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Determination Emitted Gasses from Using Three Types of Woods in Grilling Meats

Abstract- The randomly using of different woods in grilling meats may cause several health and environmental effects due to various gasses emitted from burning such woods. The current work has examined the type and concentration of several emitted gases from burning raw tree wood, wood charcoal and palm fronds. This study has measured volatile organic compounds (VOC), carbon mono oxide (CO), ozone (O₃), hydrogen sulfide (H₂S) and sulfur dioxide (SO₂). The concentrations of these emitted gasses were measured at fire start point, 15, 30 and 60 minutes. It has been found that raw tree wood gave highest mean value of VOC ranged from 6.61 ± 0.57 to 173.67 ± 12.52 ppm whilst palm fronds showed mean values lying between 17.67 ± 2.726 ppm and 48.6 ± 0.123 ppm. On the other hand, wood charcoal had emitted mean values varying from 1.33 ± 0.17 to 2.97 ± 0.13 ppm. For carbon monoxide, raw tree wood gave mean values varied from 39.6 ± 4.65 ppm to 442.67 ± 71.6 ppm while palm fronds showed mean values ranged from 39.47 ± 4.706 ppm to 432.67 ± 51.598 ppm. In addition, wood charcoal has been found to have mean values varying from 17.67 ± 2.32 ppm to 62.33 ± 3.44 ppm. In case of ozone content, raw tree wood had almost similar mean values varied from 0.02 ± 0.0 ppm to 0.02 ± 0.01 ppm and palm fronds showed mean values ranged from 0.0267 ± 0.009 ppm to 0.0433 ± 0.005 ppm. In addition, wood charcoal had almost similar mean values ($0.04 \pm 0.0 - 0.043 \pm 0.03$) during all combustion intervals but higher than those of other burning materials. Regarding hydrogen sulfide, the raw tree wood had a range mean value of 4.43 ± 1.699 ppm to 23.37 ± 0.69 ppm. Palm fronds have given mean value varying from 1.267 ± 0.205 ppm to 1.267 ± 0.205 ppm. Meanwhile, wood charcoal smokes were free from H₂S. The sulfide dioxide emitted from raw tree wood showed mean value ranged from 0.33 ± 0.06 ppm to 1.173 ± 0.17 ppm. While palm fronds had almost constant mean values, during all combustion intervals, lying from 0.433 ± 0.205 to 2.4 ± 0.38 ppm. Wood charcoal had mean values varied from 0.3 ± 0.04 ppm to 0.57 ± 0.09 ppm.

Keywords- Raw tree woods, Palm fronds, Wood charcoal, Emitted gasses, Grilling

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1. Introduction

Various types of natural fuel substances such as tree woods and plant residuals had been used for quite long time as sources of energy for cooking, water heating and home stoves. Worthwhile the complete combustion of such wood does not occur and this means that such process causes emitted Smoke containing various gases. Chemical structure of such fuel sources consist of different materials and organic compounds such as sulfur, nitrogen, carbon and volatile organic compounds that released from consumption process of these heating substances [1-4]. Furthermore, such chemical release may have significant direct and indirect effects upon public health causing various syndromes [5-8]. Several works have focused on the wood combustion and assessed types and concentrations gases that released from home stoves, indoor fireplaces and found various chemical compounds such as volatile organic compounds, hydrogen sulfide, carbon and nitrogen oxides [9-11]. Other studies have identified and measured emitted gases from wood drying sites

[12-14]. In addition, several examinations were carried out on forest and tree burning in addition to plant degradations [15-17]. A study carried out previously [4] has examined the most common emitting gases from burning 10 types of different plant trees and reported elevated concentrations of VOC and other carbon and nitrogen compounds that have various effects on public health and environment. Other work carried out in Brazilian city [18] has assessed the amount of volatiles gases released (CO₂, CO and SO₂) from three cook stoves and found elevated levels of these gases in emitted smokes. A third research [19] has reported that the burning of 1 kg woods resulted in emitting 160 gm of toxic compounds such as tetra and hexa chlorinated toxins. It is obvious that such emitted gases particularly volatile organic compounds and subsequently had received much attention being the direct causes to induce various lethal diseases such as cancer [20-23] and other health problems [24-26]. Recently, most local communities over wide Iraqi are using various woody staffs particularly tree

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woods in grilling meats and this grilling process may be unsafe due to possible contamination of meats with toxic volatile organic compounds and other chemicals released from incomplete wood combustion. Therefore, this study was designed to examine emitted gases and chemicals such carbon monoxide, ozone, hydrogen sulfide, sulfide dioxide and volatile organic compounds.

2. Material and Methods

Three types of wood stuffs (palm fronds; wood charcoal, raw tree woods) used currently as a heat source were examined and a weight of 1.5 kg from each type was obtained. Each sample was divided into three subsamples to give a total of nine experimental unites with a weight of 0.5 kg each and placed in metal fireplace for burning. Measurements of volatile organic compounds, carbon monoxide, ozone, hydrogen sulfide and sulfide dioxide were recorded using portable devices such VOC meter and GIG multi-gas detector at four combustion intervals which were 0.0, 15, 30 and 60 minutes. This experiment was carried out only to assess most emitted chemical

species and concentrations and no test was made on grilled meats.

3. Results and Discussion

Table 1 shows mean value \pm standard deviation of VOC, CO, O₃, H₂S and SO₂ emitted from examined burned wood types at four combustion intervals. In general, wood charcoal had the lowest mean values of emitted gases during all combustion intervals except for ozone and was free of hydrogen sulfide while palm fronds and raw tree wood have varied significantly from each other (Table 1). Furthermore, raw tree wood gave highest mean values of carbon monoxide and lowest mean values of ozone. Palm fronds contained highest VOC mean values. However, It has been found that raw tree wood gave highest mean value of VOC which varied from 6.61 ± 0.57 at fire start point to 173.67 ± 12.52 ppm after one hour later while palm fronds showed mean values lying between 17.67 ± 2.726 ppm and 48.6 ± 0.123 ppm at 60 min and 30 min From firing process respectively. On the other hand, wood charcoal had emitted mean values ranging from 1.33 ± 0.17 to 2.97 ± 0.13 ppm at 60 and 30 min respectively (Figure 1).

Table 1: Mean value \pm standard deviation of VOC, CO, O₃, H₂S and SO₂ emitted from examined burned wood types at four combustion intervals

Type of wood	Combustion intervals	Mean value \pm standard deviation ppm				
		VOC	CO	O ₃	H ₂ S	SO ₂
palm fronds	0.0 min.	29.97 \pm 4.599	29.47 \pm 4.706	0.0267 \pm 0.009	5.83 \pm 0.287	1.7 \pm 0.09
	15 min.	36.23 \pm 1.597	352.67 \pm 51.598	0.0433 \pm 0.005	9.33 \pm 1.65	2.4 \pm 0.38
	30 min.	48.6 \pm 1.233	237.0 \pm 14.7	0.04 \pm 0.0	4.5 \pm 0.726	0.433 \pm 0.205
	60 min.	17.67 \pm 2.726	157.0 \pm 7.348	0.04 \pm 0.0	1.267 \pm 0.205	0.0 \pm 0.0
wood charcoal	0.0 min.	2.13 \pm 0.24	17.77 \pm 2.32	0.04 \pm 0.0	0.0 \pm 0.0	0.37 \pm 0.12
	15 min.	2.53 \pm 0.62	27.33 \pm 1.96	0.043 \pm 0.03	0.0 \pm 0.0	0.57 \pm 0.09
	30 min.	2.97 \pm 0.13	62.33 \pm 3.44	0.04 \pm 0.0	0.0 \pm 0.0	0.33 \pm 0.03
raw tree wood	0.0 min.	1.33 \pm 0.17	27.67 \pm 3.18	0.04 \pm 0.01	0.0 \pm 0.0	0.3 \pm 0.04
	0.0 min.	6.6 \pm 0.571	39.6 \pm 4.65	0.02 \pm 0.0	4.43 \pm 1.699	0.533 \pm 0.094
	15 min.	16.6 \pm 1.451	4 \pm 2.37 \pm 71.6	0.02 \pm 0.0	5.83 \pm 0.471	1.1 \pm 0.08
	30 min.	24.93 \pm 1.746	257.0 \pm 24.5	0.02 \pm 0.01	23.37 \pm 0.69	1.73 \pm 0.17
	60 min.	173.67 \pm 12.52	180.0 \pm 9.35	0.02 \pm 0.0	11.47 \pm 0.806	0.33 \pm 0.06

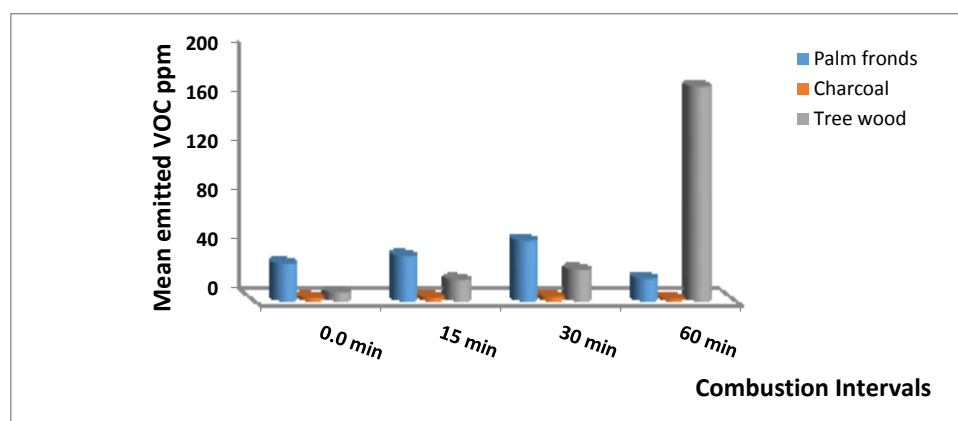


Figure 1: Mean VOC (ppm) emitted from burning palm fronds, charcoal and tree wood during combustion intervals

In case of CO, again raw tree wood had mean values ranging from 39.6 ± 4.65 ppm at fire start point to 442.67 ± 71.6 ppm after 15 minutes later whilst palm fronds had a range of 39.47 ± 4.706 ppm and 432.67 ± 51.598 ppm at starting point and 15 min later respectively. For wood charcoal, it has been found the lowest mean values (17.67 ± 2.32 ppm) was recorded at beginning period to 62.33 ± 3.44 ppm after 30 min (Figure 2).

Regarding ozone content, raw tree wood had almost similar mean values during testing period, which

varied from 0.02 ± 0.0 ppm to 0.02 ± 0.01 ppm while palm fronds showed mean values.

For hydrogen sulfide, it has been found that raw tree wood gave a rang mean value of 4.43 ± 1.699 ppm at the beginning to 23.37 ± 0.69 ppm after 30 min later. Palme fronds emitted highest mean value (1.267 ± 0.205 ppm) after 15 min and the lowest (1.267 ± 0.205 ppm) which was recorded at the burning end. Meanwhile, wood charcoal emits were free from this gas (Figure 4).

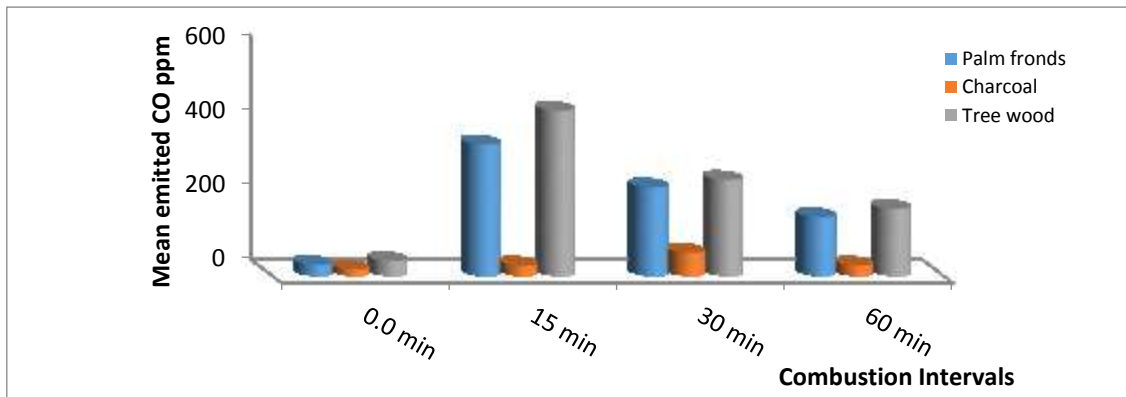


Figure 2: Mean CO (ppm) emitted from burning palm fronds, charcoal and tree wood during combustion intervals

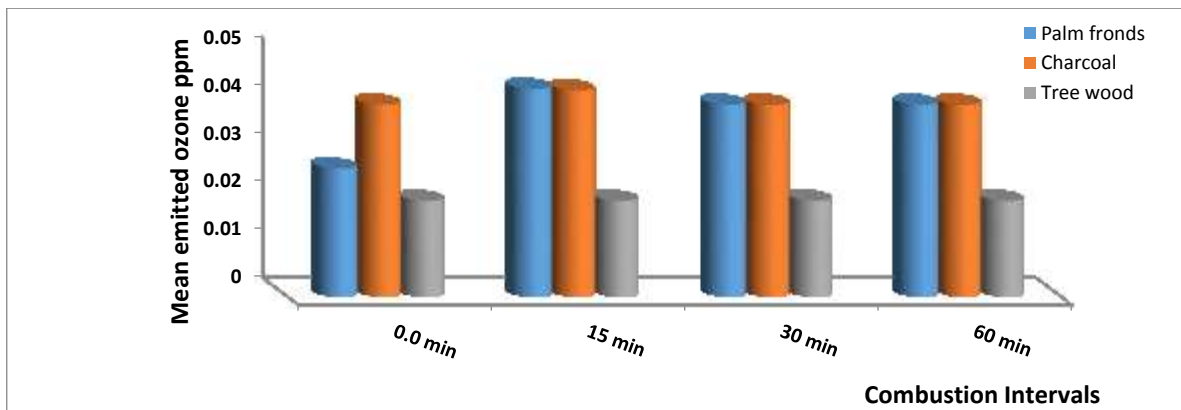


Figure 3: Mean ozone (ppm) emitted from burning palm fronds, charcoal and tree wood during combustion intervals

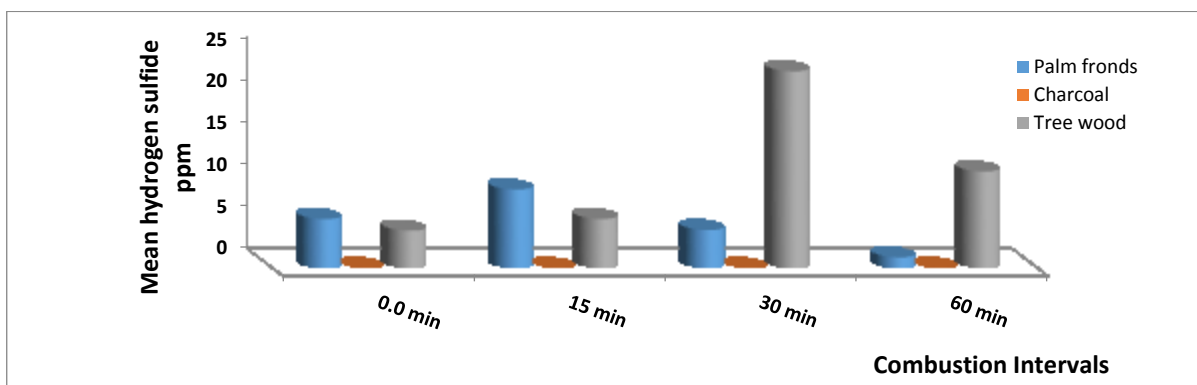


Figure 4: Mean hydrogen sulfide (ppm) emitted from burning palm fronds, charcoal and tree wood during combustion intervals

Meanwhile, the sulfide dioxide emitted from raw tree wood gave mean value varied from 0.33 ± 0.06 ppm at the end of experiment to 1.173 ± 0.17 ppm after 30 min from burning process. Whilst, palm fronds had stopped emitting such gas but gave measurable concentrations, which varied from 0.433 ± 0.205

2.4 ± 0.38 ppm at 30 and 15 min later respectively. Wood charcoal gave lowest mean value (0.3 ± 0.04 ppm) at the end of burning process while had highest value (0.9 ± 0.09 ppm) after 15 min (Figure 5).

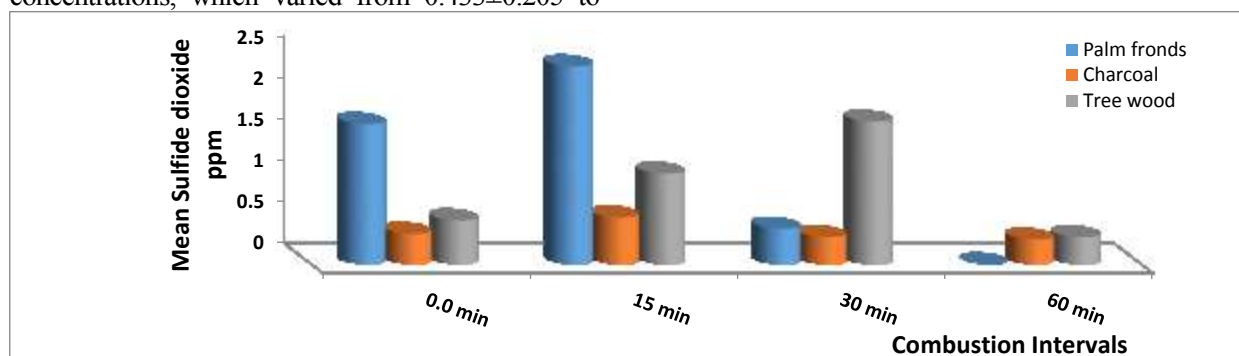


Figure 5: Mean sulfide dioxide (ppm) emitted from burning palm fronds, charcoal and tree wood during combustion intervals.

Interestingly, Palm fronds gave mean VOC concentrations higher than those released from raw tree woods at the first three combustion intervals (up to 30 min) but these concentrations were significantly decreased after 60 min to be much lower of those emitted from raw tree wood. In addition, similar pattern of concentrations was recorded in case of hydrogen sulfide. Apparently, the most environmentally problem is the existence of volatile organic compounds because they consist of many hazardous compounds such as terpenes and toluene and some of some compounds particularly terpenes may have the ability to combine with other air pollutants and forms a serious threat to public health [19, 27, and 28]. In addition, similar threat can be presented by toluene [29] and isoprene [30]. However, this work may need further investigations to examine all grilled meat using such combustion materials to assess the possible accumulated levels of these gases or even other emitted chemicals resulting from the combustion of any type of wood and to examine the impacts of such emitted chemicals upon public health and environment.

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