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Explosion Phenomenon Observed from Seed Capsules of *Pletekan* (*Ruellia Tuberosa* L.)

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Abstract

Explosion phenomenon was observed from a seed capsule of *Pletekan* (*Ruellia tuberosa* L.) when this makes a contact with water. The capsule was taken from the plant that is living weirdly in a tropical country of Indonesia. Capsules of brownies green were selected for further measurement of explosion time *i.e.* time required to crack the capsule. The observation was done based on ultrasonic waves that were reflected by the water surface used. Various weights of the capsules have been observed their explosion phenomena at room temperature and open air. From the observation it was found that the increase of weight from 0.06 to 0.12 g will be followed by the decrease of explosion time exponentially from about 40 to 5 seconds. Meanwhile, the increase of weight was also followed by the decrease exponentially a relative magnitude of explosion as measured through the water's ripple produced during explosion from 0.25 to 0.00 V. These results are encouraging as the phenomenon observed is able to explore more detail of natural phenomenon shown by the living plant that could be used for further applications besides opening a new knowledge.

Keywords : explosion time, *Pletekan*, *Ruellia tuberosa*, water's ripple

1. Introduction

Ruellia tuberosa, also known as Cracker plant is a species of flowering plant in the Acanthaceae family. The plant is originally come from Central America but presently it has become naturalized in many tropical countries of Southeast Asia such of Indonesia (http://en.wikipedia.org/wiki/Ruellia_tuberosa). The interesting phenomenon of this plant is a mechanical movement of seed capsule that will crack immediately together with producing explosion after make a contact with water. The explosion is due to the mechanical crack along the capsule's separation line that is assumed become weak their compounds by the water. Because of this weakness, mechanical springs-like exist in the capsule that is pushing out the capsule will introduce a crack along the line followed by spreading out some seeds from inside.

In a medical field, many research works have been carried out to extract the root of that plant as this was done by Chotani *et al*. (2012a). Their studies found that the extraction shows an antioxidant activity that is potentially to be used for medicine. For that purpose, they suggest to isolate the active principle responsible for the activity. Chotani *et al*., (2012b) have also worked to extract the root of Pletekan for finger print test using HPTLC. Chotani *et al.* (2010) reported the presence of alkaloid, flavanoids and phenolic compounds in various parts of the plant of *Pletekan* (*Ruellia tuberosa*).

Other research groups are also working on that plant as done by Chen, *et al.* (2006) that investigated antioxydant activity of *Pletekan* for medical purposes investigation. Meanwhile, Lin *et al* (2006) have reported their work on the extraction of stem's of *Pletekan* plant for investigation on the effect of those compounds against cancer cell. Root extraction of this plant was also carried out by Arambewela *et al*., (2003). Their results show strong and dose-dependent gastroprotective activities. From the above reports, it is shown that this plant has potential for pharmacies although studies more detail of that plant are still limited in number of publications. This plant has been studied widely regarding their potentials for medicine but no research work reported up to now of any physical phenomenon performed of explosion phenomenon due to water contact. Therefore, in this paper, we report for the first time the quantitative measurement of explosion time observed from *Pletekan*'s capsule after makes a contact with water. The capsule was taken from *Pletekan* plant living in Indonesia. The observation was done at room temperature for selected seed capsules. This new observation phenomenon may lead further application of bio-living plant of their mechanical performances.

2. Experiment

Experiment was done to observe the explosion phenomenon by contacting the seed capsule of *Pletekan* with the water at room temperature in open air. For that work, capsules were taken directly from the plant and keep for some hours before being run for the measurement. Prior to the measurement, each capsule was measured their

weight. The seed capsules were selected based on color of brownies green that is considerably mature as shown in Figure 1. To start the observation, this was done manually for each capsule sample by putting the capsule carefully on the water (pH of 7.0) prepared in the beaker glass with a water surface area of diameter about 100 mm. When explosion occurs, it will generate a ripple of water. This ripple will be monitored continuously by a computer. Ultrasonic apparatus has been used to monitor the ripple of water to determine the explosion time and also the ripple pattern as well. The transmitter will produce the ultrasonic wave of 40 kHz (12 V DC). The nose of transmitter was designed to have a diameter of 10 mm to enable wave propagates continuously about that area before hit the surface of water. The nose of receiver was also adjusted for that dimension. When ultrasonic wave hit the surface of water, this will be reflected and received by the receiver circuit.

Before explosion, the water surface is maintained to be flat (calm) with no ripple. When the explosion occurs, concurrently this will trigger the ripple of the water. With this condition, the surface of water changes its surface texture by the ripple pattern. Any changes of water's surface will affect to the reflection signal received by the receiver. This change will be measured by the receiver in electrical voltage form. The ultrasonic output was recorded by computer to obtain an accurate observation. The schematic diagram of experimental set up is shown in Figure 2. The transmitter and receiver are adjusted at about 45 degree to make sure that the ultrasonic signal received from the transmitter through the water reflection is optimum for any surface changes. From the observation of water's ripple pattern and magnitude due to the explosion, a relative magnitude of explosion could be calculated. From this measurement, a relationship between weight and relative magnitude of explosion force will be obtained.

For the measurement, the capsule used is completely close (no crack) as schematized in Figure 3, meanwhile after makes a contact with water, the capsule cracks along their separation line (during explosion phenomenon). As we can see from that figure, the capsule has split and open with a curve-springlike that plays an important role in the cracking mechanism. The explosion was indicated by the sound produced by the capsule as cracking occurs due to mechanical effect together with scattering away the seeds from inside the capsule. Repeatability is an important factor for this experiment as using samples from a natural plant we cannot adjust the dimension and weight, therefore random selection of weight has been done for the measurement. By weighting the number of capsules, we can get the variation of weights. For that purpose, in the work, we collect as many as possible samples and find out the large variation of weights.

3. Results and Discussion

Observation has been done to some seed capsules of *Pletekan* when these make a contact with water. In this experiment, the capsule was put on the water carefully to introduce a small ripple of water. Minimum water ripple leads a flat output signal received by the ultrasonic receiver as no much fluctuation introduced by reflection of water surface. When the relatively stable output signal observed, the experiment was started by putting the capsule on the water surface to measure the explosion time. Once the capsule makes a contact with water, explosion will occur for some times depend on the weight of capsule. Data collection was done from the time when the capsule start to make a contact with water until they perform an explosion. During explosion, some seeds in the capsule were thrown away in random direction. From the experiment, a relationship between weight of capsule and explosion time is obtained as shown in Figure 4. Increase of weight will be followed by decrease (shorter) of explosion time. Trend of exponential relationship for weight up to 0.12 g was obtained for explosion time from about 40 to 5 seconds that shows strong evidence for that phenomenon as an error of 10 % is given to each data point to support that trend.

When explosion occurs, this will trigger the ripple (wave) due to the mechanical crack of the capsule. Magnitudes and pattern of water ripple caused by explosion phenomenon have been recorded by the ultrasonic receiver from the experiment as shown in Figure 5. From that figure, initially the curve goes flat and then suddenly rises and down. The quick rising is due to the starting time when any mechanical crack / explosion introduced. This ripple is then detected by an ultrasonic receiver in the form of electrical voltage that is changed significantly up and down before goes to stable value. From the observation done for many samples, it was found that the increase of weight of capsule up to 0.12 g will be followed by the decrease of relative magnitude of explosion from 0.25 V to 0.00 V (as shown in Figure 6). This phenomenon may show that greater weight leads to less explosion force that may be due to the assumption that each capsule has nearly similar amount of energy disregard the weight. Therefore, greater weight of capsule introduces less force of explosion. From the observation, the direction of seed scattering from the capsule could not be determined yet. Random direction shows that there are still many parameters involved to explain this point.

Another phenomenon observed from *Pletekan*'s seed capsule is cracking partly at the corner of capsule (not along the separation line) may occur before making a contact with the water. This could be due to another property of capsule beside water contact factor that has not been investigated yet in this work. Nevertheless, it seems still any other parameters involve in triggering the explosion phenomenon by the seed capsule beside

weight parameter of capsule that needs further investigation.

4. Conclusion and further suggestion

Explosion time of *Pletekan* was observed that shows positive correlation respect to the weight of seed capsule used in this experiment. Increase of weight of capsule from 0.06 to 0.12 g will be followed by decrease (shorter) explosion time exponentially from 40 seconds to 5 seconds. There is also a relationship between weight and relative magnitude of explosion that was found to decrease exponentially from 0.25 V to 0.00 V. This phenomenon inform us that there is an interesting physical mechanism shown by seed capsule of *Pletekan* that able to perform a mechanical cracking phenomenon by ejection the seed out of the capsule when make a contact with water. To obtain more convincing results regarding the above relationship, many samples should be used for the measurement with various environment variables. Meanwhile, further application could be explored beside detail explanation of the mechanism performed from that plant.

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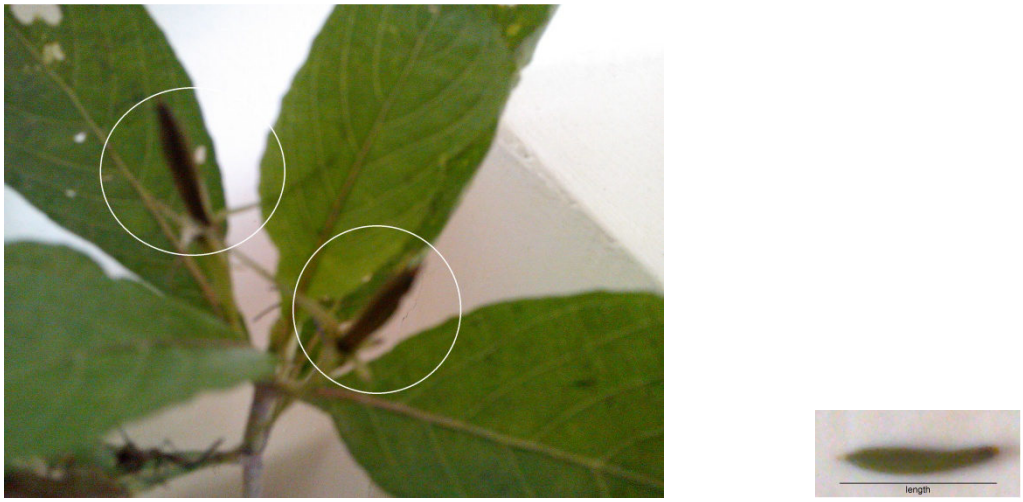

(a) (b)

Figure 1 (a) Plant with seed capsule (circled) and (b) Seed capsule (before explosion) used for the observation.

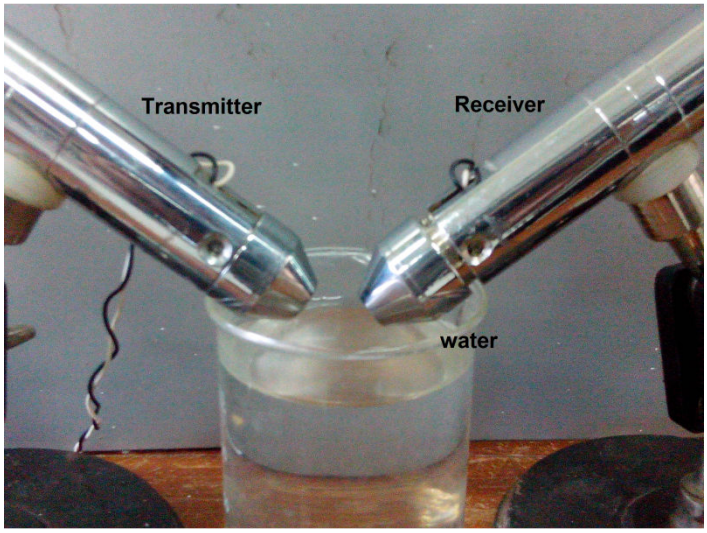

Figure 2. A pictorial set up used of ultrasonic for measurement.

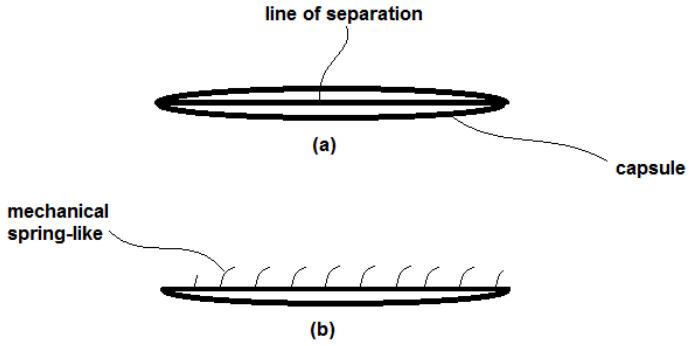

Figure 3. Schematic diagram for a seed capsule at (a) before and (b) after cracking, due to water contact.

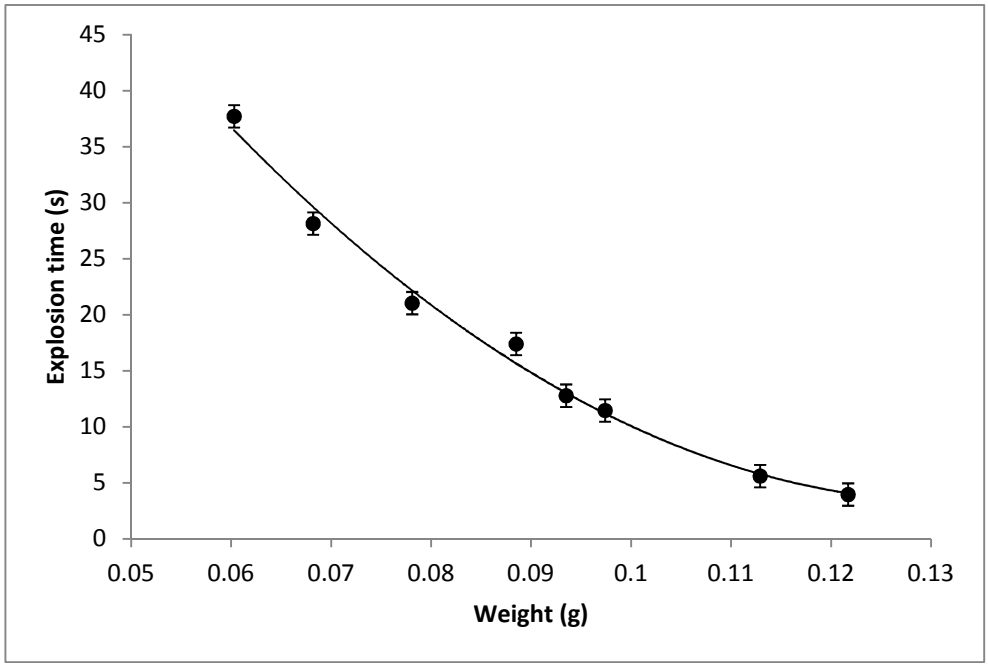

Figure 4. Relationship between ratio and explosion time observed from Seed's capsule of *Pletekan*.

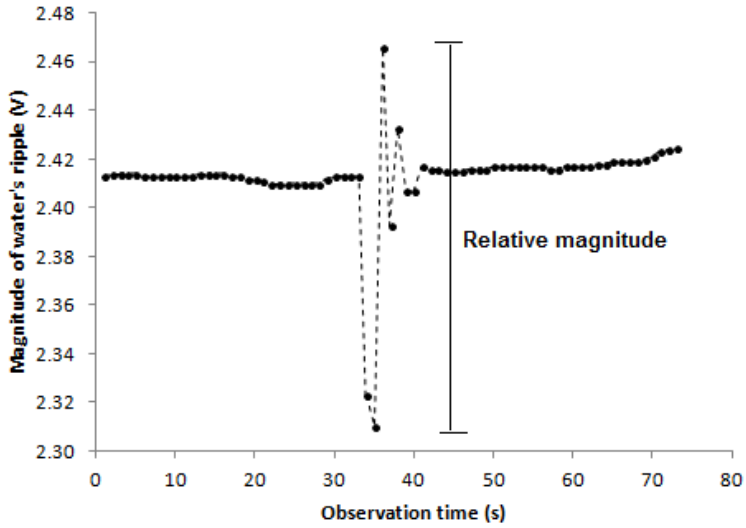

Figure 5. Relative magnitude of explosion recorded through water's ripple observed.

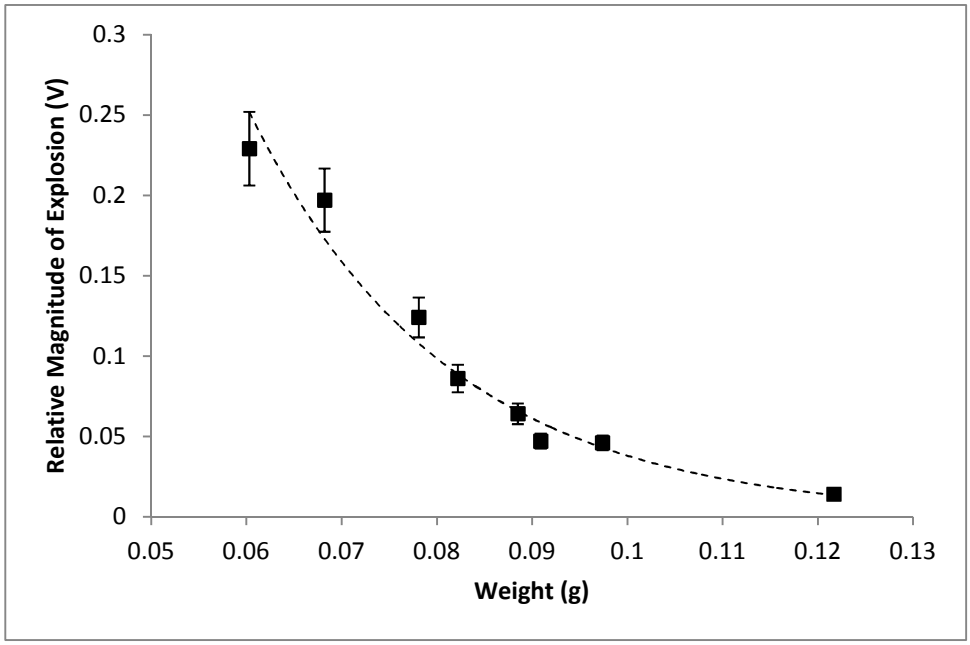

Figure 6. Relation between weight of seed capsule and relative magnitude of explosion observed.