

Identification of Diuretic Chemical Compound in Palmyra Palm (*Borassus flabellifer*) to Cure Kidney Stone Disease which Commonly Happen in Tuban

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Abstract

Tuban, East Java, Indonesia, is well-known by its high concentration of calcium and magnesium ions which are mixed in its soil and water. The consumption of high calcium-magnesium concentrated water leads to kidney stone disease in Tuban. Palmyra palm (*Borassus flabellifer*) is a common plant in Tuban. Its antiurolithiatic activity (diuretic effect) dissolve brushite crystals formed inside the kidneys. It is done due to *Borassus flabellifer*'s sap which is served as a traditional drink called *Legen*. The objective of the study is to identify that Palmyra palm (*Borassus flabellifer*) contains diuretic chemical substance and *Legen* can be used as the cure of kidney stone disease. The used research method is qualitative by field and library research. According to Shirisha (2018), sap from the flower of *Borassus flabellifer* acts as diuretic agents. The plant has been used traditionally as a stimulant, antileprotic, diuretic, and antiphlogistic (Chinnala, 2016). Pursuant to Amalo (2008), *Legen* cures kidney stone disease by consuming it once in 24 hours for 30 days constantly. Furthermore, it is also recommended to be consumed in a determined amount as a prevention of kidney stone disease.

Keywords :Tuban, calcium-magnesium concentrated water, kidney stone disease, *Borassus flabellifer*'s sap, diuretic compound.

1. Introduction

1.1 Background of Research

Clean water is a water which quality has fulfilled healthy conditions, such as physical, bacteriological, and chemical conditions. Healthy clean water quality for human is ruled in Permenkes RI (Republic Indonesia health ministry regulation) No. 416/ MENKES/PER/IX/ 1990 and Permenkes RI No. 907/MENKES/PER/ IX/2002. The physical conditions of clean water quality are colorless, tasteless, odorless, clear, and the water temperature should be below the air temperature. As for Biological condition, water should not contain pathogen. While in chemical condition, drinking water should not be polluted by chemical substance over standard set. One of the diseases which is caused by consuming unhealthy water is kidney stone disease or renal calculi.

Kidney stone define as crystal which is originated from urine settle's minerals. Based on some experiment's reports, this disease is caused by calcium (calcium oxalate), magnesium, ammonium, phosphate, uric acid, calciumphosphate, and cystine.

According to Hakim et al (1986), soil is the main source of calcium and is containing 3.6 % calcium. The main stones that contain calcium are calcite (CaCO_3) and dolomite ($\text{CaMg}(\text{CO}_3)_2$), both of the stones are sedimentary rock's composers. The amount of calcium in the soil is approximately 0.4 % in topsoil while in organic soil is 2.8 %. A great amount of calcium in organic soil is originated from water flow which carries liquid on its body.

Calcium is a chemical with the symbol Ca and atomic number 20. Calcium has an atomic mass of 40.078, which is a light gray alkaline and is the fifth largest element that forms the bowels of the Earth. Calcium is an essential requirement for living organisms, especially in cell physiology, namely the movement of Ca^{2+} calcium ions that move in and out of the cytoplasm that functions as a signal for many cellular processes. Calcium oxalate with the chemical formula namely CaC_2O_4 or $\text{Ca}(\text{COO})_2$ is a complex crystal needle-shaped chemical. Calcium oxalate is also a major component of beerstone. The most common crystal oxalate calcium in urine can cause kidney stones.

The standard calcium content in drinking water is not obtained by many references. The standard content of Calcium (Ca) in drinking water in the Indonesian National Standard (SNI) number 01-0220-1987 concerning drinking water is 10 mg / L (10 ppm) .

Kidney stones in the urinary tract (urinary calculus) are hard masses like stones that form along the urinary tract and can cause pain, bleeding, blockage of urinary flow or infection. This stone can form in the kidneys

(kidney stones) or inside the bladder (bladder stones). This process of stone formation is called urolithiasis (renal lithiasis, nephrolithiasis) .

Stones can cause urinary tract infections, if the stones block the urinary flow, the bacteria will be trapped in the urine, accumulating above the blockage, and will cause infection. If this blockage lasts for a long time, the urine will flow back to the channel in the kidney, causing stress that will inflate the kidneys (hydronephrosis) and eventually will occur kidney damage.

Tuban is one of many regencies which is located in the North Coast of East Java, Indonesia. Tuban Regency has a limestone mountain that extends from Jatirogo Sub-district to Widang Sub-district. From its geological aspect, the soil condition in Tuban Regency consists of reddish-yellow mediterranean soil that is originated from limestone sediment in the hill and mount 38 % of the total area including Semanding, Montong, Kerek, Palang, Jenu, Widang, Plumpang, Merakurak, and a part of Tambakboyo Sub-district.

Table 1. Prevalence of limestone area in Tuban Regency

Category	Area (ha)	%
Very Low potential	20267.90	10.29
Low Potential	45921.29	23.32
Average Potential	64514.36	32.76
High Potential	33511.54	17.02
Very High Potential	32709.36	16.61

Source : Engineer journal of ITS Vol. No. 2 (2017), 2337-3520 (2301-928X Print)

Because of the great amount of limestone area (table 1), freshwater in Tuban Regency is polluted by limewater. That can potentially cause someone who drinks limewater in Tuban Regency suffer urolithiasis and kidney stone disease (renal calculi). According to Radar Bojonegoro's reports (local newspaper in Bojonegoro City, a city nearby Tuban Regency), the leader of Public Health department, Achmad Hernowo, said that water which contained lime in Bojonegoro is exactly able to become one of many factors that leads to kidney stone disease (Radar Bojonegoro, March 28th 2019). On the other side, as one of the regencies which is located in Pantura area (north coast of Java Sea), Tuban has an abundant natural product. As Tuban is directly facing Java sea, this town's temperature is hot enough. This climate create typical natural product which is different from other regions. For example, *Legen*. *Legen* is a traditional drink from Tuban which is usually consumed as soft drink and even medicine. *Legen* is made from Palmyra palm's sap. Palmyra palm or *Borassus flabellifer* (figure 1) is the member of Aracaceae family. All parts of this plant can be utilized, starting from its root, stem, flower, fruit, leaf, until seed coat. This plant usually lives in dry area, like in Tuban. Extent of cultivation and productivity of Palmyra palm (*Borassus flabellifer*) is shown in table 2.



Figure 1. Palmyra Palm (*Borassus flabellifer*) Trees in Boto Village, Merakurak Sub-district, Tuban Regency.

Table 2. Extent cultivation and productivity of Palmyra Palm in Tuban Regency

No.	Regency/ City Comodity	Area (Ha)			Total	Production (Ton)	Productivity
		TBM	TM	TT/TR			
1	Sugar	0	2,362	0	2,362	11,542	4,887
2	Palmyra palm	26	247	54	327	82	332
3	Wijen	0	155	0	155	135	871
	total	1,673	11,074	5,405	18,152	19,277	1,741

Source : docplayer.info

As a traditional drink, *Legen* has a potential benefit, which is to be a cure of kidney stone disease. This traditional drink is trusted to cure kidney stone disease because some people have proven it empirically. Adapted from Suara Tuban (2015, January 31), there are three interviewees who had reported that their kidney stone disease got healed after drinking original *Legen* regularly.

1.2 Problem Formulation

Based on our background of research, the problem formulations which can be made are written below:

1. What diuretic chemical substance does Palmyra palm (*Borassus flabellifer*) contain?
2. Can *Legen* be used as kidney stone disease?

1.3 Research Purpose

From the problem formulation elaborated in the previous sub-chapter, the objectives to conduct this research are :

1. To identify that Palmyra palm (*Borassus flabellifer*) contains diuretic chemical substance.
2. To identify that *Legen* can be used as kidney stone disease.

2. Materials and Methods

2.1 Materials

Materials that are used are scientific journals, articles, and mass medias which are related to this research field. Some observation activities also done in some areas of Tuban which become Palmyra palm's sap (*legen*) processing centers. Those areas were Boto Village, Merakurak Sub-district, Tasikmadu Village, Palang Sub-district, Prunggahan Kulon Village, and Palang Sub-district. Notebook and camera are also used in the observation activities.

2.2 Methods

The method used in this research is library and field research method in order to process and collect the datas needed. Library research method is a data processing technique that examines on various books, literatures, notes, and reports which are related with the problem that wanted to be solved (Nazir, 1988). This method is suitable to answer the first formulation problem. Therefore, authors would collect some scientific journals that discuss about the chemical content in Palmyra palm, compare them, and finally conclude that Palmyra palm (*Borassus flabellifer*) contains diuretic chemical substance. While field method is defined as a way to collect data that is directly done on the field which become the object of experiment using some techniques such as observation, interview, and documentation study (Guba and Lincoln, 1981). This method is used to explain the second problem formulation. The mechanism was done by choosing 30 persons to be interviewed as the respondents. These respondents consist of native people in Tuban, including *Legen* consumer, *Legen* producer, random healthy people, academician (undergraduate student), and people who empirically had healed from kidney stone disease by drinking *Legen* regularly. To simplify this interview, questionnaires were made regarding native people's habit of consuming *Legen*. A sample of the questionnaires and its result could be seen in figure 3. This interview was done on Saturday to Sunday, July 13th – 14th 2019 in Boto and Temandang Village, Merakurak Sub-district, Tuban Regency (one of *Legen* producing centers).

Name : Mr. Hadi Noto
Address : Boto Village Boto Village, Merakurak Sub-district, Tuban Regency.
Age : 50
Status : *legen*'s producer

NO	QUESTION	RESPOND		
		YES	NO	EVER
1	Do you consume <i>legen</i> ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
2	Do you know if <i>legen</i> can cure Kidney's Stone Disease?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3	Do you know that <i>legen</i> 's merit from hereditary?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
4	Do you know if water which is consumed by you contain lime stone?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
5	Do you know if consume water which contaminated by lime water leads to kidney's stone disease?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
6	Why do you consume <i>legen</i> ?	For beverage, drug, and body's warmer		
7	Where do you know if consume <i>legen</i> can cure kidney's stone disease?	From oral to another (hereditary)		

Figure 3. Questionnaire's Paper

3. Result and Discussion

3.1 Result and Discussion

3.1.1 Identification of Diuretic Chemical in Palmyra Palm (*Borassus flabellifer*)

As an explanation about Palmyra palm (*Borassus flabellifer*) and its potential utilized in the previous chapter, further explanation in this chapter will focus on identifying diuretic chemical substance in Palmyra palm. Diuretic is something that promotes the formation of urine by the kidney (Shiel, 2018). Diuretic used to be found in herbal plants or medicinal herbs like plant from Mimosaceae and Aracaceae families.

The ethno botany of the Palmyra palm (*Borassus flabellifer*) is in the following explanation. The plant has been used traditionally as a stimulant, antileprotic, diuretic, and antiphlogistic (Chinnala, 2016). Traditionally, parts of the Palmyra palm (*Borassus flabellifer*) such as root, leaves, fruit, and seeds are used for various human diseases, including urolithiasis. Young roots are diuretic and anthelmintic (type of medicine used to destroy parasitic worms), while the decoction of young roots is given in a certain respiratory disease (Jana et al., 2017). The roots of the plants are cooling, curative, and diuretic (Arunachalam et al., 2011). Other parts of this plant are used for medicinal treatment like anthelmintic and diuretic (Gummadi et al., 2016). According to Sahni et al. (2014), different parts of the Palmyra palm have been reported to biological activities and pharmacological function including diuretic. For example, sap of Palmyra palm's female flower of matured tree stalk is prized as a tonic, diuretic agents, stimulant, laxative, anti-phlegmatic, and amebicide that are considered to be the best day to day life (Shirisha et al., 2018).

A research which was conducted by Sujatha and Ranjitha (2018) investigated ethnic practitioner of Pallathupatti, Pudukkottai District, Tamil Nadu, who stated that the fruits and leaves of *Borassus flabellifer* have medicinal uses as diuretic agent because they contain terpenoids, tannins, flavonoids, and coumarins. The use value is 0.84, which is high enough for ethnomedicinal plant (table 3). Different parts of *Borassus flabellifer* have been reported to comprise biological activities and pharmacological functions including anthelmintic, diuretic, antioxidant, and antibacterial activities.

Table 3. Ethno medicinal Plants and Their Related Information

Tree	<i>Banahinia racemosa</i>	Caesalpiniaceae	flower, fruit	scopoletin, Beta-amyrin, tannins, kaempferol & quercetin	diarrhea, rectal prolapse, tumors inflammation, hemorrhoids	0.12
Herb	<i>Boerhaavia diffusa</i>	Nyctaginaceae	whole plant	Alkaloids, flavonoids, steroids, terpenoids, tannins, cardiac glycosides, anthraquinones amino acid, boeravinone-C, xanthones, punarnavine	cancer, kidney, liver diseases, debility, carminative, anemia, hepatitis, and constipation	0.34
Tree	<i>Borassus flabellifer</i>	Arecaceae	fruits, leaves	Terpenoids, tannins, flavonoids and coumarins	biliousness, dysentery and gonorrhoea, diuretic, stimulant, snake bite, urinary troubles	0.84
Shrub	<i>Bougainvillea glabra</i>	Nyctaginaceae	Flower	pinitol, betacyanine, flavonoids, tannins and alkaloids, sugars, cardiac glycosides	Respiratory disorders, diabetes The leaves are considered to have anti-inflammatory	0.77
Shrub	<i>Calotropis gigantea</i>	Asclepiadaceae	whole plant	calotropin, giganteal, akandarin, α - and β -calotropols and β -amyrinacids, triterpene.	Treat haemorrhoids pills, carminative effect, digestive strength, cough and asthma, cholera, skin disease.	0.27
Shrub	<i>Canna indica</i>	Cannaceae	whole plant	anthocyanin, oleonolic, betulinic acid, anti-carcinogenic	laxative, urine, drug, anti oxidant, hepatitis	0.09
Tree	<i>Carica papaya</i>	Caricaceae	whole plant	papain, carpinine, carotenoids, Polyphenols	Blood pressure, dyspepsia, constipation, amenorrhoea arthritis	0.34
Shrub	<i>Cassia auriculata</i>	Caesalpiniaceae	whole plant	Alkaloids, flavonoids, saponins, cardiac glycosides, anthraquinones, tannins.	Astringent and tonic, refrigerant, stomach ache, conjunctivitis diabetes, constipation, liver diseases, urinary disorders	0.29

Source: Ethno botanical Study of Indigenous Knowledge on Medicinal Plants Used by village People of Pallathupatti, Pudukkottai District, Tamil Nadu.

Based on world journal of pharmacy and pharmaceutical sciences, family Aracaceae, including *Borassus flabellifer*, has a historical antiurolithiatic background. Their historical antiurolithiatic background was shared in a well-known book of Dioscorides. Among the parts of the plant, its fruits, leaves, roots, and rhizomes were noted as the most common (25% each) followed by its flowering buds and seeds (12.5% each). In terms of preparation, the decoction was observed most commonly (66.66%), followed by infusion (33.33%). The activity of antiurolithiatic can be seen in table 4. Antiurolithiatic in *Borassus flabellifer* is shown on *in vitro* model where some parts of this plant have the effect of resistance to Brushite (calcium hydrogen phosphate, dehydrate), one of urinary crystal types (table 5). Beside diuretic chemical, the antioxidant in *Borassus flabellifer* fights oxidant that cause many human disease like kidney disease (Talluri et al., 2017).

Table 4. Antiurolithiatic plants of Aracaceae Family

Arecaceae (07)	
<i>Areca catechu</i> L.	Nut powder --- India ^[9] India: 1.5 g of nut powder along with 250 ml of water. 250 ml BD for 7 days ^[9] .
<i>Borassus flabellifer</i> L.	Leaves / roots decoction / buds infusion --- India ^[7, 9] India: 250 ml roots / leaves decoction BD till stone expulsion. OR Eat jelly like kernel of fruit OD till stone expulsion ^[9] . Pharmacological activities: Diuretic ^[9] . Antiurolithiatic spectrum (reported): Fruits against brushite and whewellite ^[21] .
<i>Calamus rotang</i> L.	Rhizome powder / decoction --- India ^[7] ; stem and leaves --- India ^[43] India: 100 ml rhizome decoction or 5-10 g rhizome powder in one L of water. 250 ml TID till stone expulsion ^[11] . Pharmacological activities: Anti-inflammatory ^[40] .
<i>Chamaerops humilis</i> L.	Leaves --- Algeria ^[41] . Pharmacological activities: Lithotriptic ^[21] . Antiurolithiatic spectrum (reported): Bark against whewellite ^[21] .
<i>Cocos nucifera</i> L.	Fruit water --- India ^[7] ; fruit --- Indonesia ^[48] India: 30 ml of flower extract mix with 50 ml of goat milk and sugar. 80 ml OD till stone expulsion ^[9] ; Indonesia: Fruit baked and its water mixed with brown sugar or honey taken orally ^[48] . Pharmacological activities: Analgesic, anti-inflammatory, antioxidant ^[8] , litholytic ^[40] . Antiurolithiatic spectrum (reported): Fruits against brushite, whewellite and struvite ^[21] .

Source: World Journal of Pharmacy and Pharmaceutical Sciences. Vol.6, No. 8

Table 5. Antiuro lithiatic plants that acts against Brushite (Calcium Hydrogen Phosphate dihydrate)

Name of Plants	Preparation Method	Part which is used
<i>Acacia radicata</i> Savi.	NDF	Ba (Aq and Eth) SCU ^[31]
<i>Achyranthes aspera</i> L.	Le /St/Ro (Inf / Dec) ^[40]	Ro (Aq) CGG ^[34]
<i>Aerva lanata</i> (L.) Juss.	Ro (NDF) ^[43]	Ro (Aq) CGG ^[41] SSM ^[42]
<i>Averrhoa carambola</i> L.	Sh (NDF) ^[43]	Sh (Aq) CGG ^[35]
<i>Ananas comosus</i> (L.) Merr.	Fr (NDF) ^[40]	Fr (Ju) SSM, SDM, RSM, RDM ^[36]
<i>Borassus flabellifer</i> L.	Fr (Ju) ^[40]	Fr (Ju) CGG ^[31]
<i>Chenopodium album</i> L.	NDF	Fr (Ju) CGG ^[31]
<i>Citrus limon</i> (L.) Osbeck.	Le (Inf) ^[40]	Fr (Ju) SSM, SDM, RSM, RDM ^[40]
<i>Citrus cotinifolius</i> (L.) Schrad.	Fr (Ju) ^[40]	Fr (Ju) CGG ^[31]
<i>Citrus limatus</i> (Thunb.) Matsum. & Nakai.	Wp (NDF) ^[40]	Fr (Aq) SCU ^[33]
<i>Cocos nucifera</i> L.	Se (Inf) ^[40]	Fr (Ju) SSM, SDM, RSM, RDM ^[34]
<i>Ensete superbum</i> (Roxb.) Cheesman.	Fr (Wtr) ^[40]	Fr (Wtr) CGG ^[31]
<i>Mimosa pudica</i> L.	Ro (Ju); Se (Pw) ^[40]	Aq (dec) CGG ^[36]
<i>Persea americana</i> Mill.	Le (Ju); Ro (Dec) ^[40]	Wp (Aq) CGG ^[31]
<i>Tamarindus indica</i> L.	Le (Dec) ^[40]	Fr (Ju) SSM, SDM, RSM, RDM ^[36]
<i>Vitis vinifera</i> L.	Fr / Le (Dec) ^[40]	Fr (Aq) CGG ^[31]
<i>Zea mays</i> L.	Fr (Ju) ^[40]	Fr (Aq) CGG ^[31]
	Zmh (Dec/ Inf) ^[40]	Zmh/Aq/HPM ^[32]

Source : Ethno botanical Study of Indigenous Knowledge on Medicinal Plants Used by village People of Pallathupatti, Pudukkottai District, Tamil Nadu.



Figure 3. The Process of making *Legen* in Boto Village

Native people of Tuban Regency usually consume this drink. Based on observation in research area, 83.3 % of 30 respondents consume *Legen* and the rest 16.7 % don't. Those respondents consume *Legen* due to many factors such as beverage, protection from cold temperature, prevention of kidney stone disease (renal calculi), and medication to cure renal calculi disease. Whereas the rest of respondents don't consume *Legen* because of its little-bit-bad odor. From the 30 respondents (figure 5), 96.7 % of them know that *Legen* can be functioned as kidney stone disease and 3.3 % in the contrary. It is empirically proved based on the explanations previously.

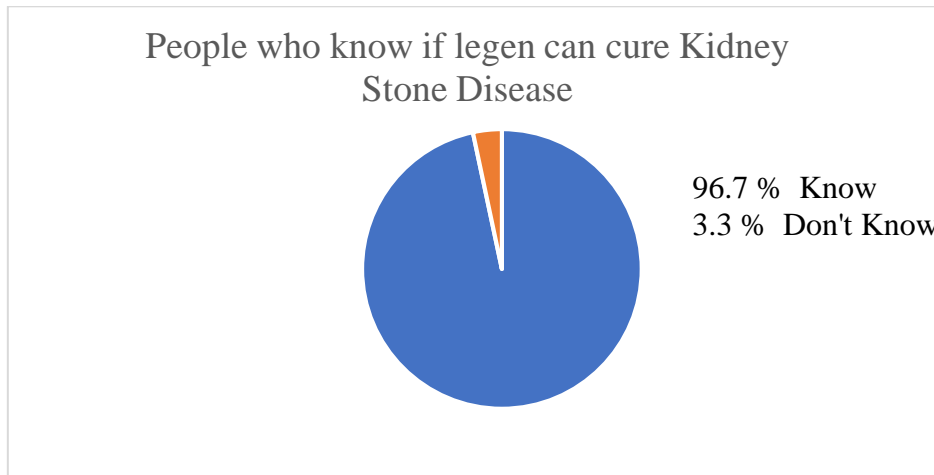


Figure 5. Total 30 Respondents about the Potential of *Legen*

As seen in figure 5, it is known that almost all of the respondents know about *Legen*'s benefits (kidney stone disease drug). They also said that *Legen*'s ability to cure kidney stone disease is known from oral to oral (hereditary). It proves that *Legen* empirically cures kidney stone disease. While the others know this information from the internet, like academicians. They know the benefits of *legen* and other products of Palmyra palm (*Borassus flabellifer*) from articles and journals.

Legen can be functioned as medicine appropriately with the following treatment. Treatment to heal kidney stone disease with *legen* consist of some steps. First, *Legen* must be genuine because counterfeit product will decrease healing ability. A freshly-made *Legen* can only last for 3 to 4 hours knowing that the alcohol would rise and the taste would get bitter as the fermentation keeps going (Amalo, 2008). Then, kidney stone disease sufferer must drink *Legen* regularly as many as three times in a day "to cure kidney stone disease, someone ought to drink *Legen* three times in a day, physician also said that, as I said" (Hadi Noto, *Legen* producer, personal communication, 2019, July 14). According to Amalo (2008) Consumption of *Legen* for once in 24 hours in a 30-day-constant can dissolve crystals formed inside the kidneys. However, over consumption is not recommended as the alcohol formed from the fermentation would act as an intoxicating agent.

4. Conclusion

Consuming highly calcium-magnesium-concentrated water is reported as one of any factors that cause kidney stone disease. Based on various journal review, some parts of Palmyra palm (*Borassus flabellifer*) contain diuretic chemical compounds which are able to dilute limestone (Ca) in kidneys. One of Palmyra palm's parts that contain diuretic substance is sap of this plant. Native people in Tuban utilize Palmyra palm's sap as beverage and even kidney stone disease's drug called *Legen*. Almost all of people in Tuban know and trust that *Legen* can be functioned as kidney stone disease. It is spread from oral to oral (hereditary). It means that *Legen* has empirically tested in healing urolithiasis. According to Amalo (2008) *Legen* should be consumed once in 24 hours for 30 days constantly in order to dissolve crystals that are formed in kidneys and it would also be a prevention of kidney stone disease for healthy people. Over consumption of *Legen* is not recommended as it would turn out to be intoxicating.

Acknowledgment

In this occasion, the authors would like to thank Airlangga University as our educational institution that has supported on funding and motivating our work to finish this paper. The authors would also thank the co-author Dr. H. Moch. Affandi, M.Si. (lecturer of Biology Department, Faculty of Science and Technology Airlangga University) who has provided references related to *Legen* in Tuban, suggestions, critics, and inputs for improvement and further studies of this paper. Furthermore, the authors would also thank Mr. Abdul Salam and Mr. Khusnan Wafi as respondents who have given current data of *Legen* and have motivated authors in getting this research done in order to become eligible to join an international conference.

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