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Cassava Processing and the Environmental Effect

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Abstract:
Cassava (*Manihot esculenta* Crantz) is a very important food crop that is capable of providing food security. Cassava roots can be converted through processing into enough food. Machine application for cassava roots processing has helped greatly to add value, leading to profit making and provision of food. The farmer at the village level depends on the sun for drying of cassava products. They obtain firewood from forests and use fossil fuel from petroleum to power the tractor and small internal combustion engine (ICE). In traditional operations, fermentation and pressing (de-watering) are done in one operation. Gari frying and flour drying are complex procedures, which depends on the skill of the operator. This paper is concerned about the effect of these activities on the environment. Waste water from cassava processing, if released directly into the environment before proper treatment, could be a source of pollution. Can this type of environmental pollution be controlled? Can the foul odour lead to contamination of surface and underground water? From the investigation, fossil fuels were found to have the biggest historical and present share of polluting emissions. This contributes directly to global warming. Firewood consumption has led to severe deforestation and desertification. Cassava processing activities like any other industry have its own share in emitting greenhouse gases that can be responsible for global warming. The level of atmospheric carbon dioxide (CO_2) affect both water availability and demand, through its influence on vegetation. It is widely accepted that the increasing concentration of greenhouse gases in the atmosphere is altering the earth's radiation balance and causing the temperature to rise. Effluent water and dangerous gases produced by cassava processing centres required better handling. Attempts needed to be made to correct them were fully explained so also the use of cleaner fuel that can lower the generation of carbon dioxide in our farm machines was proposed in other to balance the resources and climate.

Keywords: food-security; sustainability; resources; environment; global-warming; cassava-root; processing

1. Introduction

Cassava (*Manihot esculenta* Crantz) is a very important food crop that is capable of providing food security. Small-scale farmers use the traditional tools and methods to process the roots [1]. Cassava roots can be converted through processing into enough food for everyone at present and in the future. Processing cassava to other useful products normally provides assistance to farmers in reducing hunger and poverty for millions of families within urban and rural areas. Machine application for cassava processing has helped greatly to add value, leading to profit making. Aside from improving farmers' income, value addition to the harvested roots addresses unemployment and turn around the fortunes of farmers within a given community. The processing of cassava roots normally starts with peeling before slicing thinly or grated finely and sun drying. Processing includes activities from harvesting until it gets to market; including all treatments the product receives [2]. It involves the efficient and effective deployment and allocation of all resources when and where they are needed. Such resource includes financial, inventory, human skills and information technology. Peeling of cassava root is done manually at the village level are allowed to litter the processing area [3]. After peeling, the roots are grated into smaller particles (mash). A typical cassava root grater consists of a drum rotor of about 250 to 300 mm in diameter, covered with a perforated tin sheet usually powered by an electric motor or diesel/petrol engine. In traditional operations, fermentation and pressing (de-watering) are done in one operation. The grated mash is packed inside baskets, jute bags or perforated plastic sacks and left to ferment for few days, this fermentation affects the taste of gari. After fermentation has been completed, the mash is then pressed to reduce the water content. The traditional method of dewatering grated cassava mash involves tying and twisting the neck of the hessian sack over which heavy stones are placed for 24-48 hours. Fermentation and pressing take a longer time. Presently, the common practice with mechanical presses is to use either hydraulic jacks or a bolt screw and plate ram to apply pressure to woven polyethylene sacks that contain the grated cassava mash [4].This reduces time. There are a number of pulverizer and sifter machines that have been developed so far. Cassava mash process handling machine was developed [5] to combined four stages of the processing steps. Frying and bagging are the final operations in gari processing. Gari frying and flour drying are complex procedures, which depends on the skill of the operator. Most developing countries of the world depend on firewood and fossil fuel as means of processing foods and this in turn affects the environment leading to deforestation and pollution. The pollution often comes from the fuel sources as well as effluent waste from factories. Global warming is here and its effects can be seen. Gases from combustion of carbon compounds in oxygen have been identified as one of the causes. Nitrogen in air yields nitrogen dioxide and Carbon yields carbon dioxide. These are the pollutants playing a major role in global warming.

2. Results and Discussion

2.1 Environmental pollution level.

Investigations conducted confirm that small-scale cassava processing could affect environment more than large-scale. Environmental pollution from medium-scale cassava processors may be more difficult to deal with. Financial and technical resources are needed to deal with such environmental waste. A case study of the village level conducted along a road to Olorunda village at Ibadan confirms that cassava peels can be left to litter the ground. They were found on the ground fermenting making the road roads leading to the village impassable. This is not new to those living in the village but not good for the visitors. This is what is applicable at centres in developing countries, attempts were made to process dried peels to animal feed to reduce these cassava wastes, discussions is still on to handle the effluents. At the laboratory level waste water from cassava has been converted into ethanol.

2.2 Cassava processing effluents

In developing country like Nigeria, about 70% of harvested cassava roots are processed into gari, a toasted granule. Gari production is dominated by these smallholders who use simple implements for cassava processing. Significant amounts of wastes are generated during cassava processing. The traditional processing of cassava to gari generates more waste. Cassava waste waters have in suspended solids about 15,000 mg/L, they are never treated but disposed freely into the environment there by contaminating nearby water sources. The release of waste products and contaminants into surface runoff get into rivers through drainage systems, leaching into groundwater, liquid spills, waste water discharges, and littering. Soil contamination in our case occurs when drains from cassava processing factory are released by spill or underground leakage. Cassava processing effluents have serious environmental impacts causing acidification due to the hydrolysis of cassava cyanogenic glucoside, linamarin and lotaustralin (methyl linamarin) producing hydrogen cyanide, which is also toxic to household animals, fisheries and other organisms. This waste water from cassava processing centre released directly into the environment before proper treatment causes pollutions, sometimes discharged beyond the factory wall into roadside ditches or fields and allowed to flow freely sometimes they settle in shallow depressions. Eventually, this will percolate into the subsoil or flow into streams. This causes serious environmental pollution and a foul odour leading to contamination of surface and underground water and soil [6]. Sometimes cassava roots are fermented in streams and ponds, upstream of drinking water points [7]. Suspended solid particles are important as pollutants as pathogens are carried on the surface and body of the particles [8]. The smaller the particle size, the greater the surface area per unit mass of particle, and so the greater the pollutant load that is likely to be carried. This organic matter that flow out of this grated mash during dewatering generally consists of carbohydrates and exists both in suspension and in solution [9].

2.3 Carbon dioxide emission

In achieving end products, firewood has always been a means of processing local foods from cassava. Carbon dioxide emissions from fire are problems at the village level. These are part of human activities that are dangerous to our environment. Human beings are the major reason for global warming. The world's average temperature is rising because we are adding more carbon dioxide or other greenhouse gases to the atmosphere. Processing centres that do not depend on firewood depend on generators and other internal combustion (ICE) heat engines, a physical device that converts thermal energy to mechanical output. Heat engines run on a thermodynamic cycle, modeled as gasoline, turbine or steam engines. Equipment emissions are from fuel gases used in energy conversion activities. In the case of noise pollution the dominant source class is the ICE from vehicles and generators. During combustion, a large amount of reactants' chemical energy gets released in the form of thermal energy. Today, global warming is primarily caused by CO_2 emissions, oxides of Nitrogen, HC, and CO that are in large quantities causes environmental problems.

3. **Pollution from Cassava Processing**

3.1 Waste water

Pollution occurs when waste water discharged from cassava processing are allowed to percolate into the subsoil or flow into streams or when cassava roots are fermented in streams and ponds, upstream of drinking water points [7]. Okafor *et al.* [8] affirmed that suspended solid particles are important as pollutants and pathogens are carried on the surface and body of the particles. The smaller the particle size, the greater the surface area per unit mass of particle, and so the greater the pollutant load that is likely to be carried. Several attempts have been made by other researchers, Oboh [7] discussed extensively on the liquid wastes obtained from the processing of cassava into various end products. Ehiagbonare *et al.* [10] investigated the effect of cassava effluent on the environment and found out that the effluent had negative effects on plants, air, domestic animals, soil, and water. In spite of these findings, the treatment and disposal of cassava waste water from industrial sources still continues. This is because cassava waste water disposal is done improperly and allowed to accumulate over time. Most of the cassava waste water arising from processing ends up with domestic waste, while others percolate into the soil. Some of the cassava waste water is carried in suspension, others go into solution, while others have become so finely divided that they exist in a colloidal state. Water pollution causes approximately 14,000 deaths per day, mostly due to contamination of drinking water [11]. The release of waste products and contaminants into surface runoff get into rivers through drainage systems, leaching into groundwater, liquid spills, waste water discharges, and littering. Soil contamination in our case occurs when drains from cassava processing factory are released by spill or underground leakage.This cassava effluent had a negative effect on our environment.

3.2 Gaseous pollution

Carbon dioxide emission from fire and internal combustion engines are problems. These are part of human activities that are dangerous to our environment. The world's average temperature is rising because we are adding more carbon dioxide or other greenhouse gases to the atmosphere. Academic and scientific surveys have repeatedly confirmed this view [12]. All heat engines are powered by the expansion of heated gases, and the general surrounding are the heat sink, providing relatively cool gases which, when heated, expand rapidly to drive the mechanical motion of the engine. The principal constituents of the general surrounding, known as the atmosphere of the Earth, are Nitrogen (78 percent) and Oxygen (21 percent). The atmospheric gases in the remaining 1 per cent are Argon (0.9 percent), Carbon dioxide (0.03 percent), varying amounts of water vapour, and trace amounts of hydrogen, ozone, methane, carbon monoxide, helium, neon, krypton, and xenon. In cycles and engines, the working fluids are gases and liquids from the atmosphere. The equipment noise and gases transferred to the atmosphere after combustion introduces contaminants into the environment. These contaminants cause instability, disorder, harm, and discomfort to the physical systems of living organisms. Common air pollutants include carbon monoxide, sulphur dioxide, chlorofluorocarbons (CFCs) and nitrogen oxides, produced by industry and heat engines. Photochemical ozone and smog are created as nitrogen oxides and hydrocarbons react to sunlight. Adverse air quality can kill many organisms including humans [13]. Ozone pollution can cause respiratory disease, cardiovascular disease, throat inflammation, chest pain, and congestion. A detailed combustion analysis of different fuel and technology scenarios can confirm this; burning is a complex sequence of exothermic chemical reactions between fuel and an oxidant accompanied by the production of heat or both heat and light in the form of either a glow or flames. In a complete combustion reaction, a compound reacts with an oxidizing element, such as oxygen and the products are compounds of each element in the fuel with the oxidizing element.

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + heat$

In the large majority of the real world uses of combustion, the oxygen (O_2) oxidant is obtained from the ambient air and the resultant gas from the combustion will contain nitrogen.

$CH_4 + 2O_2 + 7.52N2 \rightarrow CO_2 + 2H_2O + 7.52N_2 + heat$

When air is the source of the oxygen, nitrogen is by far the largest part of the resultant fuel gas. In reality, combustion processes are never perfect or complete. In fuel gases from combustion of carbon or carbon compounds (as in combustion of hydrocarbons, wood etc.) both unburned carbon (as soot) and carbon compounds (CO and others) are present. Also, when air is the oxidant, some nitrogen will be oxidized to various oxides, mostly harmful nitrogen oxides. Exhaust stream contains a considerable amount of free single atoms of oxygen and nitrogen as the result of the heat of combustion splitting the O_2 and N_2 molecules in the air. These will readily react with each other to create Nitrous Oxide, a pollutant, in the exhaust system. The burning of hydrocarbon in sufficient oxygen minimises pollution.

The simple word equation for the combustion of a hydrocarbon in oxygen is:

Fuel + Oxygen → Heat + Water + Carbon dioxide

The simple word equation for the combustion of a hydrocarbon in air is:

Fuel + Air → Heat + Water + Carbon dioxide + Nitrogen [14]

A multi-fuel technology that mixes diesel with other fuel sources could cut CO_2 (greenhouse gas) emissions from heavy-goods vehicles [15].

In a complete combustion process, for every kilogram of hydrocarbon fuel burnt, 1.3 kg of H2O and 3.1 kg of CO_2 is produced [14]. The undesirable exhaust emissions, Nitrogen Oxides, HC, CO, CO_2, Polyaromatics, soots, lead salts, nitro-olefins, and aldehydes ketones, are produced in very small quantities, only oxides of Nitrogen, HC, and CO are produced in large quantities enough to cause environmental problems. CO_2 caused concerns because it was suspected of allowing ultra-violet rays to penetrate the atmosphere. CO causes problems by being absorbed into red corpuscles of the blood, preventing the absorption of oxygen. Nitric acids and nitrogen dioxide along with HC caused smog.

4. Challenges

The global weather system is threatening to spin out of control. This means that seasons are becoming unpredictable, farming becomes riskier, freshwater supplies become unreliable, and storms and rising sea levels threaten to take away whole islands and coastal areas. Doom days were predicted by some agricultural scientists regarding the catastrophic consequences of global warming [16]. Further, examinations were conducted by researchers to see if the pollution, particularly of nitrogen and phosphates (often associated with cultivations and use of mineral fertilizers) could be reduced or eliminated, so as to be able to develop systems which could contribute to the reversal of global warming. Fossil fuels were found to have the biggest historical and present share of polluting emissions. This development contributes to global warming. Firewood consumption has led to severe deforestation and desertification [17]. Since the industrial revolution, humans have been emitting greenhouse gases that the Intergovernmental Panel on Climate Change (IPCC) believes are responsible for global warming. So many work has been done on cassava wastes [20][21][22] and its effect.

5. Conclusions

Climate change is probably the most serious challenge that the human race has ever confronted. Global climate change has become an important area of investigation. The level of atmospheric carbon dioxide (CO_2) may also affect both water availability and demand, through its influence on vegetation. It is widely accepted that the increasing concentration of greenhouse gases in the atmosphere is altering the earth's radiation balance and causing the temperature to rise. Effluent water and dangerous gases produced by cassava processing centres are with us. Attempts made to correct global warming are creating more pollutants. Internal Combustion Engines (ICE) in use at our farms is now adding more CO_2. Global warming is already happening. Its impact is being felt mostly by the world's poorest people. Food production, water supplies, public health, and people's livelihoods are all being damaged and undermined. It threatens to reverse human progress. There is every reason to sustain the climate and other natural resources. Climate change, if left unchecked now, will drive these incidents out of control. There is need for proof that cassava processing activities do not lead to global warming [24]. To sustain cassava processing, activities involved must be made to completely control all environmental contamination. The processing steps must be regulated. Adequate use of available pollution solutions must be encouraged or enforced by government agents. Effective strategies that will enhance the livelihood opportunities of the rural poor must be sustained for the ecosystem services. Cassava processing must be designed to increase economic, social, and ecological resilience to climate change. Cassava processors must adopt the use of clean energy to prevent the effects of global warming. New forms of energy development and nature conservation that are climate-friendly are needed in factories. Emissions of CO_2 and other greenhouse gases must be controlled. Governments must enforce forest conservation laws. Use of firewood for cooking and processing food must be prohibited to reduce deforestation. Mankind is expected to respond to these effects by taking adaptive measures including changing patterns of cooking and drying. Cassava processors must reduce environmental pollution at all costs. To address climate change in our locality, especially in areas where industry is highly concentrated and regarded as polluting areas for natural resources, we must start preventing the waste problem from occurring in the first place. Interaction between suspended and settled solid particles in cassava wastewater must be treated [23][24].This is the ultimate solution, and one that is available for cassava processors, in developing country, current emissions from cooking with firewood can only be minimized for now.

Conflict of Interest

The authors declare no conflict of interest.

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