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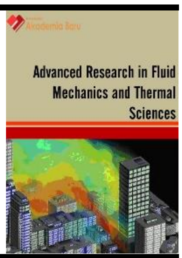

Biofuel Addition to Kerosene-A Way to Reduce the Level of Contamination

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Hasan Shakir Majdi[1], Laith Jaafer Habeeb[2], Miqdam Tariq Chaichan[3,*]

1 Mustaqbal University Collage, Babelon-Hillah, Iraq
2 Training and Workshops Center, University of Technology, Iraq
3 Energy and Renewable Energies Technology Center, University of Technology, Iraq

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ABSTRACT

This study suggests a solution to a substantial dilemma in Iraqi society. The pollutants resulted from Kerosene combustion in the stonemasonry ovens, which emits variable types of pollutants to the air and products. Biofuels produced from edible food wastes have been added to kerosene at different percentages to reduce toxicity levels, most notably the lead portion in kerosene. The results of the study show that the kerosene-biofuel blends are clean and free of lead and sulfur compounds, in addition to the availability of production potential. The use of food wastes in the production of biofuels is an economical solution to waste accumulation. The study was conducted on a stone kiln in Baghdad. Lead ratios were measured in kerosene samples and different proportions of kerosene-biofuels blends. The samples produced in the oven and two cases of the initial and final baking process were also analyzed. The results revealed that the process of mixing biofuels with kerosene reduces the proportion of lead, which is directly proportional to the proportion of biofuels, accompanied by an increase in the relative baking time (ineffective) due to the different calorific value of biofuels.

1. Introduction

White oil (Kerosene) is a chemical compound that contains a high proportion of heavy elements such as lead, vanadium and many decomposed substances. The combustion of oil-based compounds has a thick cloud of smoke, with relatively a large proportion of toxic substances such as; nitrogen oxides and polycyclic hydrocarbons (fluorine, thyme, and thionine) and lead [1]. Food exposed to such contamination causes a health risk to the human body such as allergies and asthma. Poisoning happens by heavy metals when it enters the human body and gets digested which will accumulate within its living tissues as biochemical compounds with concentrations over the Short-term exposure limit (STEL) causing the toxicity to accumulate or either a low long-term accumulate of toxicity leading

* *Corresponding author.*
E-mail address: 20185@uotechnology.edu.iq (Miqdam Tariq Chaichan)

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to occupational disease [2]. These minerals possess a high risk when accumulated and which built up in the human body faster than the body can process through the process of metabolism (metabolism) or output [3,4]. Lead is one of four metals that pose the greatest risk to human health [5]. Lead does not contribute to any systems of the human body functionality, but long-term exposure causes chronic effects or fever.

A large number of stonemasonry furnaces in Iraq use kerosene to produce different types of pastries and baked goods because of its availability at reasonable prices, in addition to the need for some baked goods to high temperatures. This excessive use of kerosene poses a new pollution problem that exposes the food security of the Iraqi citizen to many risks besides the problems of air, water and soil pollution that Iraq is currently experiencing [6]. The pollutants from burning kerosene in these furnaces interact with the flour, sludge and tools used. The bread produced in this way is an indicator of environmental pollution as it produces bread contaminated with heavy elements from different sources. Exhaust gases and furnace fumes cause contamination on stored wheat and all furnace tools [7]. Studies have shown that bread produced in kerosene ovens is more susceptible to hydrocarbons and heavy metals than bread baked in electrical ovens [8].

Iraq is one of the most important oil producing and exporting countries and has recently started exporting natural gas. This resource-rich country suffers from deteriorating infrastructure (due to 40 years of successive wars and a 13-year blockade) [9], especially fuel refineries, making Iraqi diesel and kerosene contain high sulphur content [10]. Many researchers have added several sulphur-free additives to reduce this ratio and to improve the combustion and contaminant properties of these products. The researchers added biofuels to diesel [11], others added water [1], and water mixed with nanoparticles [12]. Ekaab *et al.,* [13] studied the production of fuel which is a mixture of kerosene and biofuels. The study proved a significant improvement in the performance and pollutants emitted from the burning of this fuel in diesel engines.

Al-Rashdan *et al.,* [14] took samples and classified it into several categories: (1) bread made from white wheat flour, (2) bread made from brown wheat flour, and (3) sandwich bread made with white wheat flour. These samples were baked using gas oven toasting and the poisonous hydrocarbon materials were evaluated. Analysis of eighteen samples of baked bread confirmed the presence of 16 polycyclic aromatic hydrocarbons (PAHs).

Kerosene is a by-product produced during the oil distillation process in large quantities in Iraq. This product does not have many uses except in oil heaters that are used extensively in winter (this season is short and does not exceed two months per year), and in stone ovens (used throughout the year). Although this action is against all international regulations. This fuel is still used in stone ovens, which began to be used from the 1940s until today, and Iraqis have eaten their products since then. Although this baking process is not healthy due to the fact that it is affected by lead from burning fuel, it is permitted and is still spread all over Baghdad, the capital. Till today, Successive Iraqi governments have not enacted any legislation to prevent the use of this fuel in food products. In this study, samples of dough and product were checked, but the aim here is not to treat the food as much as to highlight the risks of burning kerosene in these furnaces.

After an in-depth research, we could not find any study on this topic, but we did find statistical research on this topic, where I tested different samples of products for a group of rock furnaces using different mixing ratios of hydrocarbon (white and black) oil) without discovering solutions to reduce the level of pollution in the production process. In order to detect the level of pollution in these products of these rock furnaces that use kerosene fuel either as part or as a whole of the combustion mixture. The study proposes a solution to reduce lead pollution by adding biofuels to kerosene as it is clean fuels free of lead and sulphur. This proposal is an elementary stage in the way to the final elimination of lead risks. This study focused on the followings

i. Investigating the lead concentration in the fuel used (white and black oil) in the stonemasonry furnaces in the city of Baghdad.
ii. Examine the type of fuel used in the furnaces and its association effect on lead contamination as well as the effect of distinctive stages of roasting in the percentage of lead contamination.
iii. The effect of adding biofuels to kerosene on the percentage of lead produced in furnaces.

2. Methodology
2.1 Biofuel Preparation

Biodiesel, or methyl ester, is a renewable, biodegradable and nontoxic alternative fuel produced using catalyst-oil extraction process as in Figure 1, which can be successfully utilized in various applications. In this study, a manufacturing process used to sterilize vegetable oil by mixing it with methanol. For the purpose of this study, used cooking oil was used due to availability and low cost.

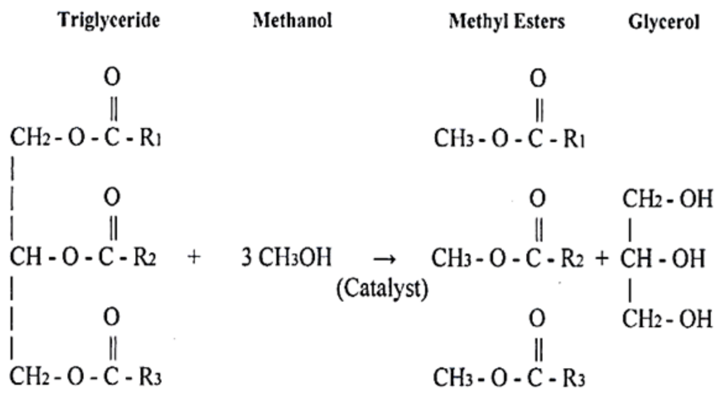

Fig. 1. Preparation process of biofuels (biodiesel) [15]

2.2 Preparation of Fuels Blends Used in The Study

A sample of the fuel (kerosene) used in the furnace was mixed with the produced biofuel at variable weight fractions. Physicochemical tests were conducted on the mixture as shown in Table 1.

Table 1
The physicochemical properties of the used blends

Physicochemical properties	Kerosene to biofuel ratio					
	K100 (kerosene)	K75B25 (75% kerosene+25% biofuel)	K60B40 (60% kerosene+40% biofuel)	K50B50 (50% kerosene+50% biofuel)	B100 (Biofuel)	International Kerosene specifications [16]
Density (kg/m^3)	806	819	837	828	868	810
Kinematic viscosity at 40°C (cSt)	1.37	2.1	3.14	2.55	4.88	2.71
Flash point (°C)	46	71.2	109.5	92	174	65
Cloud point (°C)	-	-2	2	-1	5	13
Poured point (°C)	-7	-5	0	-3	2	12
Lead concentration in fuel (mg/l)	0.42	0.11	0.18	0.13	0	0

It is very important to clarify here that the tests were carried out on the kerosene used at the time and on the manufactured biofuels, both of which are not fixed, as the specifications of kerosene change with the change of the crude oil extracted from it. Also, for the biofuel derived from waste vegetable oil, it may change in large range, depending on the supply of waste vegetable oil.

2.3 Proposed Working Method

A kerosene fuel oven in Baghdad has been selected for practical experiments. Samples of fuel mixtures (biofuels and kerosene) were prepared in special plastic containers and burned in the same way as the furnace works without any changes to the designs of the burner. Dough samples 1/4 kg from inside the kneading machine) were taken and packaged and stored in pre-sterilized plastic containers inside the refrigerator immediately to minimize microbial contamination. Random samples of bread produced from the oven were taken in two stages: the first stage 3.5 minutes after the dough was inserted into the oven and the second stage after finishing the final baking process. These samples were stored in plastic containers intended for this purpose. The general CODEX standard (Rev2-2006 CODEX STAN193-1990) was used in the collection of samples. During all tests, sterile gloves were worn, especially when collecting samples. All samples were examined using an atomic absorption spectrometer (4) in the laboratories of the Ministry of Commerce - General Company for Food Trade to determine the total lead content. The results obtained were compared with international, Arab and Iraqi standards and according to the allowable percentages of heavy metals in food as shown in Table 2.

Table 2
Maximum permissible heavy elements values in the food according to the specifications of International, Arab and Iraqi Standards (mg/l)

Specifications	Lead to mg/l
International	0.20
European	0.20
Egypt	0.50
Iraq	0.50

3. Results

Table 3 reveals that the highest concentration of lead existed in K100 with an average of 0.22 mg/l, for K70B25 the lead concentration was (0.18 mg/l) representing the impact of added biofuel. Biofuel effect on lead concentration become clearer when K60B40 and K50B50 were used as the lead concentration reduced to 0.13 and 0.11 mg/l, respectively. As for the dough contamination of lead, Table 3 manifests a clear effect of the kerosene percentage variation in the contamination of lead. The maximum lead concentrations achieved were in the samples baked with K75 and K100 (0.53 and 0.55 mg/l, respectively). The minimum lead concentration recorded when K50B50 was used (0.23 mg/l). Comparing the results of total lead concentration in the samples with the Iraqi Standard Specification No. 37 listed in Table 2, the concentration of the total lead in the samples of the dough baked with kerosene at percentages 75% and 100% exceeded the permissible limit. The lead pollution comes from kerosene combustion, which leads to contamination of flour, dough, kneading tools, machines, and workers. This result is harmonious with Zou *et al.,* [17], Torbica *et al.,* [18] and Soesilowati *et al.,* [19] results.

Table 3
Lead concentration (mg/l) for different fuel samples

Lead concentration in dough	Lead concentration in fuel	Fuel mixture ratio
0.55	0.42	100K
0.53	0.18	K75B25
0.28	0.13	K60B40
0.23	0.11	K50B50

Figure 2 indicates the difference in toxicity level after 3.5 minutes of the beginning of the baking process. The study demonstrated that 3.5 minutes is sufficient time for lead to accumulate on the dough. The samples of the furnaces when K100 and K75B25 used have a higher contamination rate (0.58 and 0.53 mg/l, respectively), while the toxicity level after the first baking stage is reduced in the furnaces using K60B40 and K50B50 as higher biofuels in the blends reduces lead concentrations to limits (0.22 and 0.16 mg/l, respectively). Comparison of these results shows that the total lead concentration in the first grilling stage is very close to the lead content in the dough before entering the oven. This indicates that the first barbecue stage (after 3.5 minutes) has no effect on the amount of lead accumulated in the oven. The concentrations are mainly due to the condition and duration of heating required in the preparation of the oven before starting to roast the dough. This period depends on the factor estimation of the condition of the oven, and some ovens shorten the heating period during the peak period, resulting in large amounts of smoke due fuel rapid combustion, which increases the lead contamination on dough in the oven during the early stages of baking.

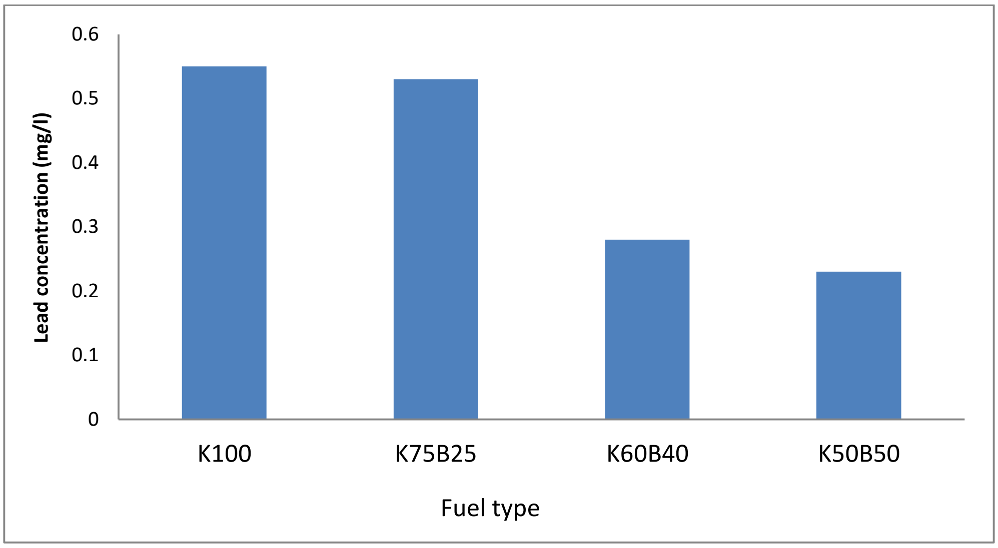

Fig. 2. Lead concentration (mg/l) for dough samples

Table 4 shows that the average level of lead in bread increased after the completion of the baking process compared to the lead content after 3.5 minutes of baking. The average lead when using kerosene only as fuel was 0.65 mg/l due to lead accumulation with time while the results differed completely when adding biofuels. The lead content in the K75B25 recorded a high lead concentration of 0.60 mg/l exceeding the allowable rate of heavy elements of the Iraqi standard. The burning of fossil fuels used in these furnaces can be considered an important cause of contamination of baked products in accordance with Khaniki *et al.,* [20] and Tajdar-oranj *et al.,* [21]. Therefore, this study recommends restricting the use of kerosene alone and it should be mixed with a high percentage of biofuels when burned in stone kilns. From the above results, it is preferable to use kerosene-biofuels blend such as K50B50 because it caused a significant decrease in lead concentrations (0.15 mg/l).

Continuous cleaning of baking tools and machines should also be emphasized as it contributes to lower pollution rates.

Table 4
Baking time effect on lead concentration (mg/l)

Fuel mixture ratio	Lead concentration	
	Done baking	After 3.5 min of baking
K100	0.65	0.58
K75B25	0.60	0.53
K60B40	0.32	0.22
K50B50	0.15	0.16

4. Conclusions

In this study, the concentration of lead in baked bread was measured in stone ovens using Iraqi kerosene as fuel. To reduce these concentrations, biofuel produced from food waste was studied using a catalyst extraction process. The results showed that the Iraqi kerosene contains 0.22 mg/l which causes high lead concentrations in dough and bread. The addition of biofuels to kerosene in a weight fraction of 25% did not reduce lead concentrations to acceptable level. The addition of biofuels by 40% and 50% showed a significant decrease in lead concentrations and made it below the maximum permissible heavy elements values by Iraqi standards. The results of the study support not to use Iraqi kerosene alone, but to add biofuels to it by at least 40% in order to maintain the health of citizens.

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