Future Trends in Vegetative and Fruits Energy-A New Renewable Energy Source for Future Electricity

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Abstract

Vegetative and fruits have a medicinal value. This research work has given information that it is possible to generate power from various vegetative and fruits. Some were considered as a sample for power generation like Pathor Kuchi Leaf (PKL), Tomato, Aloe Vera, Arum Leaf, Lemon and Myrobalan etc. Their constituents,scientific name, cultivations and vernacular names have been studied through literature review. Kalanchoe/Bryophyllum is one of the genera under the leave succulent family Crassulaceae. The other genera, such as Echeveria, Crassula, Pachphytum and Aeonium, from the same family are far more popular. Their diversity of compact and symmetrical forms (compact rosettes or 4-angled column) makes them very attractive to succulent collectors. While Kalanchoes/Bryophyllum may not have such geometrical neatness in their form, they win many of the hearts of succulent lovers by their wide range of leaves shape and color. They are alsomore robustness. Kalanchoes/Bryophyllum can tolerate more neglect, more water, and of course one of the easiest to rise from stem or leave cuttings. Several species are so robust and propagate themselves so freely that they are considerate notorious weed in the tropics and subtropics. Several examples come to mind: Bryophyllum delagoensis (syn. K. tubiflora), B.daigremontianum (syn. K. daigremontiana), B. 'Houghton's hybrid' (a hybrid of B. delagoensis and B. daigremontianum created by A. D. Houghton in the 1930s), are all commonly named 'Mother of Thousands'. Others such as Kalanchoe blossfeldiana and its many varieties are very common popular indoor flowering houseplant. Different has been taken for doing comparative study.

Keywords: *Vegetative and fruits, electrochemical cell, Chemical composition, Physical and Chemical Properties, biomass energy*

I.Introduction

The production of electricity from PKL was invented by Prof. Dr. Kamrul Alam Khan, Department of Physics, Jagannath University, and Dhaka, Bangladesh[1-23]. During his research work in his university the shortage of electricity in the country pained him a lot. He always thought about a way to solve the problem with an alternative way which will be renewable, easy to produce, affordable to all [24-50]. In the mean-time the various names of Pathor Kuchi Leaf in various part of the world made him curious. He started to collect information about PKL and finally thought to produce electricity from PKL using the electrochemical cell technology[51-70]. He started his work with the help of his student in the university and got success. But it is still need a lot of research, a lot of advancement moreover; some electrochemical criteria are still in investigations or under experiments. But the socio-economic value of what we get is very important. It may be the blessings of the people who are out of regular electricity supply[71-96]. It will also be very useful to those who are under the regular electric supply. They can use it during load shading or in place where low power is required. Dr. Md. Kamrul Alam Khan, Participated and Presented with this new innovative, alternate and useful technique in the "EnergyTech2013Conference sponsored by the Institute of Electrical and Electronic 8 Engineers(IEEE) at the Case Western Reserve University in Cleveland, Ohio, USA, 21 may- 23 May ,2013, USA[97-110]. He also presented this ides at the Ohio State University USA, 24 May, 2013 on "Electrochemistry of Pathor Kuchi Leaf Electricity"[111-125]. He also Participated and Presented his thought on PKL electricity as an invited Speaker in the "International Conference on Nano science and Nanotechnology, Aligarh Nano-IV International 2014", March 8-10, 2014 and 12-14 March, 2016, Aligarh Muslim University, UP, India. Prof. K.A.Khan also participated and presented this new concept inside the country at IEB (Institute of Engineers Bangladesh), Bangladesh Physical Society (BPS) One more Seminar, ASB, KUET, Chittagong University, Jahangirnagar University, AEC, Sylhet, Rangpur and NOAMI. He was also conducted research as principal investigator for One year PKL electricity research project on "Electricity Generation from

Pathor Kuchi Leaf (Bryophyllum) for Practical Utilization in Bangladesh" funded by Ministry of Science and ICT (FY : 2011-12)[126-135]. By this time he achieved the following awards on PKL electricity: Best Innovation Award-2012, Presented by Texas University, Austin, USA, Tombarg Award for Environment Sustainability-2012, Joint 3rdWharton Innovation[136-140] Tournament Award- 2012, Presented by Wharton School at the University of Pennsylvania, USA (The tournament, created by Wharton School at the University of Pennsylvania, USA, was hosted in collaboration with the Higher Colleges of Technology. "They've run this global tournament twice in Philadelphia but this is the first time it's been held outside the USA," said Professor Karl Ulrich, vice-dean of innovation at Wharton.). Held in Dubai, UAE March-2012, HSBC Enterprainer Award 2009-2010 at 05.05.2010 on Electricity Generation from Pathor Kuchi Leaf (Source: Daily Prothom-Alo on 19.05.2010, Bangladesh), He achieved Razzaq-Shamsun Physics Prize for on 11.12.2010 presented by the Vice-Chancellor, University of Dhaka, Bangladesh[141-143]. In this work it has been discussed electricity generation from different vegetative and fruits and their comparative analysis.

II. Theory

II A. Chemical composition of Pathor Kuchi Leaf

The chemical composition of PKL has been studied which has been executed below:
Major and minor acids present in dried leaf tissue of *Bryophyllum calycinum* were identified or characterized using the combined methods of ion exchange chromatography, paper and thin-layer chromatography, gas chromatography and infrared spectroscopy. After etherification of the acids in methanol containing H^+ form cation exchange resin, their amounts were determined by gas chromatography. The acids identified and their approximate percentage amounts of the total acid content were: malice acid 32.5%, citric 10.1%, isocitric acid 46.5%, succinic acid 1.0%, fumaric acid 0.9%, pyruvic acid 1.0%, oxalacetic acid 0.4%, α-ketoglutaric acid 0.5%, glyoxylic acid 0.1%, lactic acid 0.2%, oxalic acid 0.2%, and*cis*-aconitic acid 1.6%. Tentative characteristics were proposed for previously undetermined acids present mainly in amounts from 0.05% to 0.6%. These were apparently mono-, di-, and tricarboxylic acids containing from three to seven carbons in the carbon chain. Most of these evidently had additional functional groups, including methyl, keto, and hydroxyl groups. The boiling points of the methyl esters of these acids ranged from 140°C to 300°C.

II B Aloe Vera jells as a source of biomass energy:

Aloe Vera leaves contain photochemical under study for possible bioactivity, such as acetylated manners, polymannans, anthraquinone C-glycosides, enthrones, other anthraquinones such as emodin and various lections.

Fig.1: Plantation of Aloe Vera

II C. Chemical and Physical Properties of Aloe Vera

Table 1 Chemical and Physical components of Aloe Vera

Parameters	Quantity (100 g–1 fresh gel)	Parameters	Quantity (100 g–1 fresh gel)
Moisture	98.93 ± 0.06	Energy (kcal.g–1 sample	5.84
Protein	0.12 ± 0.01	aw	2 0.99 ± 0.01
Fat	0.01 ± 0.02	pH	4.74 ± 0.01
Crude fiber	12 ± 1.20	Acidity (% malic acid)	0.06 ± 0.02

Ash	0.16 ± 0.02	Glucose	25.20 ± 0.06
Available carbohydrates 1	0.66	Fructose	9.30

This table shows the contents of two of the main sugars present in the gel, namely fructose and Glucose (9.3 and 25.2 g/100 g dry matter, respectively). The concentration of free glucose was higher than the concentration of free fructose, which was also reported by Bozzi for glucose and fructose in the commercial Aloe Vera powders with respective values of 11.85 and 5.3 g/100 g dry matter. Femenia also determined higher glucose content compared to fructose; they found 26.7 g glucose/100 g dry matter in Aloe Vera gel compared to 0.64 g fructose/100 g dry matter.

Aloe Vera grows well in soils with neutral pH, or a pH of 7. The pH scale runs from 0 to 14. Higher than 7 is alkaline and lower than this is acidic and aloe vera may not grow as well in these soils. However, a pH close to 7, such as 6 or 8, may not show any direct signs of stress on the Aloe Vera plant. However Aloe Vera has the perfect PH level of 5.5.

II D The lemon (Citrus x lemon) is a fruit tree that belongs to the genus Citrus, Rutaceae family, to which belong also citrus fruit, such as oranges, tangerine, bergamots, citrons and grapefruit.

Fig.2**:** Plantation of lemon tree.

II E Chemical composition of lemon

Table 2: Chemical composition of lemon

Parameter	**Quantity**	**Parameter**	**Quantity**
Energy	121 kJ (29 kcal)	**Vitamins**	
Carbohydrates		Thiamine (B1) (3%)	0.04 mg
Sugars	2.5 g	Riboflavin (B2) (2%)	0.02 mg
Dietary fiber	2.8 g	Niacin (B3) (1%)	0.1 mg
Fat	0.3 g	Pantothenic acid (B5) (4%)	0.19 mg
Protein	1.1 g	Vitamin (B5) (4%):	0.08 mg
Minerals		Foliate (B9) (3%)	11 µg
Calcium (3%)	26 mg	Chorine (1%)	5.1 mg
Iron	0.6 mg	Vitamin (1%)	5.1 mg
Magnesium (2%)	8 mg		
Manganese (1%)	0.03 mg		
Phosphorus	16 mg		

(2%)			
Potassium (3%)	138 mg		
Zinc	0.06 mg		

II F Tomato juice as a source of biomass energy

The tomato is the edible, often red berry-type fruit of the nightshade Solanum, lycopersicum [10, 11] commonly known as a tomato plant. The tomato is consumed in diverse ways, including raw, as an ingredient in many dishes, sauces, salads, and drinks. The English word tomato comes from the Spanish word, tomato, derived from the Nahunta (Aztec language) word tomato. It first appeared in print in 1595 [12].

Fig.3: Plantation of tomato tree.

II G Chemical composition of tomato

Table 3: Chemical composition of tomato

Parameter	Quantity	Parameter	Quantity
Energy	74 kJ (18 kca)	Vitamins	
Carbohydrates	3.9 g	Vitamin A equiv. (5%)	42 µg
Sugars	2.6 g	Beta-carotene (4%)	449 µg
Dietary fiber	1.2 g	lutein zeaxanthin	123 µg
Fat	0.2 g	Thiamine (B1) (3%)	0.037 mg
Protein	0.9 g	Niacin (B3) (4%)	0.594 mg
Minerals		Vitamin B6 (6%)	0.08 mg
Magnesium (3%)	11 mg	Vitamin C (17%)	14 mg
Manganese (5%):	0.114 mg	Vitamin E (4%)	0.54 mg
Phosphorus (3%):	24 mg	Vitamin K (8%)	7.9 µg
Potassium (5%):	237 mg		
Other constituents			
Water	94.5 g	Lycopene	2573 µg

The pH of Tomato juice without water is 4.10.The pH of Tomato juice with water (10% solution) is 4.3.

II H Arum Leaf juice as a source of biomass energy

Fig.4: Colocasia esculenta/Arum Leaf

II I Reason of arum leaf juice for generation of electricity

There are some reasons are given below:

1. All compounds are aromatic alcohol.
2. All compounds are formed resonance structure. As a result oxygen is partially negative charged. On the other hand hydrogen or proton is positive charge. For this reason hydrogen ion release from structure to the arum leaf juice/sap electrolyte.
3. As a Bronsted Lowry concept or protonic concept the above three compounds from mentioned above 4 components are acitic properties.
4. pH range of the above 4 compounds lie between 4.16 – 4.54

II J Myrobalan for Power Production

Fig.5 Myrobalan

II K Chemical components of Myrobalan

Glutamic acid, proline, aspartic acid, alanine, and lysine are 29.6%, 14.6%, 8.1%, 5.4% and 5.3% respectively of the total amino acids. Pulpy portion of fruit, after drying found to contain: gallic acid 1.32%, tannin, gum13.75%; albumin 13.08%; crude cellulose17.08%; mineral matter 4.12% moisture3.83%. *Myrobalan* fruit ash contains chromium- 2.5ppm, zinc-4 ppm and copper-3 ppm. Compounds isolated from *Myrobalan* fruit are gallic acid, ellagic acid, 1-O- galloyl-beta-D-glucose, 3,6-di-O-galloyl-D-glucose, chebulinic acid, quercetin, chebulagic acid, corilagin, 1,6- di-O- galloyl beta-D-glucose, 3-Ethylgallic acid (3-ethoxy 4,5-dihydroxybenzoic acid) and isostrictinin, *Myrobalan* fruit also contains flavonoids, kaempferol-3-O-alpha L-(6"- methyl) rhamnopyranoside andkaempferol-3-O-alpha L (6"-ethyl) rhamnopyranoside.

III. Methods and Materials

Materials: Samples for experiments (PKL, Aloe Vera, Tomatoes and Lemons were collected from the farmers and markets of Bangladesh.

Instruments and apparatus: pH meter, Multi-meter, Ammeter, Resistor (1ohm), Balance, Meter scale, screw gauge. Bulb holders for various sizes of bulbs, Stopwatch, Wire cutters, Resistors etc.

PKL Juice Preparación

In order to produce electricity from the leaf of the *Bryophyllum*, first of all, its leaves have been collected and then blended by blenders.1000gm of PKL solution was prepared from the 800gm PKL sap and 200gm water. This mixture can be used directly for electricity generation. This solution is filtered out to get the clean juice. Fig.8 shows the procedure of preparation of juice.

Fig.6: PKL juice preparation.

Aloe Vera Juice Preparation

Aloe Vera leaves have been collected from the tree. After washing we have used a sharp knife to remove the thorny edges of the leaves, then carefully separated the inner part of the leaf and cut into pieces. Then we have placed the Aloe Vera gel in a blender and mixed it properly until become smooth. The remaining Aloe Vera gel was stored in a bottle. For this purpose we have prepared 1000gm Aloe Vera juice, where Aloe Vera gel 800gm and fresh water 200gm. We have taken 720 gm Aloe Vera juice for this experiment.

Fig.7: Aloe Vera juice preparation.

Lemon (with skin) Juice Preparation

The lemon has been collected from the tree. After washing we have used a sharp knife to cut into two or more pieces. Then we have placed the pieces of lemon in a blender and mixed it properly until become smooth. The remaining lemon juice was stored in a bottle. For this purpose we have prepared 1000gm lemon juice, where lemon juice 800gm and fresh water 200gm. We have taken 720 gm lemon juice for this experiment.

Fig.8: Lemon juice/extract preparation

Tomato Juice Preparation

For preparing tomato juice firstly we have taken some tomato. After washing we used a sharp knife for piece into two or more piece. Then transferred those pieces into blender and mixed it properly until becomes smooth.
For this purpose we have prepared 1000gm of tomato juice, where tomato sap was 800gm and fresh water 200gm. We have taken 720ml tomato juice for experiment.

Fig.9: Tomato processing for juice/extract preparation

III.Methodology

To improve the conductivity and remove corrosion on the surface, we used extra fine steel wool for clean the electrode strips. Fresh samples were used in each experiment. The amount of each sample used in the experiment at a time was obtained by considering the cubic space of the modified voltaic cell model for PKL, Aloe Vera, Tomato and Lemon are (PKL=800 g & H_2O = 200 g, No of Anode (Zn) = 6, No of Cathode (Cu) =3,where average height of an anode is 140 mm and cathode is 140 mm, average length of anode and cathode is 138 mm and 121 mm, average thickness of anode and cathode is 0.674 mm and 0.19 mm. average mass of anode and cathode is 38 g and 20 g. Distance between Anode & Cathode are 5 cm, Volume of Electrolyte is 720 cc or 720 ml, for each case we have been taken (PKL, Aloe Vera, Tomato and Lemon) sap 576 g and fresh water 144 g. We also took the pH of each specimen with a pH meter and found 4.49, 4.56, 3.56 and 2.83 for PKL, Aloe Vera, Tomato and Lemon respectively. Experimental set-up for PKL, Aloe Vera, Lemon and Tomato are given below:

Fig.10 A typical diagram of an electrochemical cell battery

Experimental Set-up of Cell

The inner volume of the cell was 720 cm^3. We took all the reading for our comparative study in the same cell. Every times, the electrodes were immersed 120 mm deep in the saps. This depth was kept fixed throughout this experiment. We put three copper plate as cathode and six zinc plate as anode. The connections among the electrodes are given below.

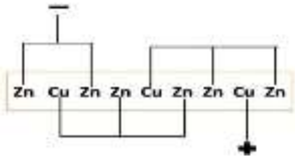

Fig. 11: Schematic diagram of parallel and series connections between anodes and cathodes.

An ammeter and a load of 1 Ω were connected with the two terminals of the electrodes in series and a voltmeter was connected across the load. The space (gap) between two consecutive electrodes was kept 5 mm.

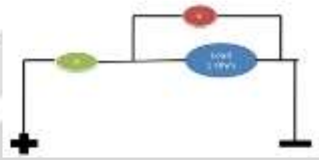

Fig.12: Schematic diagram of the ammeter and voltmeter connection in the cell.

Fig.12 shows the schematic diagram for measuring the current and voltage with a calibrated multimeters.

Figu.13: The collection of PKL, Aloe Vera, Tomato and Lemon Juice as well as the Experimental set-up of the test cell.

It is shown in Fig.13 about the filtrated extract preparation by a blender machine.

IV. Results and Discussion

Table-4: Comparative study of V_L (V) – Time duration (minutes) characteristics of PKL, Tomato, and Aloe Vera and Lemon juice electrochemical cell

Time (min)	V_L (V) of PKL	V_L (V) of Lemon	V_L (V) of Aloe Vera	V_L (V) of Tomato
0	1.51	1.18	0.98	0.85
60	1.5	1.08	0.95	0.52
120	1.47	0.95	0.92	0.52
240	1.47	0.93	0.86	0.47
480	1.45	0.86	0.69	0.47
600	1.44	0.86	0.64	0.47
720	1.44	0.86	0.54	0.46
1200	1.4	0.84	0.46	0.45
1380	1.38	0.84	0.46	0.45
1500	1.38	0.83	0.45	0.45
1620	1.38	0.82	0.45	0.44
1800	1.38	0.81	0.43	0.44
1920	1.3	0.81	0.4	0.4
2040	1.3	0.8	0.38	0.4

2160	1.3	0.8	0.37	0.4
2640	1.3	0.79	0.22	0.4
2760	1.3	0.79	0.21	0.4
2880	1.29	0.79	0.21	0.4
3000	1.29	0.79	0.16	0.4
3120	1.29	0.77	0.14	0.4
3240	1.28	0.77	0.13	0.39
3360	1.28	0.76	0.25	0.39
3480	1.28	0.76	0.23	0.39
3780	1.28	0.75	0.21	0.38
3900	1.27	0.74	0.21	0.38
4005	1.27	0.74	0.21	0.38
4140	1.27	0.73	0.21	0.35
4260	1.25	0.73	0.21	0.35
4380	1.25	0.73	0.21	0.35
4620	1.25	0.72	0.21	0.35

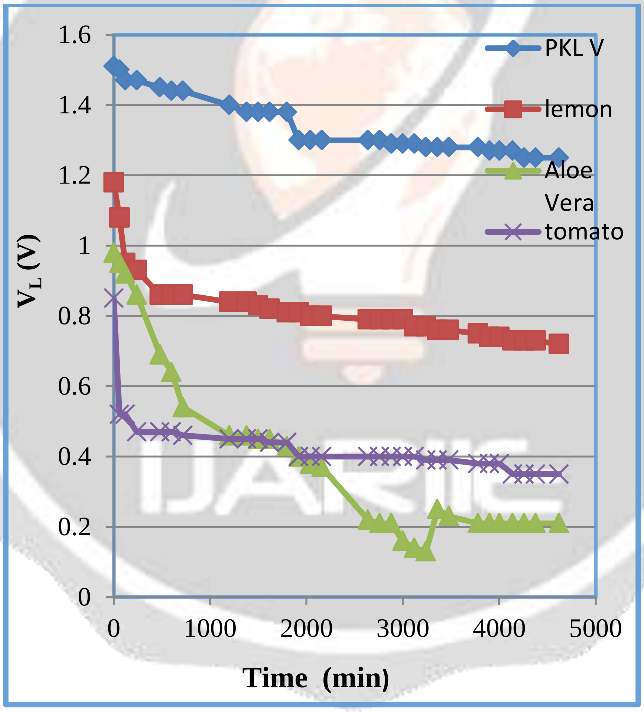

Figure 14**:** Variation of load voltage of all four specimens with time.

Figure 14 shows that the load voltage of the PKL remains higher than the others throughout our observations. An important nature of load voltage of PKL, Lemon and Tomato shows that the load voltage can be considered as constant in all three cases, which makes all of the three feasible to produce electricity. But for Aloe Vera the load voltage decreases rapidly than the others.

Table-5: Comparative study of I_L (A) – Time characteristics of PKL, Tomato, and Aloe Vera and Lemon juice electrochemical cell

Time (min)	I_L (A) of PKL	I_L (A) of Lemon	I_L (A) of Aloe Vera	I_L (A) of Tomato

0	1.5	1.2	0.6	0.84
60	1.47	0.9	0.45	0.51
120	1.25	0.84	0.37	0.46
240	1.18	0.66	0.33	0.46
480	1.02	0.64	0.29	0.46
600	1	0.58	0.26	0.45
720	0.98	0.52	0.24	0.44
1200	0.94	0.5	0.24	0.44
1380	0.92	0.48	0.22	0.44
1500	0.86	0.48	0.21	0.43
1620	0.82	0.44	0.19	0.43
1800	0.75	0.41	0.19	0.42
1920	0.65	0.39	0.16	0.42
2040	0.62	0.39	0.16	0.42
2160	0.6	0.39	0.15	0.41
2640	0.56	0.39	0.15	0.38
2760	0.5	0.34	0.13	0.36
2880	0.48	0.34	0.13	0.36
3000	0.44	0.32	0.12	0.36
3120	0.4	0.31	0.1	0.28
3240	0.38	0.31	0.15	0.27
3360	0.37	0.29	0.14	0.25
3480	0.32	0.29	0.13	0.19
3780	0.3	0.29	0.12	0.18
3900	0.28	0.26	0.12	0.18
4005	0.28	0.26	0.12	0.18
4140	0.25	0.24	0.12	0.18
4260	0.24	0.23	0.12	0.18
4380	0.2	0.23	0.12	0.17
4620	0.2	0.23	0.12	0.1

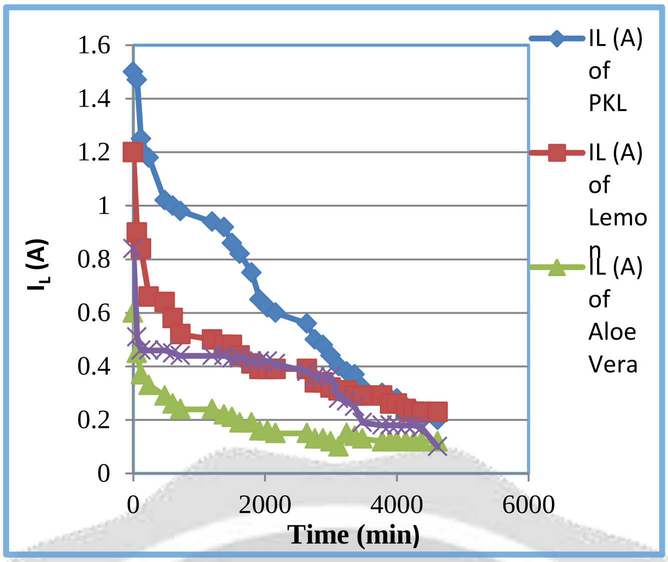

Figure 15: Variation of load current of all four specimens with time.

The above figure 4.6 demonstrates the load current is dropping with time. Although the load current is higher for PKL throughout the observations, but the decrease rate is much higher than the other three. For Tomato and Aloe Vera, the current is comparatively small, but the decrease rate is very low.

Table-6: Comparative study of load Power – Time Characteristics of PKL, Tomato, Aloe Vera and Lemon juice

Time (min)	P_L (W) of PKL	P_L (W) of Lemon	P_L(W)of Aleo Vera	P_L (W) of Tomato
0	2.256	1.416	0.588	0.714
60	2.205	0.972	0.4275	0.2652
120	1.8375	0.798	0.3404	0.2652
240	1.7346	0.7812	0.2838	0.2162
480	1.479	0.5676	0.2001	0.2162
600	1.44	0.5504	0.1664	0.2162
720	1.4112	0.4988	0.1296	0.207
1200	1.316	0.4368	0.1104	0.198
1380	1.2696	0.42	0.1012	0.198
1500	1.1868	0.3984	0.0945	0.197
1620	1.1316	0.3936	0.0855	0.1892
1800	1.035	0.3564	0.0817	0.1892
1920	0.845	0.3321	0.064	0.168
2040	0.806	0.312	0.0608	0.168
2160	0.78	0.321	0.055	0.168
2640	0.728	0.308	0.033	0.164
2760	0.65	0.308	0.0273	0.152
2880	0.6192	0.2686	0.0273	0.144
3000	0.5676	0.2686	0.0192	0.144
3120	0.516	0.2464	0.014	0.144
3240	0.486	0.2387	0.0195	0.1092
3360	0.4736	0.2356	0.035	0.1053

3480	0.4096	0.2204	0.0299	0.0975
3780	0.384	0.2175	0.0252	.0722
3900	0.3556	0.2146	0.0252	0.0684
4005	0.3556	0.1924	0.0252	0.0684
4140	0.3175	0.1898	0.0252	0.063
4260	0.3048	0.1752	0.0252	0.063
4380	0.3048	0.1679	0.0252	0.063
4620	0.2875	0.1656	0.0252	0.063

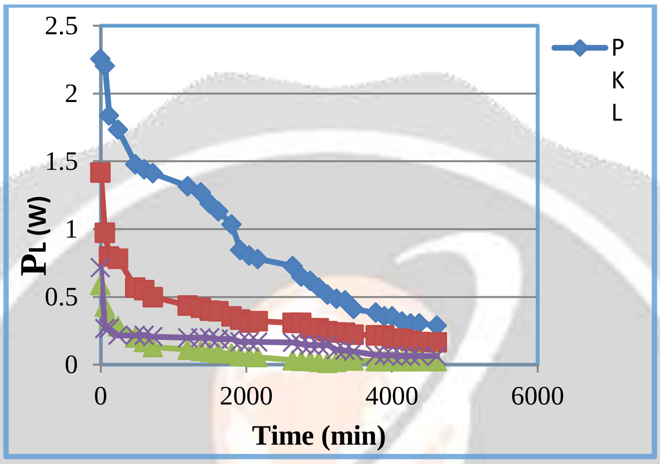

Fig. 16: Variation of load power of all four specimens with time.

The good and constant nature of output power makes a battery more usable. Here, the Fig.16 shows an interesting character between them. The power is much higher for PKL than others but the decrease rate is also high. For the first 1800 minutes or 30 hours, it can supply more than 1watt of electricity continuously. A series or parallel combination of this kind of three cells or three times larger cell can run a 3watt of LED bulb for 30hours continuously. By changing some juice, we can continue for the next run. Again the above figure shows the low decrease rate of power for other three, but for the insufficient power supply puts them behind to PKL.

V. Conclusion

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