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The world's insatiable hunger for oil began 150 years ago when humans first began developing drilling equipment for the search and extraction of underground fossil fuels (M). Since then our consumption of "black gold" has exponentially increased over the course of modern human history.

Oil, natural gas and coal are used in a variety of applications within daily life. Fossil fuels are used for heating, product fabrication, cooling, cooking and modern propulsion by land, sea and air. You name it, and fossil fuels are involved. The modern infrastructure and production methods that we use today are mainly fed by nonrenewable fossil fuels. In other words, from the day you wake of to the day you fall asleep you are touching materials made by oil, coal, and/or natural gas; Unless, you lie in a field of flowers or hug trees for days on end.

This dependency on fossil fuels is definitely not considered a viable solution for future inhabitants of the earth. Not simply due to the scarcity and finite nature of these resources, but due to their adverse affects on human health and the well-being of other living organisms when exposed to them. Yes, you heard right! Direct and even indirect exposure to carbon-based fossil fuels is highly detrimental to the health of ALL biota on this earth. Traces of oil and other fossil fuels can sometimes be found in the food you eat, the water you drink, and even the air you breathe. However, with the development of cleaner and renewable forms of alternative energy—such as biodiesel—we will sever our

dependency off of fossil fuels and the harmful carcinogens they contain, thereby creating a healthier environment for all.

What exactly is biodiesel? Why are petroleum-based fuels so bad for our health? Will biodiesel help us in our quest to finding a viable alternative energy sources without a drastic change in current infrastructure dedicated to the production of carbon-based fuel sources? These questions and many others are answered in the feature film, *FUEL*. This documentary takes an in-depth view of the mission of Josh Tickell, the director and narrator of the movie. He was adversely affected by petrochemical industry and decided to help spearhead the movement for the development and innovation of biofuels (a cleaner burning fuel now derived from grease, animal fats, and vegetable oils) in order to find a safe alternative to carbon-based fuels. Also, Josh Tickell interiews an array of proponents advocating the use of biodiesel and how seamless the transition was. All you need is an automobile with a diesel engine, some biodiesel, and you are off! Keep in mind that this is without any additional mechanical modification to the original engine.

When the movie begins, Josh Tickell describes the initial stages of his quest to promote biodiesel. He first discovered this type of alternative energy when he was studying on a European farm as part of a degree in sustainable living from The New College of Florida. During his work on these organic farms, he discovered that the machinery used for the farm's upkeep was powered by biodiesel manufactured from the biomass of the crops that the farmer grew. After finishing his degree, he flew to the United States and began a project that would advertise the "biodiesel cause" to America. His idea was to purchase a regular diesel-powered Winnebago R.V. and tour the country propelled solely by used vegetable oil acquired from restaurants throughout the journey.

His trip lasted from 1997 to 1999 and was ended by his mother who fell desperately ill. His mother, Deborah Dupre, lived in Louisiana, which also happens to be the largest gas producing state in the nation due to their numerous oil deposits and refining and processing centers. In fact, there are 150 petrochemical facilities within a 100-mile area along the Mississippi River between Baton Rouge and Louisiana (M). The Environmental Protection Agency of Louisiana pronounces the air and soil surrounding the petrochemical facilities as the fallout area due the large concentrations of lethal chemicals that are present in these areas (M). The households that are within these fallout areas are also subject to high levels of oil refinement byproducts that are correlated with the onset of many debilitating and, in some cases, life-threatening diseases. Of which include asthma, bronchitis and cancer (M).

During the gas refinement process, crude oil is heated in distillation towers where some oil vapor are released through the top of the tower and into the environment. According to the scientific data compiled by Dr. Cheryl L. Waldner and Dr. Edward G. Clark, experts in the field of environmental and occupational health, the vapor extruded into the atmosphere contains a mixture of highly dangerous chemical agents including, hydrogen sulfide, sulfur dioxide and volatile organic compounds (VOCs) (6). Waldner and Clark have also found correlations between the different chemicals emitted by the petrochemical factories and the various diseases that are prominent when chronically exposed. Close contact with high levels of hydrogen sulfide and sulfur dioxide are commonly connected with symptoms that include increased incidence of respiratory infections, bronchial hypersensitivity, coughing and wheezing, negative effects on airway resistance and lung function, permanent neurobehavioral impairment, and increases in the

incidence of diseases of the nervous system and sense organs (7).

The inhalation of VOCs, such as benzene and toluene, is associated with respiratory tract irritation, central nervous system dysfunction and the suppression of bone marrow function (inhibit cell-mediated and humoral immune responses. (Waldner 7)

The chemical agents emitted from the distillation towers are not the only byproducts of the crude oil refinement process. In addition, solid toxic waste must be discarded. According to Josh Tickell, the oil companies in Louisiana have been dumping the remaining hazardous waste in waterways and on patches of land for the past seventy years. As a result of the continued dumping by the oil companies, the local biota in the river and land systems—such as small animals, fish, and plants—have also been affected. The continued pollution of these environments causes highly detrimental side effects to the local ecosystem and, in some cases, destroys the life that inhabits the area.

According to the Oregon State University's toxicology database, these chemicals enter the various plants and animals by means of bioaccumulation and biomagnification. The process of bioaccumulation is defined as an increase in the concentration of a chemical in a biological organism over time, compared to the chemical's concentration in the environment. Bioaccumulation is a process that results in the accumulation of a chemical in an organism at higher levels than are found in its food. It occurs when a chemical becomes more and more concentrated as it moves up through a food chain—the dietary linkages between single-celled plants and increasingly larger animal species.

The interplay between the processes of biomagnification and bioaccumulation result in abnormally high concentrations of contaminants within the environment's

intricate food web. This, as a result, can lead to various diseases, syndromes, deformities, and in some cases, death (M).

Intentionally, the area of petrochemical facilities along the Mississippi River is known as "Cancer Alley" due to the large amount of health abnormalities that are experienced within this area. An investigative reporter for *The Nation*, Barbara Koeppel, describes Cancer Alley as place where:

> People living nearest the factories and waste dumps are sick and dying. Clusters of asthma, stillbirths (a full- term baby that dies at or within 1 hour of birth), miscarriages, neurological diseases and cancers have mushroomed. And residents have long claimed that the waste has poisoned domestic animals, wildlife and fish. (16)

The article also refers to the case study of eight-year-old Caleb Thomas. Caleb and his family lived in Gonzales, Louisiana, which sits in the wake of five petrochemical plants and several waste dumps (Koeppel 16). On his second birthday, Caleb's parents made a gruesome discovery. Caleb had contracted rhabdomyosarcoma, a rare childhood cancer that afflicts one in a million children a year (Koeppel 16). Koeppel also adds in her article, "But in Gonzales, cancer is no rarity. Two other boys were also diagnosed with rhabdomyosarcoma, bringing to three the total who fell ill within fourteen months."

"In Zachary, forty miles away, four more had developed it a few years earlier. All have died" (Koppel 16). Also, in 1999, five more children in or near Gonzales have developed leukemia (16). Koeppel also concludes that:

> The scene is the same all along the corridor and in parishes (counties) nearby. In Denham Springs and Walker (combined pop. 14,000), six

> children, who lived within three miles of an oil and chemical waste dump that operated in the sixties and seventies, developed neuroblastomas, deadly cancers of the central nervous system—a rate 120-200 times higher than the norm.

In addition to various types of cancers, residents of the parishes surrounding the petrochemical facilities have high rates of asthma and the development of other respiratory diseases (Koeppel 17). Imagine how the lives of these children could have been spared if those oil companies would have been refining and processing biodiesel without the addition of harmful additives into the surrounding area.

According to the 2000 Toxics Release Inventory (TRI) published annually by the U.S. Environmental Protection Agency, Louisiana is nationally ranked fourth for total on- and off-site releases from the petroleum industry, third for total releases within the state, second throughout the nation for total onsite releases, and first for the total amount of production related waste managed. The total amount of waste produced by all of the petrochemical facilities in Louisiana is 9,416,598,055 pounds (TRI 1). In addition, this is not the only "Cancer Alley" that exists. Wherever oil is processed there are usually a high volume of cases of localized incidences of cancer. For example, cancer rates are higher than normal in Westville, New Jersey, Vicksburg, Mississippi, Robinson, Illinois, and Torrance, California among others (M).

In addition to the negative impacts experience by humans, the long-term exposure to these petrochemical facilities affects our livestock as well. The team of Canadian researchers, led by Dr. Cheryl L. Waldner and Dr. Edward G. Clark, began an investigation to determine the association between exposure to emissions from the oil and

gas industry and pathology of the immune, nervous, and respiratory systems, and skeletal and cardiac muscle in beef calves. The experimental group for the study consisted of 203 herds (29,713 cows) of cattle in the areas of Saskatchewan, Alberta, and northeastern British Columbia. The cow pastures studied were at least 1.6 km away from an oil and gas facility/facilities.

After the study concluded, researchers reported that 1,531 calves were aborted, stillborn (a full- term calf that died at or within 1 hour of birth, or a full-term calf that was found dead, had not been observed alive, and was obviously recently born), or dead more than 1 hour after birth (6). Postmortem examinations of the calve tissues revealed startling results. In regards to the immune system of the calves, forty-nine percent of the tissue examinations reported lympholysis (destruction of the lymph cells) (21). Lesions (an abnormal change in the structure of an organ due to disease) to the nervous system occurred in five percent of the brain and spinal cord tissues examined (31). The most common lesions in the skeletal and cardiac muscle tissues examined were degeneration (loss of muscular tissue) and necrosis (premature death of cells and living tissue) and occurred in more than twenty-five percent of the samples obtained (23).

These results show that the exposure to various chemical agents—such as hydrogen sulfide, sulfur dioxide and volatile organic compounds—associated with the combustion of crude oil in petrochemical facilities, are presumably detrimental to the immune system and the skeletal and cardiac muscle tissue of baby calves.

In accordance with the process of biomagnification, as the amount of these chemical agents accumulate within the tissues of the cows that remain alive, they pose a greater threat towards consumption. If consumed by other higher order consumers, an

exponential increase in the concentrations of these pollutants will be reflected. As the amounts of these hazardous chemicals increase along the food chain, the possibility of life threatening diseases increase as well.

After tending to his mother, Josh Tickell once again began his public outreach mission to teach people about the potentials of biodiesel. In *FUEL*, Tickell presents the advantages of biodiesel as a form of renewable, alternative energy. In regards to carbon dioxide (CO_2) emissions, gasoline and regular crude oil-based diesel emit twenty pounds per gram when burned, while biodiesel creates two to four pounds of CO_2 per gram of fuel. That is an eighty to ninety percent offset in the release of carbon dioxide. Josh Tickell also states that, as compared to the combustion of regular diesel, biodiesel reduces the output of soot, airborne particulates, and volatile organic compounds.

Many of the claims made by the film, in regards to the advantageous health implications of using biofuel, can be validated by the published scientific findings of Dr. Mustafa Balat, an expert in the field of biodiesel research from the Sila Science Universite in Turkey. In his study he examines the fuel characteristics and the use of biodiesel as a transportation fuel. Dr. Balat's findings indicate that:

> The use of biodiesel decreases the solid carbon fraction of particulate matter (since the oxygen in biodiesel enables more complete combustion to CO_2) [and] pure biodiesel is essentially sulfur free and results in a total reduction of sulfur dioxide (SO_2) emissions as well sulfate aerosols in particulate matter. (861)

The reduction of carbon and sulfur emissions greatly decreases the occurrence of ailments afflicting the respiratory system.

Another study was conducted by Dr. Robert L. McCormick to test the impact of biodiesel on pollutant emissions and public health. By comparing the emission compositions of regular petroleum-based diesel, B20 diesel (a blend of twenty percent pure biodiesel and eighty percent oil-based diesel), and pure biodiesel, the environmental health benefits were clear. Biodiesel blends of twenty percent produce reductions of fifteen percent or higher in emissions of particulate matter, carbon monoxide, total hydrocarbons, and a group of toxic compounds including vapor-phase hydrocarbons, aldehydes, ketones, and selected semi-volatile and particle-phase PAH and NPAH (McCormick 1033). In other words, there is a considerable reduction in the amount of carcinogens and other harmful chemicals that are released from the combustion of biodiesel. The absence of the chemicals found in fossil fuels, as opposed to biodiesel, will promote a healthier environment and less of a likelihood of contracting ailments associated with carbon-based fuel byproducts.

The byproducts reduced by the use of B20 diesel are the primary contributors to ground-level ozone (smog). Ground-level ozone is correlated with incidences of airway irritation, coughing, wheezing and other breathing difficulties, respiratory tissue inflammation, aggravation of asthma, increased susceptibility to respiratory illnesses like pneumonia and bronchitis, and permanent lung damage with repeated exposures (EPA).

Also, the use of pure biodiesel adds additional benefits by way of reducing the harmful chemicals from exhaust emissions even further; in some cases up to a forty-two percent decrease as compared to petroleum-based diesel (McCormick 1037). As you can see, not only is biodiesel a viable, renewable energy resource, but also it is a leader in the race to reduce human-harming pollutants as byproducts of combustion.

In summation, along with the scientific evidence presented and resulting increase of public awareness regarding the benefits of biodiesel, *FUEL* also documents the growing participation of government agencies, businesses, celebrities, and others. With this growing awareness, and in turn, increasing use of biodiesel, many benefits, besides those concerned with health issues, have also been discovered. For example, *FUEL* uncovered an in invaluable energy relic from the presidency of Jimmy Carter (1977-1981). It was the Department of Energy's Aquatic Species Program, which examined the feasibility of a new form of biodiesel derived from algae. This government project concluded that ALL of America's fuel needs could be grown using only fifteen percent of the Sonoran Desert (18,000 square miles) and only cost $25 million over twenty years (qtd. Aquatic Species Program). Keep in mind that this was around 30 years ago! Also, by the time Carter left office, he managed to reduce America's energy usage by twenty five percent (M). Not only is biodiesel more feasible to produce in regards to the space needed, its obvious health benefits, and the lower cost of production, but it also yields more energy. Every 1 unit of energy (BTU) placed into the production of petroleum, it yields only 0.8 BTU per unit of oil (M). In other words, the production of petroleum is energy negative. On the other hand, for every 1 unit of energy (BTU) placed into the production of biodiesel, it yields 3 BTUs per unit of biodiesel (M).

With all of the time and money invested towards the research into the benefits of biodiesel, why don't we make the switch? Well, it is up to, you, the consumer to contact your congressman or your local gas station and demand biodiesel. Together we can make the world a better place.

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