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The Use of Arduino Interface and Date Palm (*Phoenix Dactylifera*) Seeds in Making an Improvised Air Ionizer-Purifier

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Abstract: ***The objective of this research study is to create an improvised air ionizer-purifier out of Arduino Interface and Date Palm seeds to reduce indoor pollution with the use of eco-friendly and economical resources. For the detection of air pollutants, Arduino Interface, an open-source electronics platform based on easy-to-use hardware and software, was used for its boards to read inputs and turn them into outputs. Likewise, Date Palm seeds, a material with cleansing abilities, were used to create the activated carbon needed to make the air purification process more efficient. The improvised air ionizer-purifier functions as a cleanser of air pollutants and a creator of negative ions. Thus, it had three main components. The results of the study show the arrestance and dust holding capacity of the air purifier. Additionally, the air ionizer was proved through the air quality and the number of negative ions produced. Lastly, the sensor was tested over time. The results demonstrated that the improvised air ionizer-purifier was helpful in generating fresh air as a residential air purifier, contributing to the safety of the environment through effectiveness and detection time.***

Keywords: Air Ionizer, Air Purifier, Arduino Interface, Date Palm seeds, Indoor Air Pollution

I. INTRODUCTION

Nowadays, indoor air pollution is one of the world's major environmental problems as a result of burning fuel sources like wood causing respiratory-related illnesses such as bronchitis, emphysema, asthma, pneumonia, and cancer. The World Health Organization (2018) reported that each year, approximately 4 million people die prematurely from illness attributable to household air pollution nearly half of the pneumonia-caused among children under 5 years old were caused by particulate matter, specifically, soot, inhaled from household air pollution. Hence, air ionizers and purifiers have made significant impacts on people suffering from hay fever and other seasonal allergies. According to Arista Air Conditioning Corporation (2017), they can even remove up to 99 percent of airborne bacteria including dust, cigarette smoke, molds, soot, pollen, and household odors. In addition, they trap dust before it has the chance to settle, reducing build-up, leaving people with less to clean.

By generating a balanced stream of positively and negatively charged ions, an air ionizer neutralizes the static charge on insulated and isolated objects by drawing opposite polarity charges from the air to minimize and neutralize whatever static charge is present on objects in the work area. On the other hand, an air purifier uses layers of filters that can filter particulate matter which can contribute to having illnesses such as allergic respiratory disorders. There is ample evidence that air filtration reduces indoor particulate matter rates that could cause diseases (Sublett et al., 2010). Most air ionizers and purifiers need sensors to detect the number of pollutants in the air, thus, Arduino, an open-source electronics platform based on easy-to-use hardware and software, has boards that can read inputs like lighting a sensor and turn it into an output like activating a motor. Likewise, carbon filters, which use a bed of activated carbon, are needed to make the air purification process more efficient. Date Palm, or Phoenix dactylifera, is a widely cultivated and abundant plant across many tropical regions, especially in the Middle East, known for its sweet fruit called Dates. The seed, a scrap product of its fruit, is high in lignin, a unique hydrocarbon found in plants, making it practical for low-cost activated carbon production (Al-Balushi, 2016). Containing organic complex polymers abundant in plant cell walls, its seeds are used as precursors in making carbon fibers for air purification, specifically CO2 emission absorptions (Ogungbenro et al., 2017).

Through the use of scrap materials, ion generators, and air filters, this study will be able to reduce pollution. The air ionizer-purifier operates by producing negative ions. It will also be of help in lessening pollutants in the air. This study focuses on the use of date seed filters as well as the Arduino Interface to detect dust. The use of this study may also reduce the chances of having various diseases caused by indoor pollution.

II. METHODS

A. Research Design

This study utilized the experimental design of research. Tanner (2018) defined the experimental research design as being applied when the researcher is inquiring as to what the cause-and-effect relationships are between the dependent and independent variables. In this study, the Arduino Interface and Date Palm seeds are the independent variables and the improvised air ionizer-purifier is the dependent variable. Quantitative method was used to organize the experiment properly and to ensure that the right type of data is available to answer. It is necessary to use this method because it provides a high level of control over the variables that demonstrates an outcome and has an advantage in finding accuracy, consistency, and precision in its results.

B. Research Locale

The research study was conducted in one of the researchers' houses in Doha, State of Qatar, specifically in the New Al Thumama Area (Zone 50).

Figure2. The Location map of the researcher's house, Doha, Qatar (Google Maps, n.d.)

III. DATA ANALYSIS

This chapter brings about the results and interpretation of data that were collected from the assembling and testing of the product.

A. Effectiveness of the Air Ionizer out of Arduino Interface and Date Palm seeds in terms of

1) *Air quality on a Quarter-Hourly Basis:* The researchers assessed the air quality of the air ionizer on a quarter-hourly basis by using an air quality monitor. Additionally, other air conditioning units in the room had been switched off before the testing procedure.

TABLE I
Air Quality of the Air Ionizer on a Quarter-Hourly Basis

Minutes	15	30	45
Photos			
Air Quality (in µg/m^3)	0.121	0.107	0.162

Table 1 shows the air quality of the air ionizer on a quarter-hourly basis. In 15 minutes, the air ionizer had an air quality of 0.121 µg/m^3. In 30 minutes, the air ionizer resulted in an air quality of 0.107 µg/m^3. Lastly, in 45 minutes, the air ionizer showed an air quality of 0.162 µg/m^3.

Investigating the results even further, the air quality displayed effectiveness as it had minimal changes, proving its particle filtration efficiency. The ion generators of the improvised air ionizer were able to produce an improved indoor air quality. Similarly, the study conducted by Salthammer (2019) stated that an air quality value of 0.1 µg/m^3 is recommended. Moreover, the results are supported by the study of Liu et al. (2017) which stated that an air ionizer, an electrostatic air filter, can reach from 82% to 94% of particle filtration efficiency. Hence, the results showed the air ionizer's contribution to the reduction of indoor health concerns.

2) *Number of Negative Ions Produced on a Quarter-Hourly Basis:* The researchers tested the number of negative ions produced by the air ionizer on a quarter-hourly basis by using an air ion counter. Additionally, other air conditioning units in the room had been switched off before the testing procedure.

TABLE II
Number of Negative Ions Produced on a Quarter-Hourly Basis

Minutes	15	30	45
Photos			
Number of negative ions produced (ions/cm^3)	(-1x104 ions/cm^3) converted: 10000	(-1x104 ions/cm^3) converted: 10000	(-1x104 ions/cm^3) converted: 10000

Table 2 presents the number of negative ions produced on a quarter-hourly basis. As shown, for 15 minutes, the number of negative ions produced was -1x104 ions/cm^3. For easier understanding, the number had been converted and it resulted in 10000 ions/cm^3. For 30 minutes, the number of negative ions produced was -1x104 ions/cm^3, which is the same as 10000 ions/cm^3. For 45 minutes, the number of negative ions produced was also -1x104 ions/cm^3, which is equal to 10000 ions/cm^3. All three findings showed in the same number of negative ions produced.

Evaluating the results, the number of negative ions produced by the air ionizer on a quarter-hourly basis had no changes. This means that the number of negative ions produced is constant regardless of the period of operation. Moreover, Jiang et al. (2018) stated that the negative concentration of negative ions above 1000 ions/cm^3 was known to be the threshold value for fresh air.

B. Effectiveness of the Air Purifier out of Arduino Interface and Date Palm seeds in terms of

1) *Arrestance on an Hourly Basis:* The researchers calculated the arrestance of the air purifier on an hourly basis by using the formula (1 - weight of dust passing test filter/weight of dust fed) x 100 and with the help of a digital scale and calculator. Moreover, the air purifier was fed with powder to act as dust and was done in a non-air conditioned closed area.

TABLE III
Arrestance on an Hourly Basis

Hour/s	1	2	3
Photos			
Arrestance (in percentage)	39.13	75.00	92.43

Table 5 displays the arrestance of the air purifier per hour in percentage. In the first hour, the arrestance of the air purifier was measured to be 39.13%. In the second hour, the arrestance of the air purifier resulted in 75%. In the third hour, the arrestance of the air purifier was 92.43%. This shows that the air purifier can remove more dust the longer it functions.

The arrestance of the air purifier can be interpreted through the Minimum Efficiency Reporting Value rating chart. According to the United States Environmental Agency (2020), a MERV rating describes and compares the abilities of different air purifier filters in capturing particles. The rating scales from 1-20, the lowest is for basic filters and the highest is for filters suitable for facilities like laboratories. The arrestance of the first hour falls under the MERV 1 rating. This indicates that the air purifier can block particles like carpet fibers and lint. The arrestance of the second hour falls under the MERV 3 rating. This rating applies to filters fit for removing dust mites, sanding dust, and spray paint dust. The arrestance of the third hour falls under the MERV 8 category. This means that the air purifier can now aid in removing mold spores and aerosols like hairspray. Furthermore, Trey (2020) mentioned that MERV 5 – MERV 8 filters greatly purify and eliminate most dust, soot, and etc. as they are more effective than higher rated filters when replaced regularly.

2) *Dust Holding Capacity on an Hourly Basis:* The researchers calculated the dust holding capacity of the air purifier on an hourly basis by multiplying the mass of the dust fed to the arrestance of each respective hour. The test was done with a digital scale and calculator.

TABLE IV
Dust Holding Capacity on an Hourly Basis

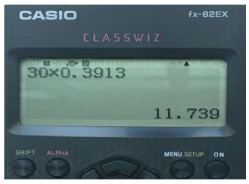
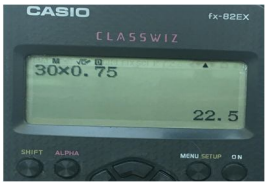
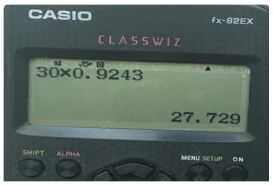
Hour/s	1	2	3
Photos			
Dust Holding Capacity (in grams)	11.74	22.5	27.73

Table 6 shows the dust holding capacity of the air purifier per hour in grams. During the first hour, the air purifier can hold 11.74 g of powder. During the second hour, the air purifier can hold 22.5 g of powder. During the third hour, the air purifier can hold 22.73 g of powder. These results show that the air purifier's dust holding capacity increases with the time of its use.

In addition, it can be seen that the dust holding capacity and the arrestance of the air purifier are directly proportional. This means that the higher the arrestance, the more dust will be collected by the air purifier.

C. Time for the Sensor to Detect Dust

The researchers tested the time it takes for the sensor to detect dust by placing powder near the sensor and recording its time of fall up to its time of detection. The sensor can have the time detection of dust programmed.

TABLE V
Time for the Sensor to Detect Dust

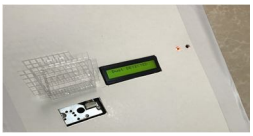
Trial No.	1	2	3
Photos			
Arduino Software	delay for 3000 milliseconds	delay for 3000 milliseconds	delay for 3000 milliseconds
Time (in seconds)	3.0	2.9	3.1

Table 7 shows the different trials of the sensor to check its consistency. In the first trial, the sensor was able to detect the powder with a delay of 3.0 seconds. In the second trial the researchers tested, the sensor was able to detect the powder with a delay of 2.9 seconds. In the third trial, the sensor was able to detect the powder with a delay of 3.1 seconds. These show the minimal changes in the detection time of the sensor.

Delving deeper into the result, it can be stated that Arduino used little storage and power while allowing sensors to remotely send accurate alerts after detection as Bahrudin et al. (2013) conducted a similar study that explained Arduino Interface's hardware reduced the possibility of false alerts reported. These findings suggest that Arduino Uno was efficient in transmitting data. Comparably, the study of Singh et al. (2018) mentioned that after testing for various conditions, Arduino Uno gave smart operating of home appliances as it provided information.

IV. DISCUSSIONS

This chapter presents the summary, conclusions, and recommendations which were all based on the gathered and interpreted data. The results were based on the questions stated in the previous part of this paper. This chapter describes the result of the improvised air ionizer-purifier made of Arduino Interface and Date Palm seeds.

A. Summary

Air ionizers and purifiers, though different in modes of operation, are both used to reduce indoor air pollution. Specifically, in the aspect of a person's health, air purifiers trap the contaminants while air ionizers release negatively charged ions, both lessening the pollutants inside the home. Hence, the risk of respiratory diseases is lessened. Date Palm seeds contain activated carbon used in air purification, specifically CO2 emissions. Additionally, Arduino Interface serves as an easy-to-understand solution to many innovative applications. This study aimed to create an improvised air ionizer-purifier out of Date Palm seeds and Arduino Interface to lessen indoor air pollution. This study sought to evaluate the air ionizer in terms of its air quality and number of negative ions produced. It also tested the air purifier through its arrestance and dust holding capacity. Lastly, the study examined the sensor for dust.

This research tackled on creating an improvised air ionizer-purifier out of eco-friendly and economical materials. To further evaluate the qualities of the product, the improvised air ionizer-purifier was examined through effectiveness. Furthermore, detection time was also measured.

B. Summary of Findings

The following are the summary of results for each Statement of the Problem of this study.

1) Effectiveness of the Air Ionizer out of Arduino Interface and Date Palm seeds in terms of:

a) *Air Quality On A Quarter-Hourly Basis:* The air quality was tested through the use of an air quality monitor. At 15 minutes of functioning, the air quality was 0.121 µg/m^3. With 30 minutes of functioning, the air quality was 0.107 µg/m^3. At 45 minutes of functioning, the air quality was 0.162 µg/m^3. During these trials, the air quality had minimal changes.

b) *Number Of Negative Ions Produced On A Quarter-Hourly Basis:* The number of negative ions was tested through the use of an air ion counter. All three trials performed had indicated the same number of negative ions produced, which was 10000 ions/cm^3.

2) Effectiveness of the Air Purifier out of Arduino Interface and Date Palm seeds in terms of:

a) *Arrestance On An Hourly Basis:* The arrestance of the air purifier was tested by feeding powder into the air purifier and using the formula (1 - the weight of dust passing test filter/weight of dust fed) x 100. The arrestance percentages per hour were 39.13%, 75.00%, and 92.43%.

b) *Dust Holding Capacity On An Hourly Basis:* The dust holding capacity of the air was tested by multiplying the mass of the dust fed to the arrestance of each respective hour. The first hour's dust holding capacity was 11.74 g. The second hour's dust holding capacity was 22.5 g. The third hour's dust holding capacity was 27.73 g.

3) Time for the Sensor to Detect Dust

The time for the sensor to detect dust was tested through the use of a timer. There were minimal changes in the detection time of the sensor. The sensors detected dust on Trial 1, Trial 2, and Trial 3 with a delay of 3.0 seconds, 2.9 seconds, and 3.1 seconds respectively.

V. CONCLUSIONS

The findings based on the statistical analysis of data lead to the following conclusions:

1) The air ionizer has proved its effectiveness under its air quality and number of negative ions both produced on quarter-hourly bases.

a) As its air quality showed an average value of 0.1 µg/m^3, it can be said that the air ionizer was able to show effectiveness.

b) The number of negative ions produced by the air ionizer always showed 10000 ions/cm^3. Hence, it is proven helpful in generating fresh air.

2) The air purifier has verified its effectiveness in terms of its arrestance and dust holding capacity on hourly bases.

a) The air purifier is categorized under the MERV 8 rating with a final arrestance of 92.34%. The air purifier is capable of removing several air impurities ranging from powders to aerosols, thus showing its effectiveness as a residential air purifier.

b) The dust holding capacity is directly proportional to its arrestance, therefore being able to productively hold any amount of dust in line with its arrestance.

3) The consistent dust detection of the sensor has proved to be a factor in the safety of the environment. Demonstrating the usefulness of the system with an average of 3 seconds, Arduino Interface is well suited for a wide variety of applications related to environmental monitoring.

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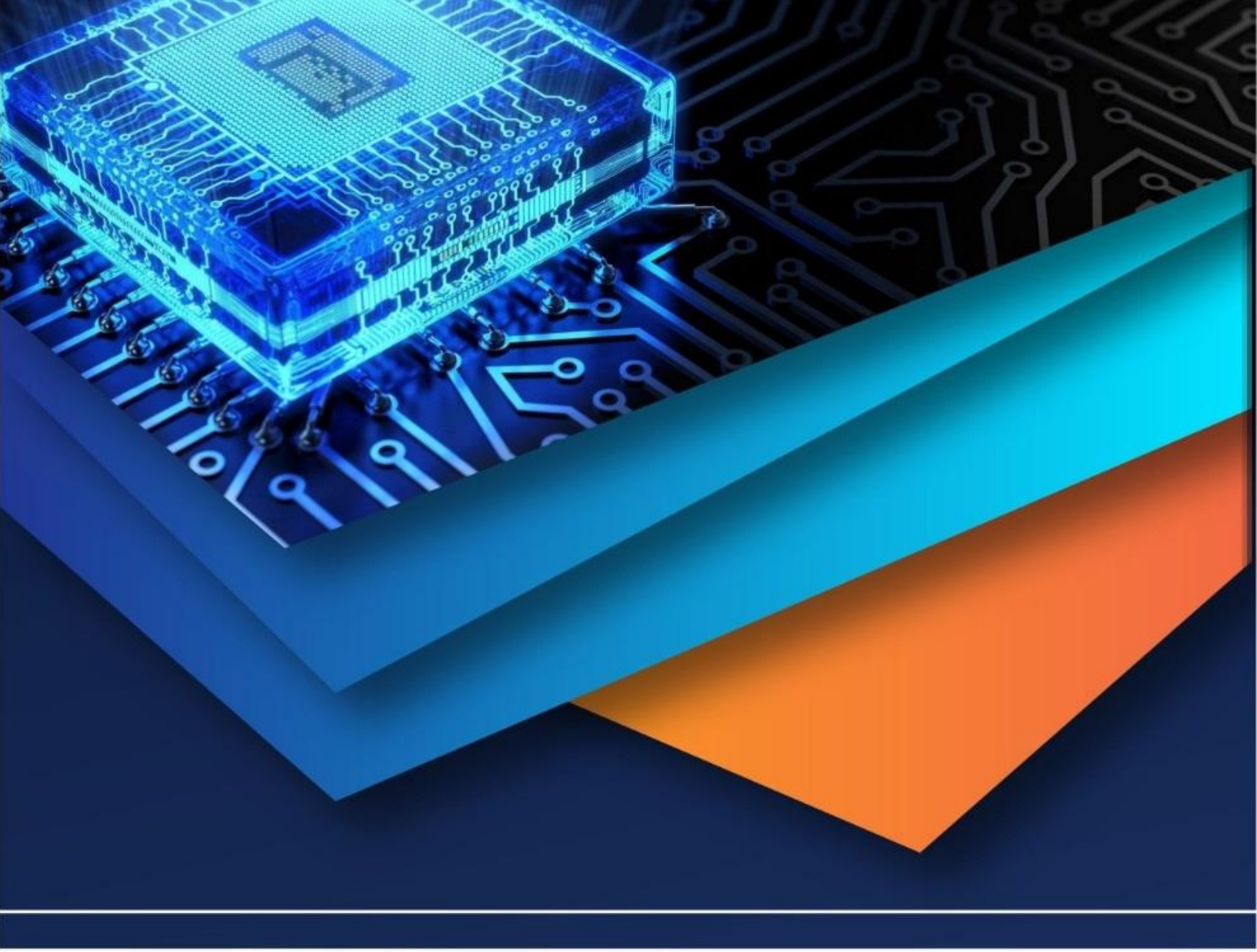
BIOGRAPHICAL SKETCH

Safia Lucille B. Barbacena is from Camarines Sur, Bicol. She was born on December 14, 2003. She was a bronze awardee in SY 2019-2020. She participated during the Science Olympiad in SY 2019-2020. She enjoys reading, learning languages, and playing various musical instruments. She lives by the quote “A loving heart is the truest wisdom.”

Roma Angelica N. Manaois is from Mangatarem, Pangasinan. She was born on November 20, 2004. She has been part of the top section of Philippine School Doha for 9 consecutive years. She is currently a grade 10 student and is The Link’s JHS Head. She is also the class president of her batch. She believes in the quote “Faith is taking the first step even when you don’t see the whole staircase.”

Mikhaela Gerrylen D. Palabrica is from La Carlota City, Negros Occidental. She was born on May 1, 2005. She has been a student from the top section of Philippine School Doha for 5 years. She was a silver awardee for SY 2019-2020. She participated in the school’s Sipnayan SY 2018-2019 and Mr. and Mrs. Intramurals SY 2019-2020 events, winning 1st runner-up for both contests. She swears by the quote “Strive for progress, not perfection.”



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