Mekanika: Majalah Ilmiah Mekanika

Procurement and Operation Technical For Meniran (Phyllanthus Niruri) Extraction Equipment

Budi Santoso[1], Fitrian Imaduddin[1], Heru Sukanto[1], Joko Triyono[1], Raymundus Lullus Lambang[1], Purwadi Joko Widodo[1] and Dwi Heru Siswantoro[1]

[1] Mechanical Engineering Department, Faculty of Engineering, Universitas Sebelas Maret

*budisant@staff.uns.ac.id

Keywords:
Procurement; Rotary vacuum evaporator; Extraction; Evaporation; Meniran

At this time the government prohibits the use of antibiotics in animal feed as a growth promoter (AGP) or antibiotic, so an effective and safe immunomodulator and herbal growth stimulant product are needed through Meniran extract products (Phyllantus niruri) and chemicals in the market are not yet optimal as immunomodulators and growth stimulants. CV. Maxipro Agrosatwa which is engaged in veterinary medicine, wholesale trade of agricultural products, and other live animals will produce feed using Meniran extract products. Extraction equipment that is needed is a Rotary vacuum evaporator. This equipment is needed to separate the solvent from the solute without high heating which will damage the solute content. The vacuum condition in the flask is to make the separation more efficient as well as accelerate the separation of the solvent from a solution by reducing the boiling point. The rotation of the flask is to increase evaporation. The complexity of this equipment is what makes CV. Maxipro Agrosatwa cannot handle it alone and requires technical assistance from the Department of Mechanical Engineering (JTM) FT UNS. Technical assistance provided by JTM FT UNS is in the form of procurement, delivery, installation, operation, and maintenance of the rotary vacuum evaporator.

1 Introduction

The government prohibits the use of antibiotics as additives in animal feed as an antibiotic and growth promoter (AGP). Meniran plant (Phyllanthus niruri) is a plant that can be used as a prevention and alternative treatment for diseases caused by Avian Pathogenic Escherichia coli (APEC), Salmonellosis, Chronic respiratory disease (CRD) in livestock, especially chickens, which can inhibit growth and productivity. Besides, Meniran can break the chain of infection in humans. [1]

Extraction is a process of separating solid or liquid materials from the mixture with the help of solvents. The solvent used must be able to extract the desired substance without dissolving other materials.

https://dx.doi.org/10.20961/mekanika.v20i1.45487

Revised 17 March 2021; received in revised version 20 March 2021; Accepted 21 March 2021
Available Online 31 March 2021

2579-3144

The process of extracting chemical components in plant cells, namely organic solvents, will penetrate the cell walls and enter the active substance's cell cavity. The active substance will dissolve in organic solvents

outside the cell so that the concentrated solution will diffuse out of the cell. The researcher repeats the process until there is a balance between the active substance's fluid concentration inside and outside the cell. [2]

Rotary Vacuum Evaporator is a device used for extraction, efficient and gentle solvent evaporation. This tool makes the separation of the solvent from a solution efficient and fast. The main components are the vacuum pipe, controller, evaporating flask, capacitor, and the resulting condensation collection flask. This tool uses vacuum distillation principle so that the pressure is lowered, and the solvent evaporates below the boiling point of atmospheric pressure (100 °C). The flask heater in this tool uses hot water equipped with a flask spinner to speed up evaporation. The purpose of evaporation under vacuum is to allow the solvent to be separated from the solute without high heating, which destroys the solute content. [3]

The use of a rotary vacuum evaporator for the extraction of Meniran (Phylantus Niruni) can produce efficient extraction of Meniran. A rotary vacuum evaporator is a device that uses the principle of distillation or separation of chemicals based on differences in the speed of evaporation of materials. Compared with other separation techniques such as the evaporation method using an oven, the distillation technique produces superior quality extractions. The way the rotary vacuum evaporator works, there are two techniques, namely heating and decreasing the pressure on the round bottom flask then rotating the round bottom flask at a certain speed, so that the solvent will evaporate and the compounds dissolved in the solvent will not evaporate. Heating below the solvent's boiling point prevents the compounds contained in the solvent from being damaged by high temperatures.

In the livestock industry, the quality of livestock products often consumed by the community is an important priority, so quality observations are needed. Livestock products that are not handled properly and are of low quality can endanger the health and even cause disease in the body. Hazards related to food safety from livestock can come from livestock diseases that are transmitted through food (foodborne disease) or contamination of chemicals and other toxic materials such as antibiotics. Antibiotics in animal feed that are used to treat livestock diseases are often given by farmers, not according to the recommendations and the dosage, resulting in antibiotic residues. Antibiotic residues have many adverse effects on health, including allergic reactions, toxicity, the immune response's performance, and resistance to microorganisms.

2 Rotary Vacuum Evaporator

2.1 Evaporator Definition

An evaporator is an equipment that can change part or all of a solvent from a liquid solution to a vapor. The evaporator has two basic principles: exchanging heat and separating the vapor formed from the liquid. The evaporator generally consists of three parts, namely the heat exchanger, the evaporation section (the place where the liquid boils and then evaporates), and a separator to separate the vapor from the liquid and then put it into the condenser (to be condensed/condensed) or to other equipment. The yield from the evaporator (desired product) can usually be a solid or concentrated solution. An evaporated solution may consist of several volatile (volatile) components. Evaporators are commonly used in the chemical industry and the food industry. For example, in the chemical industry, salt is obtained from saturated brine (an example of a purification process) in an evaporator. The evaporator converts water into steam, leaving mineral residue in the evaporator. The steam is condensed into de-salted water. In a cooling system, the cooling effect is obtained from the absorption of heat by the rapidly evaporating coolant (evaporation requires heat energy). Evaporators are also used to produce drinking water, separating it from seawater or other contaminants.

The rotary vacuum evaporator is an instrument that uses the principle of distillation (separation). This instrument's main principle lies in decreasing the pressure in the round bottom flask and rotating the round bottom flask so that the solvent can evaporate more quickly below its boiling point. This instrument is preferred because the results obtained are very accurate. Compared with other separation techniques, for example, using the usual separation technique, which uses the evaporation method using an oven, then it can be said that this instrument will be far superior because this instrument has a different technique from other separation techniques. Furthermore, the technique used in this rotary vacuum evaporator lies not only in heating it but by lowering the pressure in the round bottom flask and rotating the round bottom flask with a certain speed. Because of this technique, a solvent will evaporate, and the compounds that dissolve in the solvent will not evaporate but precipitate and by heating below the boiling point of the solvent so that high temperatures do not damage the compounds contained in the solvent.

2.2 Rotary Vacuum Evaporator History

Walter BUCHI takes the idea of C.C. Draig, and ME Volk works together with the Basel chemical industry and develops the first-ever rotary evaporator. The first patented instrument was sold in 1957 in Basel and introduced to the international public for the first time at ACHEMA in Frankfurt in 1958. The smash hit Rotavapor Model 1957 featuring a spark-free induction motor and a strong glass condenser with a cooling coil. For the first time, it is possible to adjust the motor rotation speed continuously between 0-240 rpm with a preset potentiometer. The condenser is placed on the control unit using a standard connection. After the first variant in 1957, it allowed a continuous liquid intake during distillation with the feed tube and cock. A water jet pump is used as a source of vacuum and a water reservoir, in which the flask can be rotated and partially immersed for heating.

During the seventies, when television was no longer a luxury in Switzerland, viewership reached more than one million households, and the United States faced the invention of the floppy disk, BUCHI once again took the international scene with the laboratory trendsetter. The evaporation instrument in a new design integrated with the water and oil container offers a pleasant surprise. Nothing is left out: A diagonal condenser is provided for standard distillation at a limited ceiling height. A space-saving reflow condenser is provided for foaming solvents. A dry ice condenser allows evaporation of low boiling solvents. Although the instrument remains extremely compact, operational security is increased with a larger platform. The motto in 1971 was to support variety and increase safety. So, almost all customer needs, and every application area can be fulfilled. Success is that if it doesn't fail to appear, the Rotavapor-R became a laboratory trendsetter in the seventies

2.3 Evaporator Classification

Evaporators are divided into several types, namely:

- Steam heated evaporator is a heated evaporator where steam or other condensable vapor is a heat source where the steam condenses on one side of the heating surface, and heat is transmitted through the walls to the boiling liquid.
- The submerged combustion evaporator is an evaporator heated by a fire that burns below the liquid's surface, where hot gas bubbles through the liquid.
- Direct fired evaporator is a direct ignition evaporator where the fire and combustion gases are separated from the boiling liquid utilizing metal walls or heating surfaces.

2.4 Evaporator Selection

Evaporator Selection Considerations are:

1. Heat contact should keep the product that has to be vaporized
2. The size is adjusted according to the production capacity
3. Checking the surface is relatively easy by opening the evaporator rack
4. Economical stratified or thermal/mechanical recompression

5. Easy to operate and quiet
6. Easy to clean and maintain
7. The material is quite goodlaboratory trendsetter in the seventies

2.5 Evaporator Capacity

For tube type evaporators with steam heating, the evaporator performance is measured based on the evaporator capacity. Capacity is defined as the number of pounds of water evaporated per hour. To transfer heat energy as desired, the heat transfer surface of the evaporator must have sufficient heat transfer capacity so that all the refrigerant that will be evaporated in the evaporator can run optimally and produce maximum cooling as well. The heat transfer in the evaporator can occur in two ways, namely convection and conduction. The amount of heat transfer capacity in the evaporator depends on five variables: surface area, temperature difference, heat conductivity factor, the thickness of material used, and time, such as a vacuum evaporator. This evaporator is usually made of stainless steel 312 and 308 with a capacity from 20 liters to 120 liters.

2.6 Rotary Vacuum Evaporator Components

Figure 1. A rotary vacuum evaporator is equipped with a vacuum pump and chiller.

The components of the rotary vacuum evaporator are:

1. Condenser: functions as a coolant that speeds up the phase change process, from the gas phase to the liquid phase.
2. Water bath: as a water container heated by a hot plate for a bottom flask containing "samples."
3. The refrigerator functions as a water cooler that runs from the refrigerator to the condenser and returns to the refrigerator.
4. The vacuum pump functions to reduce the pressure in the round bottom flask so that the solvent evaporates below its boiling point.
5. The end of the "sample" rotor: functions as a place for the round bottom flask to hang on.
6. The end of the "catch" rotor: functions as a hanging round bottom flask.
7. Hot plate: functions to adjust the temperature at the water bath with the desired temperature (depending on the solvent's boiling point).
8. Condenser hole: serves as the exit for water from inside the condenser.
9. Condenser hole: It serves as the water entering into the condenser where a vacuum pump sucks the water.
10. Round bottom flask for storage: functions as a container for solvent storage.

2.7 Factors Affecting Evaporator Process

- Concentration in liquid

For the liquid entering the evaporator in a dilute state, the more concentrated the solution, the higher the boiling point of the solution, and for this, you must pay attention to an increase in the boiling point.

- Solubility of the solute in a solution

a. Thus, the concentration of the solution, the higher the concentration of the solute, so that the limit of the product of solubility can be exceeded, which consequently forms a solute crystal. If this is the case, in evaporation, the limit of the maximum solute concentration that can be generated by the evaporation process must be considered.

b. In general, the solubility of a granule / solid increases with higher temperature so that when "drainage" is cold, crystals can form, which can damage the evaporator. So the drainage temperature must be considered.

c. Material sensitivity to temperature and heating time. Some substances that are heated in evaporation are not resistant to high temperatures or too natural heating. For example, biological materials such as milk, juices, pharmaceutical ingredients, and so on. So for such substances, a certain way is required to reduce heating time and operating temperature.

d. Froth and splash creation. Sometimes some substances, such as NaOH solution, "skim milk," and some fatty acids will cause high liquid splashes accompany foam, a lot of foam during evaporation. This foam/splash can be carried away by the steam coming out of the evaporator, and consequently, there is a loss. So efforts must be made to prevent it.

e. Crust formation. Many solutions are easy to form crusts/deposits. With this scale formation, it will reduce the overall heat transfer coefficient, so it is necessary to maintain the right concentration/evaporation technology because of the cost of descaling or consuming time or money.laboratory trendsetter in the seventies

2.8 Storage Method and Maintenance

- Storage Method

The rotary evaporator is usually kept in an instrument laboratory. We recommend that the rotary evaporator be stored on a table or a permanent place to avoid shocks that can damage the appliance. The rotary evaporator is also better kept in a place that is not too hot or too humid.

- Maintenance

There are many kinds of rotary evaporator treatments. Treatment of the cooler, namely water used by aqua bikes water, prevents cooling damage due to rusting on the inside of the appliance. Aquabides must also be replaced periodically; for example, it should be replaced every two weeks if used frequently. Care for glassware is the same as for other glassware; that is, it is stored in a clean and dry condition and stored in a place with room temperature. Water baths are treated by changing the water regularly, for example, if it is frequently used twice a week. Also, it is a good idea for each device to have its switch. Water bath for water bath switch, cooler for coolant switch, and so on.

3. Implementation of Service Method

The stages of service activities can be seen in Figure 2.

3.1 Survey

This activity is carried out utilizing field visits to partners to obtain information about the production process of Meniran extract, production capacity as well as available resources. Types of rotary vacuum evaporators available in the market are also a matter of discussion with partners.

3.2 Preparation of Technical Specifications for Equipment

This part of the activity makes procurement provisions: terms and conditions, payment methods, and technical specifications for the rotary vacuum evaporator and vacuum pump. The preparation of technical

specifications for the equipment is adjusted to its financial capabilities, but operations can be performed reliably and easily.

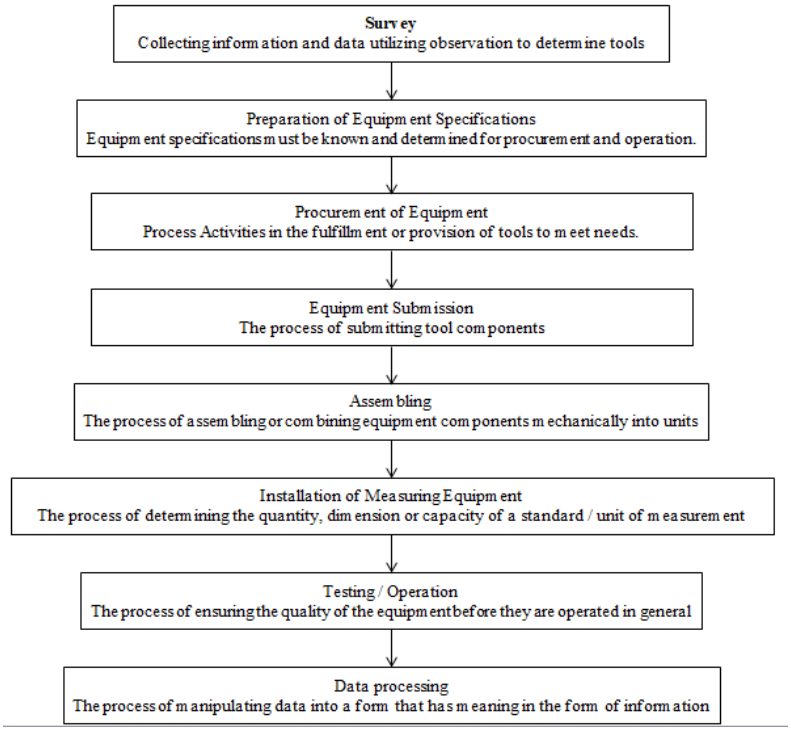

Figure 2. The stages of service activities

3.3 Procurement of Equipment

Equipment procurement assistance activities are carried out in direct communication with providers with consideration of time efficiency. The procurement of equipment always considers the financial aspects of partners, the capacity of equipment, functions, and commissioning. Price quotes obtained from providers are compared by considering the price, equipment reliability, after-sales warranty, and the capabilities of the provider of the goods.

3.4 Assembling

The equipment used consists of a rotary vacuum evaporator, a vacuum pump, a water pump, and supporting equipment, so assembly activities are needed. Supporting equipment consists of a water tank, table, pump holder, hose, clamp, etc. The service team carries out this activity.

3.5 Installation of Measuring Equipment

Several measuring instruments are needed to test the equipment, such as a pressure gauge indicator, a temperature gauge, and a measuring cup. This measuring instrument is installed to obtain data.

3.6 Testing and Operation

The Service Team carries out testing before the equipment is handed over to the Partner. The service team made SOP and equipment maintenance. Operators of partners are explained and trained on the equipment's working principles, running equipment, and maintain SOPs.

3.7 Data processing

Data processing aims for publication material, which is a requirement for activities. The expected data is the production capability of the tool.

4. Result

4.1 Survey

Survey result for Rotary Vaccum Evaporator to make Meniran extract can be seen at Table 1.

Table 1. Survey Result for Rotary Vacuum Evaporator

Location	Item	Method	Information
CV. Maxipro Agrosatwa	The process of making Meniran extract	Interview	Rotary Vacuum Evaporator equipment is used for evaporation, not extraction, as described in Figure 3.
Lab. Proses Teknik Kimia FT UNS	Rotary Vacuum Evaporator	Interview and Visit	• Requires a vacuum pump and condenser cooling system. • The vacuum pump works continuously during the evaporation process. • Vacuum pumps often fail • Brand: IKA RV10 for 1 liter • Price: 80 million
Toko Online	Rotary Vacuum Evaporator	Browsing	• 2-liter flask • Price: 25 - 67 million • Not including condenser cooler and vacuum pump
Toko Online	Complementary equipmentRotary Vacuum Evaporator	Browsing	• Vaccum pressure sensor and controller. • Vacuum pump. • Condenser cooling pump. • Power supply DC 12-24 volts • Port, water hose, and air hose. • Water trap. • Gas solenoid valve

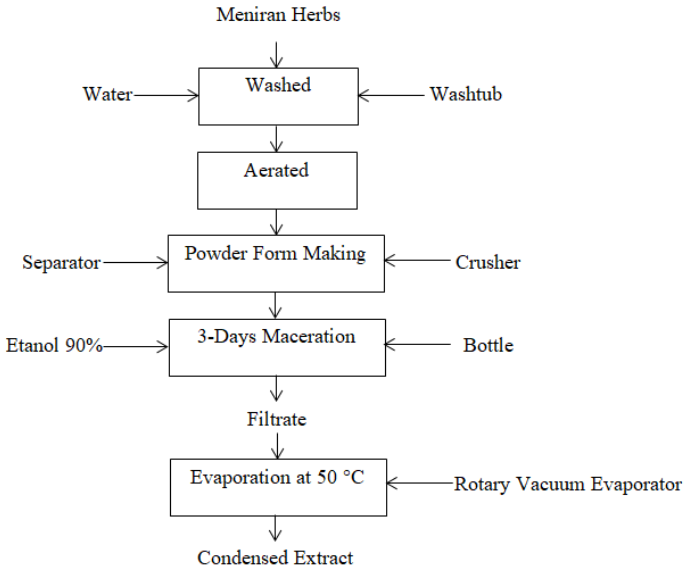

Figure 3. Procedure for Making Meniran Extract

The survey results obtained the agreed terms, namely:

1. The capacity of the Flash Flask is 2 liters.
2. The cheapest price / made in China.
3. The vacuum pump operates at certain vacuum pressure intervals to prevent damage.
4. Rotation of the flash flask is less than 200 rpm.
5. Equipped with an operation timer/operation limiting equipment

6. Flash flask heater can be controlled
7. The flash flask pressure can be controlled
8. Glass and stainless steel materials
9. Positioning of the flash flask is manual
10. Immersion of the flash flask in hot water is done manually.
11. Gas Trap so that the vacuum pump is durable.

4.2 Preparation of Technical Specifications for Tools

Specifications and the number of items to be purchased are shown in Table 2.

Table 2. Spesification

Item	Spesifikasi	Quantity
Rotary Vaccum Evaporator	HAOCHENG new rotary evaporators. Main Features 1.Manual lift with integrated safety "lift-out-function" 2.Water/oil heating bath with integrated ergonomic carrying handles 3.Key-button with locking function for the heating bath temperature 4.Adjustable immersion angle 5.Digital displays for rotation speed and heating bath temperature 6.Single-hand operation; ambidextrous design 7.Speed range 0 - 120 rpm Items: • Type of cooling vertical condenser • Collect flask 1 L • Rotary Flask 2 L • Motor Power 40W • Bath power 1000w • Bath Material Stainless steel combined bath. • Sealing Teflon + Fluorelastome . • Cooling surface 1500 cm2 • Evaporation rate 2L/ H • Speed range 0 - 120 rpm • Heating temperature range RT to 99°C • Heat control accuracy 1 ±K , PT100 thermocouple . • Bath volume max. 2L	1
Vacuum Pump	Vacuum Pump VE115N	1
Vaccum pressure sensor and controller.	DP-101 Digital Vacuum Pressure Sensor Pressure Controller Vacum Control	1
Selenoid valve gas	Selenoid gas valve 1/4 220VAC	1
Condenser Cooling Pump		1
Support Tools	DC power supply 12-24 volts Port, water hose and air hose.	1
Gas trap.	AFR2000 air filter regulator single filter water trap kompresor 1/4 inch gauge air filter compressor / Comes with pressure gauge and mounting bracket Pipe Thread: G 1/4 inch / Rating Flow: 2000L / min Endurable Pressure: 1.5 MPa / Fluid Temperature: 5 - 60 degC Max. Press: 0.99 MPa Pressure Range: 0.05 - 0.85 MPa	1

4.3 Procurement of Equipment

The activities for the procurement of the Rotary Vaccum Evaporator can be seen in Figure 4. This procurement is carried out online with guaranteed delivery assurance. In the delivery of goods, there is a broken feeding valve. Repairs were made by adding pipes to the valves affixed with iron glue to overcome this problem.

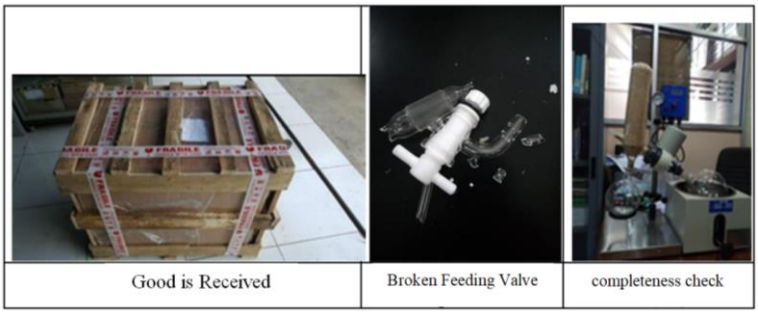

Figure 4. Item checking

4.4 Assembling and Installation of Measuring Tools

In this activity, the work carried out is:

1. Install the electric selenoid valve on the input side of the vacuum pump.
2. Install the controller vacuum pressure sensor
3. Make a 24 volt DC power supply
4. Creating operation time limiter device
5. Attach a hose to vacuum the pressure gauge boiling flask
6. Installing the gas trap
7. Prepare the condenser cooling water reservoir
8. Install a water pump to supply condenser water
9. Attaching the hose to and leaving the condenser
10. Assemble the rotary vacuum evaporator according to the instruction book
11. Connect the electrical system
12. Running tool:
    a. Fill the pot with water
    b. Turn on electricity
    c. Set the vacuum pump operating pressure interval
    d. Turn on the water batch and set the water temperature limit
    e. Turn on the rotary motor and adjust the rotation
    f. Set up the vacuum pressure sensor

Figure 5 shows the assembling work.

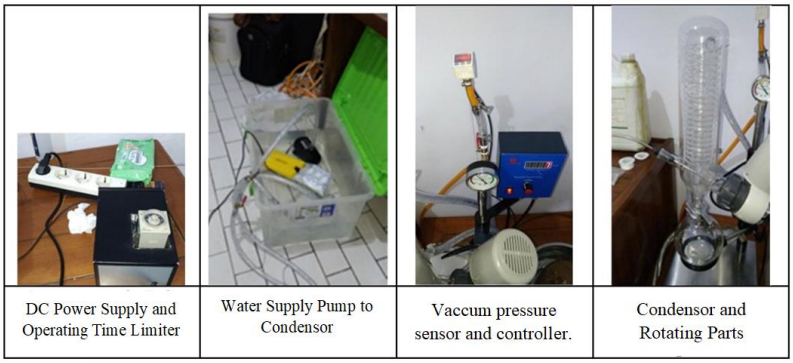

Figure 5 Rotary Vacuum Evaporator Assembly

4.5 Testing and Operation

Testing of the equipment is carried out without the extraction liquid first, then the operation is continued with the extraction process, as shown in Figure 6.

Figure 6. Testing and Operation

The steps for the extraction process are:

1. Remove the boiling flask and fill with the filtrate liquid
2. Put the boiling flask at the end of the lower rotary
3. Run the Rotary Vacuum Evaporator for 1 hour
4. Turn off the appliance
5. After cooling, the boiling flask is removed, and the liquid filtrate sediment is taken with a spatula

5. Conclusion

Community service activities regarding Technical Assistance for the Procurement and Operation of Meniran (Phyllantus Niruri) Extraction Equipment have been carried out. The production of Meniran extract is through the evaporation process in a rotary vacuum evaporator. The specifications of the rotary vacuum evaporator are adapted to the production process of Meniran extract and at low prices. The rotary vacuum evaporator is equipped with a vacuum pressure sensor that can regulate its working pressure, and the electric solenoid gas valve and vacuum pump work according to the settings. The rotary vacuum evaporator is equipped with an operating time limiting timer.

6. Acknowledgement

This service received LPPM UNS support through the Group Research Service Grant Scheme for the 2020 Fiscal Year through the 453 / UN27.21 / PN / 2020 contract.

References

1 Anonim, Antibiotic Growth Promoter/AGP, http://intp.fapet.ipb.ac.id/?p=1783 accessed on February 2, 2020.
2 L. D. Wilson, E. R. Adlard, M. Cooke, and C. F. Poole, “Encyclopedia ofSeparation Science”, *Academic-Press. New York.* 2000.
3 M. H. Leurance, and J. M. Christopher, “Experimental Organic Chimetry: Principles and Practice, Illustrated ed.,” *Blackwell Scientific Publications*, pp 47-51, 1989.
4 Amazon, https://www.amazon.com/HNZXIB-Rotary-Evaporator-Chiller-Vacuum/dp/B07L2SSVHC, accessed on February 2, 2020.