Hindawi
Journal of Nanomaterials
Volume 2022, Article ID 2834206, 10 pages
https://doi.org/10.1155/2022/2834206

Research Article

A Study on the Application of Solar Cells Sensitized With a Blackberry-Based Natural Dye for Power Generation

Alamry Ali,[1] Shukur Abu Hassan,[2] Amal BaQais ,[3] and J. S. Binoj[4]

[1]*Department of Mechanical Engineering, College of Engineering in Al-Kharj, Prince Sattam Bin Abdulaziz University, Al-Kharj 11942, Saudi Arabia*
[2]*Centre for Advanced Composite Materials, Office of Deputy Vice-Chancellor (Research & Innovation), Universiti Teknologi Malaysia, Johor Bahru, 81310 Johor, Malaysia*
[3]*Department of Chemistry, College of Science, Princess Nourah Bint Abdulrahman University, P.O. Box 84428, Riyadh 11671, Saudi Arabia*
[4]*Micromachining Research Centre, Department of Mechanical Engineering, Mohan Babu University, Tirupati, 517102 Andhra Pradesh, India*

Correspondence should be addressed to Amal BaQais; aabaqeis@pnu.edu.sa

Received 27 December 2021; Revised 29 January 2022; Accepted 3 February 2022; Published 21 February 2022

Academic Editor: Palanivel Velmurugan

This research paper is aimed at evaluating the use of natural dyes from blackberry (*Rubus glaucus*) obtained naturally for their subsequent application in laboratory solar cells to place them in dye-sensitized solar cells (DSSC) for the generation of electrical energy. The problem of the study is the high demand generated by global warming. Natural dyes were used to sensitize six solar cells, which were tested for their ability to absorb ultraviolet and visible light using a spectrophotometer in the ultraviolet-visible range, a solar simulator, and a current-voltage tester. The voltmeter was used to show how much energy each solar cell emitted over eight to 18 hours of daylight, with a required absorbance of 400-500 nm using six solar cells that had been sensitized with natural dyes. To reduce the high demand generated by global warming, use natural dyes from plant species as a supplement to improve efficiency in capturing renewable energy (solar) and converting it into electrical energy. Blackberries are lyophilized and then macerated for one day at room temperature in a dark, cool place to maximize dye's absorption. With two electrodes, the photo and contra, and an electrolyte in between, a Gratzel-type DSSC can be built. Using the doctor blade technique, the titanium dioxide film is added to the fluorine-doped tin oxide (TiO2) in the photoelectrode. By immersion, a natural colourant is then applied. TiO2 glass with a platinum film deposited on it serves as the counterelectrode.

1. Introduction

Currently, there is a high increase in the population and, at the same time, the technology with new devices that consume energy; however, the greatest energy demand comes from nonrenewable sources. Many of them are running out, motivating economists and scientists to look for cheaper and more ecological alternatives comparable to fossil fuels [1]. During the last years, humanity's scientific and technological development has been facing the great consumption of energy and controlling the levels of CO_2 emissions to reduce the greenhouse effect. So, the need to look for alternatives such as renewable energy arises. Several international agreements were signed to reduce pollution, such as the 2002 Kyoto protocol, dividing energy sources into the wind, geothermal, hydroelectric, tidal, and solar energy. Solar energy is one of the most abundant, clean, and renewable energy sources, so solar cells have become an alternative. Many of them are made of silicon. However, manufacturing costs are high. The electrode is also called an anode; the thickness of its broadband layer is microns of TiO_2. It has a semiconductor function in which it is not sensitive to light, so the

Table 1: Sample quantity.

Sample name	1	2	3	4	5	6	7	8	9
Blackberry	50 g	52.5 g	55 g	57.5 g	60 g	62.5 g	65 g	67.5 g	70 g

Table 2: Techniques and instruments and equipment, materials, and supplies.

Techniques and instruments		
Technique	Instrument	Sources/informants
Documentary analysis	Summary tabs	Books, articles
Observation	Data collection sheets	For the dye extraction process
Chemical analysis	Spectrophotometer	For absorbance of films and colorants.
Equipment, materials, and supplies		
Spectrophotometer	Materials	Supplies
Multimeter	Porcelain mortar	Titanium dioxide Degussa P25
Electronic scale	Erlenmeyer flask	Acetyl acetone
Solar cell	Foil	Distilled water
Multimeter	Magic tape	Triton X-100
Stirring plate and magnet	Glass substrate	Hexane
Spectrophotometer	Stove	Chloroplatinic acid
	Beaker, filter paper	Hydrochloric acid

titanium oxide particles have to be sensitized with the layer of dye molecules since they are capable of absorbing light in the visible spectrum. The electrode consists of placing a layer of TiO_2 nanoparticles to produce a TiO_2 film by sintering it at 450 and 500°C with a thickness of 10 μm; this TiO_2 film normally contains larger particles (250-300 nm), which they scatter the incident photons to capture the light better; the porosity in the film is of great importance since the redox ions of the electrolyte must fulfil the function of entering the film [2–4]. However, the technology of solar cells has been progressing more and more, testing 3 generations: silicon (first generation), thin layers of semiconductor (second generation), and dye sensitized by third-generation DSSC (dye-sensitized solar cells), being easy to manufacture and low cost, unlike conventional cells [5–7]. The typical architecture of a DSSC consists of a "sandwich" arrangement that is mainly composed of four parts: (a) photoanode (semiconductor oxide deposited on a transparent substrate), (b) light-sensitizing dye, (c) electrolyte (for redox), and (d) counterelectrode (generally a thin film of Pt or carbon graphite. According to Valles (2016) [8] in "Optimization of the adsorption time of natural photosensitive pigments on titanium dioxide to increase the efficiency of organic solar cells," the main objective was to obtain the optimal adsorption time of the dye on the TiO_2 semiconductor for greater cell efficiency (DSSC), the methodology used in a laboratory where 36 solar cells were prepared, for each adsorption time implemented in the research. The efficiency of the DSSCs was characterized with equipment that simulated solar irradiation of 1000 watt/m^2. According to the efficiency in volts, two efficient dyes for solar cells were obtained as a result, from plants such as *Baccharis latifolia* and *Gladiolus hortulanus* presenting 0.43 V and 0.50 V, respectively. We can find natural colourants in fruits and flowers easy to extract by elementary methods. Besides being low cost, free of toxicity, and biodegradable, they are advantages for implementing a DSSC [9, 10]. Sensitizers in DSSC have included a variety of natural dyes [6]. The goal of this project is to enable people in our country learn about, use, and understand different natural or clean technologies that can generate power without harming the environment. Graze-type sensitized solar cells with blackberry and pumpkin dye were employed to meet the goals of this study. The fundamental issue in distant places with limited resources has always been a shortage of light; this sensitized solar cell system will demonstrate that it may be of tremendous assistance in this situation because the cost of implementation is inexpensive. In this manner, it will be possible to determine the advantages it will provide as well as the repercussions that other sources, such as the problem to health and the environment, will be known. Through the results obtained, it will be possible to change the lifestyle of the human being and their awareness; that is, it will be learned that there are different methods to generate energy without harming the environment. Considering two hypotheses: in general hypothesis, we have the use of solar cells sensitized with blackberry dye has a significant influence on the generation of electrical energy. And as a null hypothesis, the use of solar cells sensitized with blackberry dye has an insignificant influence on the generation of electrical energy. The objectives of this research are based mainly on evaluating the use of solar cells sensitized with blackberry dye for the generation of electrical energy, comparing the efficiency of blackberry with existing studies in the energy generation process, measuring the absorbance of the glass plates of the cells sensitized by the dyes of blackberry, and showing that

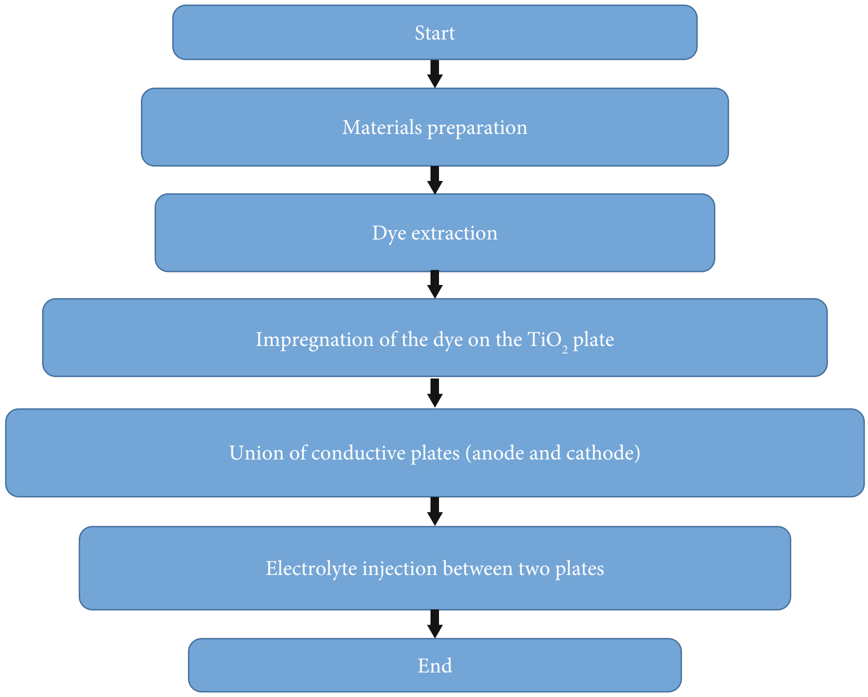


Figure 1: Flow chart of the cell manufacturing process.

Table 3: TiO_2, photoelectrode, and counterelectrode.

Materials	Process
TiO_2 dioxide	
Titanium dioxide Degussa P25	We add 12 g of Degussa P25 titanium dioxide to a porcelain mortar.
Porcelain mortar	Add 0.4 ml of acetylacetone and 3.6 ml of distilled water and stir for 5 minutes.
Acetyl acetone	We add 16 ml of distilled water slowly to the mixture.
Distilled water	We add 0.2 ml of newt X-100 to the mixture that will help us to disperse it on the substrate.
Triton X-100	
Photoelectrode	
2.5 × 2.5 cm glass plate	We cover the glass plate with a fluorine-doped tin oxide film.
Tin oxide with fluorine	Wash the glass plate with a solution of 10 ml of acetone and 10 ml of deionized water.
Titanium dioxide (paste)	Using the doctor blade method, we directly coat the glass plate with the titanium dioxide paste.
Natural dye	Then, it is passed to the oven at 450°C for 30 minutes.
Counterelectrode	
2.5 × 2.5 cm glass plate	We cover the glass plate with a fluorine-doped tin oxide film.
	Wash the glass plate with a solution of 10 ml of acetone and 10 ml of deionized water.
Chloroplatinic acid	We add chloroplatinic acid directly to the glass plate.
	Then, it is passed to the oven at 450°C for 30 minutes.

the presence of electricity can be generated from blackberry dye. The present investigation has the type of applied investigation since it has an information base with theoretical knowledge to be carried out. With a correlational level, we will evaluate the data obtained from the measurements of the two variables. The design is experimental because the variables are manipulated. This shows that if the values of the independent variable (sensitized solar cells) are changed, the values in the dependent variable (generation of electrical energy) will be modified.

The variables, both dependent and independent, will be reliant on power generation in order to ensure study compliance; these include the following: dependent variable: electric power generation; independent variable: sensitized solar cells.

2. Material and Methodology

In power generation, these variables, dependent and independent, are going to depend, which are of the utmost

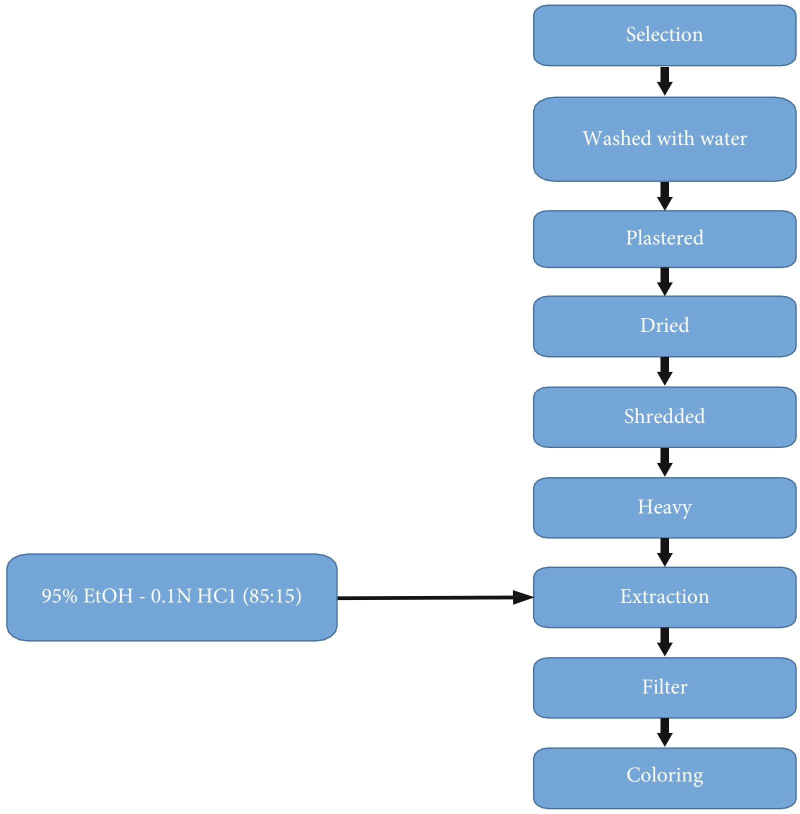


Figure 2: Flowchart of the process of extracting the blackberry.

Table 4: pH of blackberry dye.

50 gr	52.5 gr	55 gr	57.5 gr	60 gr	62.5 gr	65 gr	67.5 gr	70 gr	72.5 gr
3.3	3.4	3.3	3.4	3.4	3.3	3.6	3.5	3.6	3.6

importance to achieve compliance with the study; these are the following:

Dependent variable: electric power generation

Independent variable: sensitized solar cells

2.1. Population, Sample, and Sampling. Population: this research work was developed in Baghdad to obtain electrical energy from the blackberry commercialized in the area.

Sample: 10 samples from 1 kg of blackberry of the blackberry will be made; with 50-70 g of blackberry, the use of each sample per gram is shown in Table 1.

2.2. Data Collection Techniques and Instruments, Validity, and Reliability. In this study, direct observation was used to measure the facts because it is a technique where the researcher combines all the data without manipulating the variables. In the data collection, the analysis of documents and measurement equipment was used since it will allow us to obtain very reliable research data. The techniques and instruments to use are shown below, along with a comparative in Table 2 that will be used to differentiate the results of the electricity generation of the blackberry dye.

Table 5: Technical specifications of the TRUPER MUT 105 multimeter.

Range	Resolution	Precision	Protection is overloaded
200 mV	0.1 mV	±(0.5% + 5)	230 V AC
2 V	1 mV		1000 V DC, 750 AC
20 V	10 mV		
200 V	100 mV		
1000 V	1 V	±(0.8% + 5)	

Spectrophotometer: spectrophotometry is a technique widely used in the branch of analytical chemistry where measurements are made of the exchange of energy with matter. And the result that we obtain represents the ratio of the intensity of the initial energy and final intensity. Some factors can influence the correct measurement, which could be noise, the stability of the equipment, the variation of the wavelength, the diffuse light, and the repeatability of the data collection of the samples, for which it is necessary for the team to have a validated certification, either by the most recognized in Iraq or a good sampling [11]. The light-catching

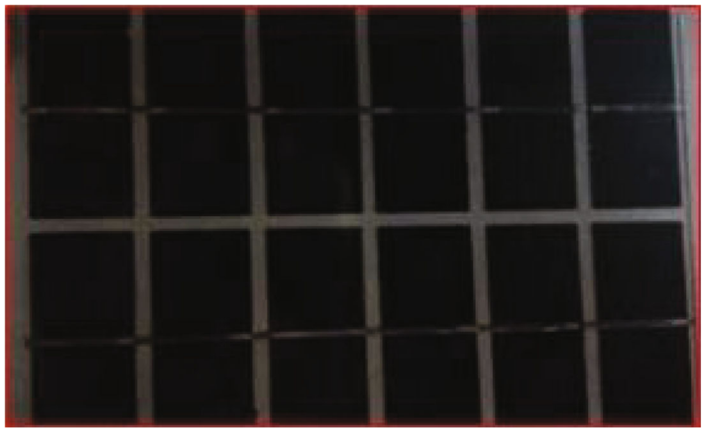


Figure 3: DSSC module.

pigments absorb and transfer the energy into the reaction, which constitutes the chlorophyll molecules, and the photochemical reaction is carried out. In carotenoids, there are conjugated double bonds, and it has the ability to capture and transfer energy, and these are measured by the spectrophotometer [12].

(i) Electronic scales. They are used as an instrument to find out and transmit data on the weight of objects; they are made of steel for their durability and accessibility

(ii) Erlenmeyer flask. This flask is used mainly in the laboratory; the characteristic it presents is its conical shape with a cylindrical neck, the base is flat, and its use is to heat liquids that are in danger of losing their evaporation, since this flask is and safe in avoiding the loss of substances

(iii) Porcelain mortar. This is a tool used to grind and mix substances; the mortar comes with a pestle where the round end is used for crushing or grinding; this can be made of porcelain and wood, carved stone, among others

2.3. Procedure. Once the methodology was established, it was decided to continue with the initiative, establishing a sequence of activities that are shown in Figure 1.

The photoelectrode and the counterelectrode have a thin layer of fluorine-doped tin oxide TiO_2. Since it is one of the characteristics of a DSSC for low resistance, 5-10 ohm/plate with transparency to solar radiation, this influences the throughput for light absorption and series resistance in two ways. We will call this substrate.

The sequence of activities for the extraction of blackberry:

(i) Take 615 g of blackberry cut into cubes (freeze-drying); this process is based on dehydrating it in airtight bags to provide a better colouring

(ii) Following this lyophilization process, 50 g of sample was used; they were crushed until obtaining a fine powder

Table 6: Voltmeter.

Sample	Sample	Sample
50 gr	52.5 gr	55 gr
3.3 pH	3.4 pH	3.3 pH
0.43 V	0.40 V	0.45 V

(iii) The powder obtained is introduced into the flasks with hexane as a solvent. This happened to be stirred for an hour, covered with aluminium foil, and then filtered

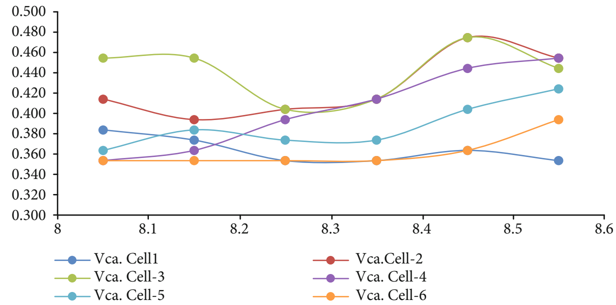
2.4. Titanium Dioxide TiO_2 (Paste). It is a low-cost semiconductor with photochemical, photocatalytic, and photovoltaic properties. Substantial progress has been made in recent years in developing methods to synthesize new structures, such as nanoparticles, nanorods, nanowire, nanosheets, nanotubes, and nanoporous material. To make the paste titanium dioxide, we will use the following materials (Table 3).

Photoelectrodes. They are used to obtain measurements of the data of the electrical measurements of the solar cells. We will do the same to measure the absorbance, with the difference that we will not use tin oxide so that it does not influence the absorbance measurement.

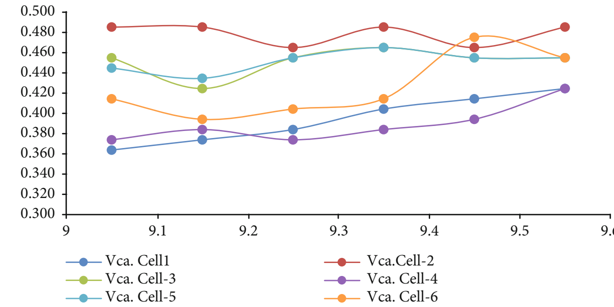
Blackberry extraction. Activity sequence of blackberry extraction is shown in Figure 2.

The blackberry is crushed to reduce its size and reduce drying time.

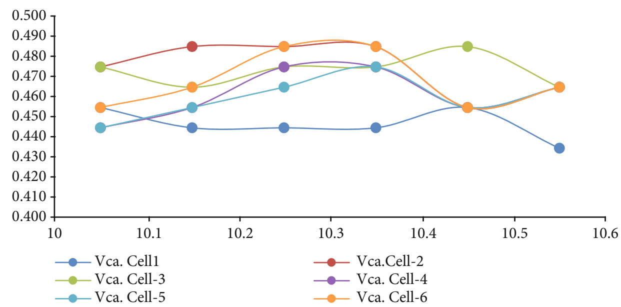
2.5. Data Analysis Method. The method to be used is ANOVA; it is a statistical method where it is possible to compare the acquired results obtained and thus contrast the hypothesis. The ANOVA method is used for situations where the quantitative response must be analyzed. We usually call a dependent variable under experimental conditions by categorical variables such as treatment and sex and called independent variables. When it shows only one variable under different experimental conditions, the analysis is named ANOVA of a factor [13]. The measurements were



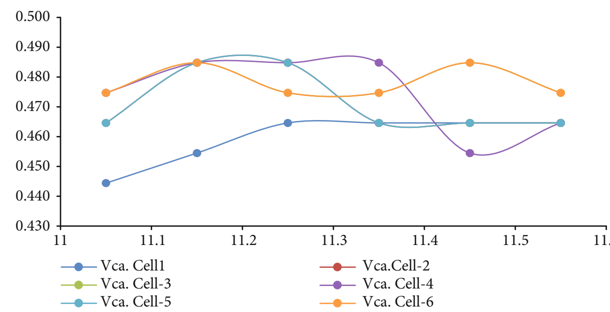
(a) The highest point was recorded at 8:45 in the cells (Vca. cell-2 and Vca. cell-3) with peaks of 0.47 V and the lowest in 0.35 V of the rank at 8:05 of the morning



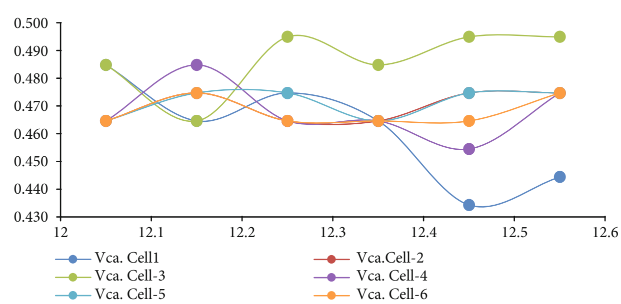
(b) The highest point was registered in cell 2 with peaks of 0.48 V and the lowest in 0.36 V. at 09:05 am



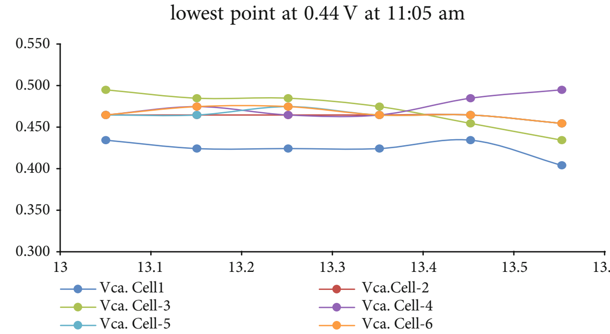
(c) The highest point was registered at 0.48 V and the lowest point at 0.43 V at 10:05 am



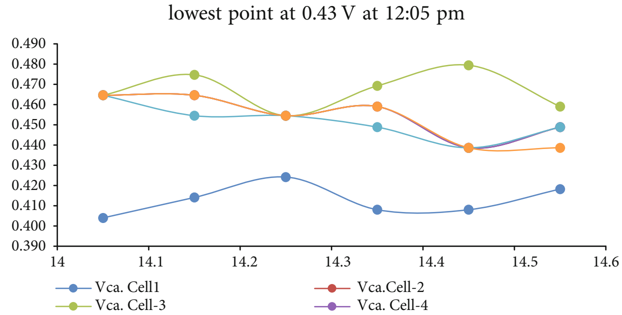
(d) The highest point was registered at 0.48 V and the lowest point at 0.44 V at 11:05 am



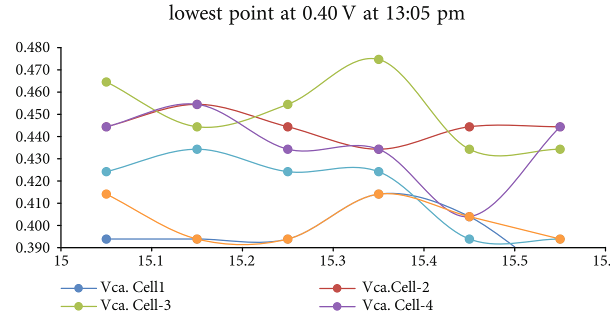
(e) The highest point was registered at 0.49 V and the lowest point at 0.43 V at 12:05 pm



(f) The highest point was registered at 0.49 V and the lowest point at 0.40 V at 13:05 pm

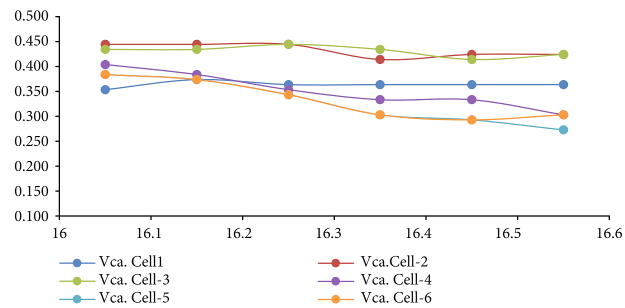


(g) The highest point was registered at 0.47 V and the lowest point at 0.40 V. at 14:05 pm

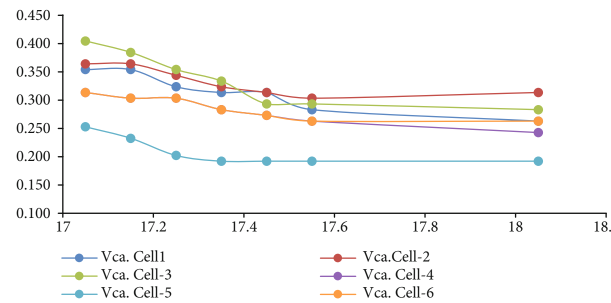


(h) The highest point was registered at 0.47 V and the lowest point at 0.37 V at 15:05 pm

Figure 4: Continued.



(i) The highest point was registered at 0.44 V and the lowest point at 0.27 V at 16:05 pm



(j) The highest point was registered at 0.40 V and the lowest point at 0.19 V at 17:05 pm

Figure 4: (a–j) The blackberry cell results that were obtained by recording the open-circuit voltage data, based on the day.

made for the time of 08:05 to know how much energy it generates at the beginning of the day.

Ethical aspects. This present work tries not to falsify results or data; that is, the integrity of the study will be taken into account, always respecting the intellectual properties of the authors who provide their contributions in books, theses, articles, among others, always citing correctly.

3. Results

When obtaining the colourant from the substrate of the blackberry, they were subjected to the validation of their pH; this affects its structure and stability because it is anthocyanin, and its acidity has a protective effect on the molecule; the pH measurement was carried out for each sample.

As shown in Table 4, taking advantage of solar energy depends on the solar radiation incident on the solar cells; the characteristic current-voltage curve must be taken into account; this curve represents the possible combinations of I and V in a solar cell, under the conditions of incident solar radiation. The highest performance of solar cells is obtained when a right angle is formed with the ray of sunlight. The circuit voltage will be recorded using a TRUPER MUT-105 category II and III digital voltmeter, as shown in Table 5.

To know how much energy the solar cell produces. First, the dye must be impregnated into the cell, it is going to immerse and then wait for it to dry, and later, using the voltmeter, the data of each cell (energy) will be known, as shown in Figure 3.

It was carried out according to the climatic conditions; for the data recording it was carried out on November 25, 2020, the solar cells were located, the orientation and the required inclination were observed to obtain good results, also avoiding the obstruction of the cells with the shadows, 6 suitable cells with good absorption were selected within all the samples that were carried out in the study, 6 blackberry cells, and they were formed as follows (Table 6 and Figure 4).

4. Discussion

According to Valles (2016) in “Optimization of the adsorption time of photosensitive natural pigments on titanium dioxide (TiO_2) to increase the efficiency of organic solar cells”, the main objective was “To determine the optimal adsorption time of the natural pigment on the semiconductor TiO_2 for greater efficiency of the dye-sensitized solar cell (DSSC),” plants such as *Baccharis latifolia* presenting 0.43 V and 0.50 V, respectively; on the other hand, in our research, we used the dyes from the blackberry *Rubus glaucus* maximum where solar cell showed us data from 0.26 V to 0.45 V in the day. According to Ahmed et al. (2019) [14], in solar cells sensitized with photosensitive dyes obtained from plants in the Iraqi region, whose objective of this research was the optimization of the dye extraction process in the study, the absorbance measurement data is 512 nm; in the same way, it was measured in this research work where the data provided by the spectrophotometer were 400, 500, 600, and 750 nm, which corresponds to the range of anthocyanins and is acceptable for light absorption. The solar cells used in this study were built using silicon solar cells that show to be low cost and of good efficiency; on the other hand, Lee et al. (2009) [15] carried out the manufacture and characterization of sensitized solar cells of TiO_2 nanoparticles modified with NiO, whose objective of his research was to contribute to the development of new energies to supply the needs of the population in the future; in the case of this author, the cost of inputs is much higher. Silicon provides good efficiency for the transport of energy; that is why silicon was used in the solar cell of this study for the colourant of blackberry, as well as Son et al. (2014) [16] in its model of cells sensitized by dye, whose objective of the research was to develop dye-sensitized silicon solar cell modules; a silicon module with an efficiency of 3.78% and a sensitized solar cell module were done; we managed to increase the absorbance of the TiO_2 substrates in comparison with making a TiO_2 substrate with only titanium dioxide. The solar cell with the best efficiency has been the carrot one.

A panel of 6 solar cells was done to generate enough energy to be used as a charger, but each cell generates 0.35 V on a not so sunny day at 0.45 V in an hour with a lot of solar energy; the blackberry is more efficient in time where the sun is not radiant because it is from the anthocyanin family as well as Shiyani et al. (2020) [11] in their work on research generation of electrical energy by sensitized photoelectrochemical cells with electrolytic silver plating at the laboratory level, electrical energy was generated using a photovoltaic panel made up of photoelectrochemical cells; the

Table 7: The results of the blackberry cells that were obtained when recording the open-circuit voltage data as a function of the day.

Hours (time)	Via. cell-1	Via. cell-2	Via. cell-3	Via. cell-4	Via. cell-5	Via. cell-6
8.05	0.384	0.414	0.455	0.354	0.364	0.354
8.15	0.374	0.394	0.455	0.364	0.384	0.354
8.25	0.354	0.404	0.404	0.394	0.374	0.354
8.35	0.354	0.414	0.414	0.414	0.374	0.354
8.45	0.364	0.475	0.475	0.444	0.404	0.364
8.55	0.354	0.455	0.444	0.455	0.424	0.394
9.05	0.364	0.485	0.455	0.374	0.444	0.414
9.15	0.374	0.485	0.424	0.384	0.434	0.394
9.25	0.384	0.465	0.455	0.374	0.455	0.404
9.35	0.404	0.485	0.465	0.384	0.465	0.414
9.45	0.414	0.465	0.455	0.394	0.455	0.475
9.55	0.424	0.485	0.455	0.424	0.455	0.455
10.05	0.455	0.475	0.475	0.444	0.444	0.455
10.15	0.444	0.485	0.465	0.455	0.455	0.465
10.25	0.444	0.485	0.475	0.475	0.465	0.485
10.35	0.444	0.485	0.475	0.475	0.475	0.485
10.45	0.455	0.455	0.485	0.455	0.455	0.455
10.55	0.434	0.465	0.465	0.465	0.465	0.465
11.05	0.444	0.465	0.475	0.475	0.465	0.475
11.15	0.455	0.485	0.485	0.485	0.485	0.485
11.25	0.465	0.485	0.475	0.485	0.485	0.475
11.35	0.465	0.465	0.475	0.485	0.465	0.475
11.45	0.465	0.465	0.485	0.455	0.465	0.485
11.55	0.465	0.465	0.475	0.465	0.465	0.475
12.05	0.485	0.465	0.485	0.465	0.465	0.465
12.15	0.465	0.475	0.465	0.485	0.475	0.475
12.25	0.475	0.465	0.495	0.465	0.475	0.465
12.35	0.465	0.465	0.485	0.465	0.465	0.465
12.45	0.434	0.475	0.495	0.455	0.475	0.465
12.55	0.444	0.475	0.495	0.475	0.475	0.475
13.05	0.434	0.465	0.495	0.465	0.465	0.465
13.15	0.424	0.465	0.485	0.475	0.465	0.475
13.25	0.424	0.465	0.485	0.465	0.475	0.475
13.35	0.424	0.465	0.475	0.465	0.465	0.465
13.45	0.434	0.465	0.455	0.485	0.465	0.465
13.55	0.404	0.455	0.434	0.495	0.455	0.455
14.05	0.404	0.465	0.465	0.465	0.465	0.465
14.15	0.414	0.465	0.475	0.465	0.455	0.465
14.25	0.424	0.455	0.455	0.455	0.455	0.455
14.35	0.408	0.459	0.469	0.459	0.449	0.459
14.45	0.408	0.439	0.479	0.439	0.439	0.439
14.55	0.418	0.449	0.459	0.449	0.449	0.439
15.05	0.394	0.444	0.465	0.444	0.424	0.414
15.15	0.394	0.455	0.444	0.455	0.434	0.394
15.25	0.394	0.444	0.455	0.434	0.424	0.394
15.35	0.414	0.434	0.475	0.434	0.424	0.414
15.45	0.404	0.444	0.434	0.404	0.394	0.404
15.55	0.374	0.444	0.434	0.444	0.394	0.394

Table 7: Continued.

Hours (time)	Via. cell-1	Via. cell-2	Via. cell-3	Via. cell-4	Via. cell-5	Via. cell-6
16.05	0.354	0.444	0.434	0.404	0.384	0.384
16.15	0.374	0.444	0.434	0.384	0.374	0.374
16.25	0.364	0.444	0.444	0.354	0.343	0.343
16.35	0.364	0.414	0.434	0.333	0.303	0.303
16.45	0.364	0.424	0.414	0.333	0.293	0.293
16.55	0.364	0.424	0.424	0.303	0.273	0.303
17.05	0.354	0.364	0.404	0.313	0.253	0.313
17.15	0.354	0.364	0.384	0.303	0.232	0.303
17.25	0.323	0.343	0.354	0.303	0.202	0.303
17.35	0.313	0.323	0.333	0.283	0.192	0.283
17.45	0.313	0.313	0.293	0.273	0.192	0.273
17.55	0.283	0.303	0.293	0.263	0.192	0.263
18.05	0.263	0.313	0.283	0.242	0.192	0.263

efficiency found was 0.26% in which it is suitable for use in processes of electrolytic silver, laboratory level. The colourant that obtained the best adsorption was purple corn; its voltage was high with 0.785 V; its anthocyanin concentration was 9.88 mg/g.

5. Conclusions

The complete evaluation was achieved by demonstrating step by step how the solar cells sensitized with blackberry dyes are capable of generating electrical energy, demonstrating through the voltmeter the amounts of energy that each solar cell emitted in a time range from 8 hours to 18.05 hours of the day, reaching a range of 4 V to 6 V using 12 solar cells sensitized with natural colourants. Since the desired absorbance was 400-500 nm, the absorbance measurement was critical in determining how much to work with. Six cells were chosen from that data, and Table 7 of six cells was created using that quantity in grams. Table 7 of cells demonstrated that electrical energy can be generated from natural substrates, that it is not necessary to use other sources that are costly or have negative environmental consequences, and that some clean techniques or tools, such as the cell phone that was shown to be charged using Table 7 of cells sensitized by blackberry dye, are beneficial for everyday use.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by the Princess Nourah Bint Abdulrahman University Researchers Supporting Project Number (PNURSP2022R230), Princess Nourah Bint Abdulrahman University, Riyadh, Saudi Arabia.

References

[1] R. Barreto, "Fossil fuels, alternative energy and economic growth," *Economic Modelling*, vol. 75, pp. 196–220, 2018.

[2] W. J. Jang, J. S. Cha, H. Kim, and J. H. Yang, "Effect of an iodine film on charge-transfer resistance during the electro-oxidation of iodide in redox flow batteries," *ACS Applied Materials & Interfaces*, vol. 13, no. 5, pp. 6385–6393, 2021.

[3] A. N. Zulkifili, T. Kento, M. Daiki, and A. Fujiki, "The basic research on the dye-sensitized solar cells (DSSC)," *Journal of Clean Energy Technologies*, vol. 3, pp. 382–387, 2015.

[4] M. B. Alazzam, A. T. Al-Radaideh, N. Binsaif, A. S. AlGhamdi, and M. A. Rahman, "Advanced deep learning human herpes virus 6 (HHV-6) molecular detection in understanding human infertility," *Computational Intelligence and Neuroscience*, vol. 2022, Article ID 1422963, 2022.

[5] R. Voloshin, V. S. Bedbenov, D. Gabrielyan et al., "Optimization and characterization of TiO2-based solar cell design using various plant pigments," *International Journal of Hydrogen Energy*, vol. 42, no. 12, pp. 8576–8585, 2016.

[6] G. J. Bartolome, J. Mesa, J. Adona, and A. E. Torres, "Performance of dye-sensitized solar cells with natural dye from local tropical plants," *Mindanao Journal of Science and Technology*, vol. 18, pp. 242–258, 2020.

[7] R. Wang, M. B. Alazzam, F. Alassery, A. Almulihi, and M. White, "Innovative research of trajectory prediction algorithm based on deep learning in car network collision detection and early warning system," *Mobile Information Systems*, vol. 2021, Article ID 3773688, 2021.

[8] J. Yin, *The application of natural dyes in dye-sensitized solar cells*, ScienceDirect, 2016.

[9] S. Saxena and A. S. M. Raja, "Natural dyes: sources, chemistry, application and sustainability issues," in *Roadmap to Sustainable Textiles and Clothing*, Textile Science and Clothing Technology, S. Muthu, Ed., pp. 37–80, Springer, Singapore, 2014.

[10] M. B. Alazzam, F. Hajjej, A. S. AlGhamdi, S. Ayouni, and M. A. Rahman, "Mechanics of materials natural fibers technology on

thermal properties of polymer," *Advances in Materials Science and Engineering*, vol. 2022, Article ID 7774180, 2022.

[11] A. M. Ammar, H. S. Mohamed, M. M. Yousef, G. M. Abdel-Hafez, A. S. Hassanien, and A. S. Khalil, "Dye-sensitized solar cells (DSSCs) based on extracted natural dyes," *Journal of Nanomaterials*, vol. 2019, Article ID 1867271, 10 pages, 2019.

[12] M. B. Alazzam, A. S. AlGhamdi, and S. S. Alshamrani, "Corneal biomechanics computational analysis for keratoconus diagnosis," *Computational and Mathematical Methods in Medicine*, vol. 2021, Article ID 6126503, 2021.

[13] Y.-M. Lee and C.-H. Lai, "Preparation and characterization of solid n-TiO2/p-NiO heterojunction electrodes for all-solid-state dye-sensitized solar cells," *Solid-State Electronics*, vol. 53, pp. 1116–1125, 2009.

[14] M.-K. Son, H. Seo, K.-J. Lee et al., "A simple method for modelling dye-sensitized solar cells," *Thin Solid Films*, vol. 554, pp. 114–117, 2014.

[15] M. B. Alazzam, A. A. Hamad, and A. S. AlGhamdi, "Dynamic mathematical models' system and synchronization," *Mathematical Problems in Engineering*, vol. 2021, Article ID 6842071, 2021.

[16] T. Shiyani, S. Agrawal, and I. Banerjee, "Natural dye-sensitized photo electrochemical cells for solar energy conversion," *Nanomaterials and Energy*, vol. 9, no. 2, pp. 215–226, 2020.