The Impact of Cooking Systems on Indoor Air Quality

Indoor air quality (IAQ) plays a crucial role in our health and well-being, yet it is often overlooked. Surprisingly, the air inside our homes, offices, and other indoor spaces can sometimes be more polluted than outdoor air. This is due to the accumulation of pollutants such as combustion by-products, dust, mould, and chemicals from various sources, including cooking systems.

Within the framework of the K-HEALTHinAIR pills (K-pills), we are exploring different issues affecting IAQ and identifying potential solutions to create healthier indoor environments. In this K-pill, we present preliminary results comparing the impact of two common cooking systems—electric and gas—on IAQ. As is widely known, combustion processes release a range of pollutants into the air, which can accumulate in poorly ventilated indoor spaces. Even when smoke is not visible, gas cooking systems emit particulate matter and harmful gases, alongside the usual CO_2 and water produced during combustion.

IAQ was monitored during two weeks in three different houses. The parameters provided by the monitoring tools (MICA by INBIOT) were carbon dioxide, CO_2, particle matter, $PM_{2.5}$, and formaldehyde. A simple questionnaire was filled by the home owners and main issues are shown in the Table 1.

Table 1. Main issues of the different studied kitchen.

	Kitchen 1 (K1)	**Kitchen 2 (K2)**	**Kitchen 3 (K3)**
Cooking system	Electric	Electric	Gas
Inhabitants	4	4	3
Smokers	NO	NO	NO
Ventilation	Manually through windows	Manually through windows	Manually through windows
Kitchen configuration	Independent kitchen from other rooms	Independent kitchen from other rooms	Independent kitchen from other rooms

The Table 2 presents the average, maximum, and minimum values for the three parameters analysed: concentration of CO_2, formaldehyde, and PM.

Table 2. Evolution of CO_2, PM and formaldehyde over the two-week period in each home.

		Kitchen 1 (K1)	**Kitchen 2 (K2)**	**Kitchen 3 (K3)**
CO_2 (ppm)	Average	654	493	729
	Maximum	1290	1058	2390
	Minimum	400	400	400
Formaldehyde ($\mu g/m^3$)	Average	30.75	15.52	80.70
	Maximum	462	324	455
	Minimum	1	1	0
PM 2,5 ($\mu g/m^3$)	Average	3.31	1.51	15.31
	Maximum	31	97	1161
	Minimum	0	0	0

First, the evolution of CO_2 concentration is shown in Figure 1 as a simple way to assess the ventilation level in the kitchens, showing that kitchen 3 displays the highest values, indicating that the ventilation level is likely lower and that there may be additional sources of CO_2 emissions besides human activity, such as, in this case, the gas stove.

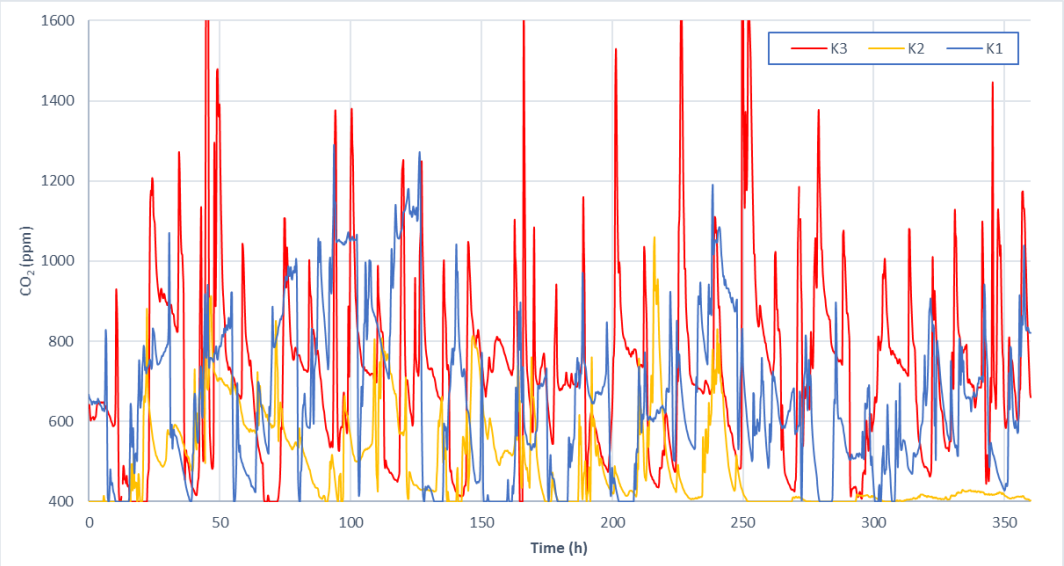

Figure 1. Evolution of CO_2 concentration.

Next, the evolution of formaldehyde concentration is presented in Figure 2. As can be observed, the baseline levels in kitchen 3 are also significantly higher, although the peak values are not as elevated. There are sources of formaldehyde, such as slightly burnt toast, but the combustion from the gas stove produces formaldehyde much more frequently.

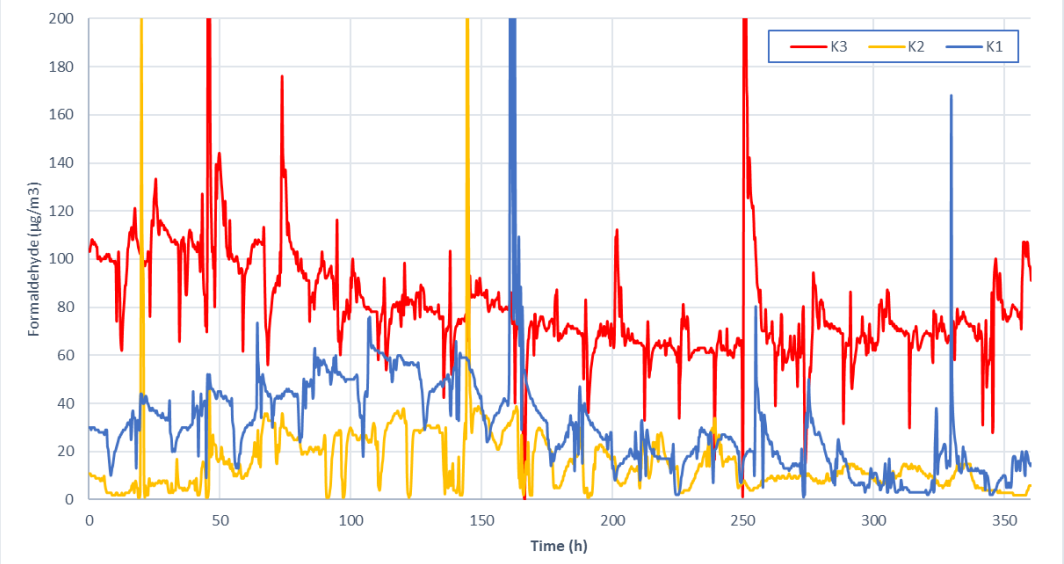

Figure 2. Evolution of formaldehyde concentration.

Lastly, the evolution of PM is shown in Figure 3 and it is also found that the air in kitchen 3 has significantly higher levels, both in average concentration (15 µg/m^3 compared to 1 and 3 µg/m^3) and in maximum value (1161 compared to 31 and 97 µg/m^3).

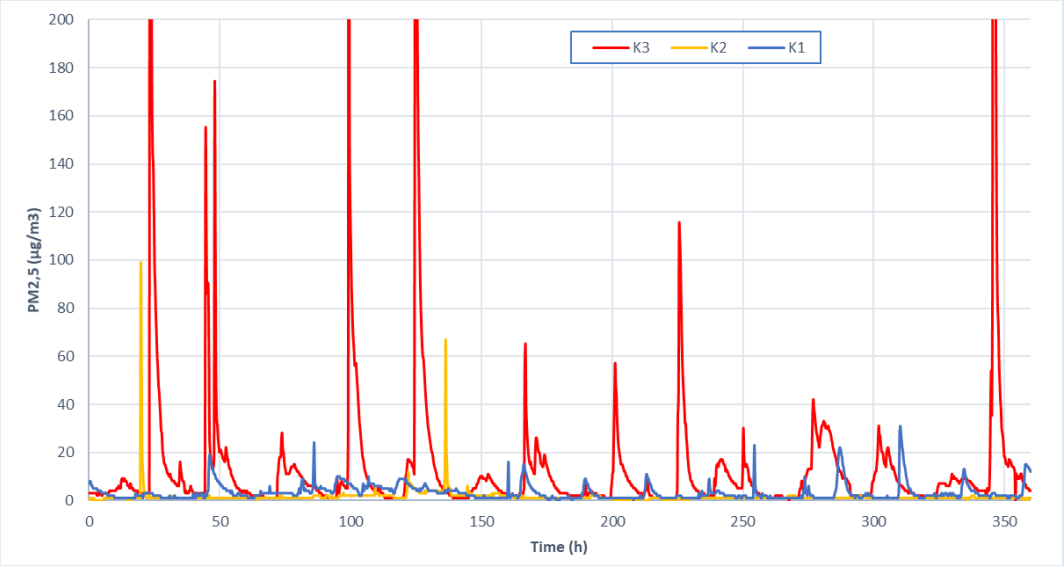

Figure 3. Evolution of $PM_{2.5}$ concentration.

In conclusion, the results from this study underscore the impact that gas cooking systems can have on indoor air quality, particularly in terms of elevated CO_2, formaldehyde, and $PM_{2.5}$ levels. According to the World Health Organization (WHO), the recommended annual average limit for $PM_{2.5}$ is 5 µg/m³, and short-term exposure (24-hour mean) should not exceed 15 µg/m³. The European Commission's current standard sets the annual limit at 25 µg/m³ for $PM_{2.5}$ but these are under revision. The values recorded in Kitchen 3 exceeded these limits, with peak concentrations reaching 1161 µg/m³. Such high exposure levels can pose serious health risks, especially for vulnerable groups like children, the elderly, or individuals with pre-existing respiratory conditions. Therefore, it is crucial to ensure proper ventilation and the use of hoods in kitchens, particularly in those using gas stoves, to reduce pollutant accumulation and protect occupants' health.