (2017). Simultaneous treatment of phenol and cyanide containing synthetic/simulated wastewater using mixed culture immobilized on coconut shell activated carbon biomass in a packed bed bio-column reactor. *J. Integr. Sci. Technol.*, *5*(1), 9-14.
Siye Wei, Guofeng Shen, Yanyan Zhang, Miao Xue, Han Xie, Pengchun Lin, Yuanchen Chen, Xilong Wang, and Shu Tao : Field Measurement on the Emission of PM, OC, EC and PAHs from Indoor Crop Straw Burning in rural China; Environ Pollut, 2014 January; 184 : 18-24. doi: 10.1016/j.envpol. 2013.07.036

Smith K, Desai M (2002) The contribution of global environmental factors to ill-health. In: Environmental change, climate, and health: issues and research methods. Martens P, McMichael A, eds. Cambridge University Press, Cambridge.

Smith KR, Mehta S (2003) Burden of disease from indoor air pollution in devel¬oping countries: comparison of estimates. International Journal of Hygiene and Environmental Health, 206:279-289.

Smith KR, Samet JM, Romieu I, Bruce N (2000) Indoor air pollution in devel¬oping countries and acute lower respiratory infections in children. Thorax, 55: 518-532.

Sofoluwe GO(1968) Smoke pollution in dwellings of infants with bronchopneumonia. Arch Environ Health 16: 670–672.

Steve Hankey, Kelly Sullivan, Amanda Kinnick, Amber Koskey, Katarina Grande, Jane H. Davidson, Jullian D. Marshall : Using objective measures of stove use and indoor air quality to evaluate a cookstove intervention in rural Uganda; Energy for Sustainable Development 25 (2015) 67-74.

Sudha Singh, Gyan Prakash Gupta, Bablu Kumar, U.C. Kulshrestha : Comparative study of indoor air pollution using traditional and improved cooking stoves in rural households of Northern India; Energy for Sustainable Development 19 (2014) 1-6.

Sram RJ, et al. Ambient air pollution and pregnancy outcomes: a review of the literature. Environmental Health Perspectives. 2005;113:375–382.

S.V. Vassilev, C.G. Vassileva, Composition, properties and challenges of algae biomass for biofuel application: An overview, Fuel. 181 (2016) 1–33.

Tianxin Li, Suzhen Cao, Delong Fan, Yaqun Zhang, Beibei Wang, Xiuge Zhao, Brian P. Leaderer, Guofeng Shen, Yawei, Zhang, Xiaoli Duan : Household concentrations and personal exposure of PM2.5 among urban residents using different cooking fuels; Science of the Total Environment 548-549 (2016) 6-12.

T. Saud, T.K. Mandal, Renu Gadi, D.P. Singh, S.K. Sharma, M. Saxena, A. Mukherjee : Emission estimates of particulate matter (PM) and trace gases (SO2, NO and NO2) from biomass fuels used in rural sector of Indo-Gangetic Plain, India; Atmospheric Environment 45 (2011) 5913-5923.

T. Saud, R. Gautam, T.K. Mandal, Ranu Gadi, D.P. Singh, S.K. Sharma, Manisha Dahiya, M. Saxena : Emission estimates of organic and elemental carbon from household biomass fuel used over the Indo-Gangetic Plain (IGP, India; Atmospheric Environment 61 (2012) 212-220.

Vassilev S, Vassileva C, Vassilev VS. Advantages and disadvantages of composition and properties of biomass in comparison with coal: An overview. Fuel. 2015; 158: 330-50.

Velema JP, Ferrera A, Figueroa M et al. (2002) Burning wood in the kitchen increases the risk of cervical neoplasia in HPV-infected women in Honduras. International Journal of Cancer, 97: 536-54

Vassilev S, Vassileva C, Baxter D.(2014) Trace element concentrations and associations in some biomass ashes. Fuel 2014;129:292–313.

Vassilev S, Vassileva C, VassilevV.2015Advantages and disadvantages of composition and properties of biomass in comparison with coal: an overview. Fuel 2015;158:330–50.

Vassilev SV, Vassileva CG (2016). Composition, properties and challenges of algae biomass for biofuel application: an overview. Fuel 2016;181:1–33. https://doi. org/10.1016/j.fuel.2016.04.106.

Wadhwa nee Dabas, M., & Kaur, K. (2017). Child's Construction of Knowledge: Role of Activities in Classroom. *Integr. J. Social Sciences*, *4*(1), 20-25.

Wang TJ, Zhou BS, Shi JP (1996) Lung cancer in nonsmoking Chinese women: a case-control study. Lung Cancer, 14:S93-98.

Wang X, Ding H, Ryan L, Xu X (1997) Association between air pollution and low birth weight: a community-based study. Environmental Health Perspec¬tives, 105:514-520.

Xinying Fan, Bin Chen, Xueyan Zhang : Field Survey on Indoor Air pollution Transport Path in Rural House in Northeast China; Procedia Engineering 121 (2015) 430-437.

Zhao, Y., Wang, S., Aunan, K., Seip, H. M. & Hao, J. Air pollution and lung cancer risks in China--a meta analysis. Sci. Total Environ. 366, 500–513 (2006).

Zhong L, Goldberg MS, Gao YT, Jin F (1999b) Lung cancer and indoor air pol¬lution arising from Chinese-style cooking among nonsmoking women living in Shanghai, China. Epidemiology, 10:488-494.

Zodpey S, Ughade S (1999) Exposure to cheaper cooking fuels and risk of age- related cataract in women. Indian Journal of Occupational and Environ¬mental Medicine, 3:159-161.