

## Kapok Seed Separator Machine

**Hafsa Mohammad Noor<sup>1,2,\*</sup>, Mazleen Adha Mazlan<sup>1</sup>, Asyraf Hakim Johan<sup>1</sup>**

<sup>1</sup>Department of Mechanical Engineering, Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

<sup>2</sup>Sustainable Product Development (S-ProuD), Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia, Pagoh Higher Education Hub, 84600 Pagoh, Johor, MALAYSIA

\*Corresponding Author Designation

DOI: <https://doi.org/10.30880/mari.2023.04.04.016>

Received 01 September 2023; Accepted 15 October 2023; Available online 01 December 2023

**Abstract :** Kapok is a silky fibre obtained from the pods of the kapok tree. It highly uses for pillows, mattresses, toys, upholstery, insulation material, and as a substitute for absorbent cotton in surgery. Kapok is also naturally hypoallergenic, anti-microbial, and dust mite resistant which can overcome the health issues such as bacteria breeding and skin diseases. Kapok pillows get high demand because of the beneficial use of the kapok and its lifespan. The traditional method to separate the seed from the kapok is using bare hands or beating using a wooden bamboo stick. However, there is a lack of safety and health issues when using traditional methods to make kapok pillows which may lead to itching and harm. The improper equipment also needs to be concerned because the process required blade rods composed of seed and stem. The difficulty in obtaining technical devices is due to the high cost of maintenance and acquisition of these machines, which does not match consumer money. Inadequate labor to complete the kapok filling process. In this study, a kapok seed separator machine is fabricated in order to evaluate the cleanliness of the kapok after the separation process and increase the speed of kapok pillow production. An electric motor and blower are used to separate aside the seed and kapok and instantly fill up the pillowcase with the well-separated kapok. As has been demonstrated, the Kapok Machine requires only 11 minutes to complete the process of making kapok pillow. The number produced for 1 kg kapok that can be done is 6 pieces. The design of this Kapok Machine ensured can assist SMEs to produce technologies that can reduce the risk of injury to employees during the process of seed separation from kapok and increase the speed of kapok pillow.

**Keywords:** Beating Rod, Kapok Processing Machine, Kapok Seed Separator Machine

## 1. Introduction

Kapok or kapok-like fluff plants can largely be found in Mexico, West Africa, Northern South America, and Southeast Asia, including Malaysia. The kapok tree is usually cultivated for its seeds and fiber which may also be referred to as silk kapok, Java kapok, or ceiba [1]. Kapok is widely used for stuffing pillows, mattresses, and cushions. Pillows are an easy place for bacteria to breed as pillows easily absorb dust and sweat. It can cause skin diseases and health problems such as asthma and sinusitis. Kapok pillows are in high demand because of the beneficial usage of the kapok and its lifespan. Kapok fiber is naturally hypoallergenic, anti-microbial, and dust mite resistant. The kapok fiber naturally repels moisture, making it unsuitable for mold, mildew, and bacteria to thrive [2]. Pillows that contain kapok are unrecommended to be washed because it might damage the quality of the kapok inside them. This pillow can only be dried in direct sunlight to eliminate bacteria and restore the fluff.

Through research conducted, the process of separating the kapok and seeds is still used until now in traditional methods to separate them. The kapok fruit will be torn to separate it from the skin of the kapok fruit. It contains kapok also kapok seeds. A worker will tear and separate the kapok seeds from the kapok. The workers use a wooden bamboo stick tool or a drill tool to chop and separate the seed from the kapok. However, there are weaknesses in safety aspects that can cause more serious injury. In addition, the tools used are inappropriate and dangerous for co-workers. Kapok pillow suppliers and manufacturers have difficulty buying a technological machine because it is quite costly and inadequate regular maintenance budget. It does not correspond to capital issued. Considered that they prefer to use the traditional method to save on processing costs. However, there are some issues faced by the suppliers and manufacturers industry which are difficulties with seed separation and the process to fill kapok in pillowcases. It requires a lot of manpower, health issues, and slow processing time.

The kapok used in the manufacture of mattresses and pillows is said to last longer than the kapok synthetic pillow produced by other factories, but it needs to be kept dried and beaten with a wooden bamboo stick to remove the crushed mist dust [3]. The main goal of this study is to fabricate a machine that can separate kapok fiber from seed for Small and Medium Enterprises (SMEs) which can directly fill it into the pillowcase.

## 2. Literature Review

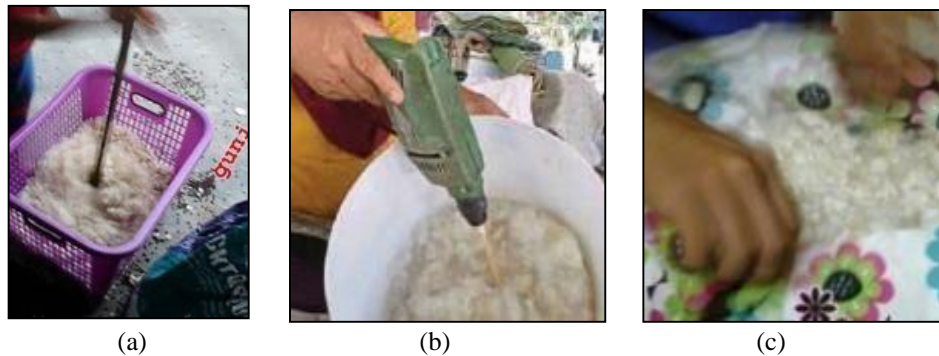
Kapok is a tree with a height of 70 m. It grows well at higher than 50 m in height [1]. The tree is easily broken by a strong wind. Kapok fruit is a source of fiber, used for basic materials such as mats, pillows, wall wear, protective clothing, and retaining heat and sound. **Figure 1(a)** shows the oval-shaped kapok fruit, green, which resembles the bark of the stems and leaves. If the kapok berries are old, they will turn dark brown as shown in **Figure 1(b)**. Inside the fruits, there is a fine white fiber called kapok and seed as shown in **Figure 1(c)**. The old kapok fruit will break apart, causing the white kapok fibers to fly in the wind.



**Figure 1: (a) Unripe kapok, (b) ripe kapok and (c) kapok fruit with seed**

## 2.1 Traditional Method of Processing Kapok

Through the research, there are three types of methods that can be used to conduct the separating seed from kapok process which is using bare hands, wooden bamboo stick, and drill. First, the kapok fruit needed to be torn to separate the contents from the skin of the kapok. After that, the workers will collect all the contents of the kapok into a large container or strainer. Isolate the kapok using a bamboo stick or a wood that has been twisted as shown in **Figure 2(a)**. A driller is used in this step in order to twist the stick in a short period as shown in **Figure 2(b)**. Shake the container to dissolve the kapok so that the kapok seeds fall on the floor. All the kapok that has been processed are filled compressively in the pillowcase using a wood/hand and all the seeds are removed by using the bare hands method as shown in **Figure 2(c)** [4].



**Figure 2: (a) Wooden bamboo method, (b) driller method, and (c) bare hand method**

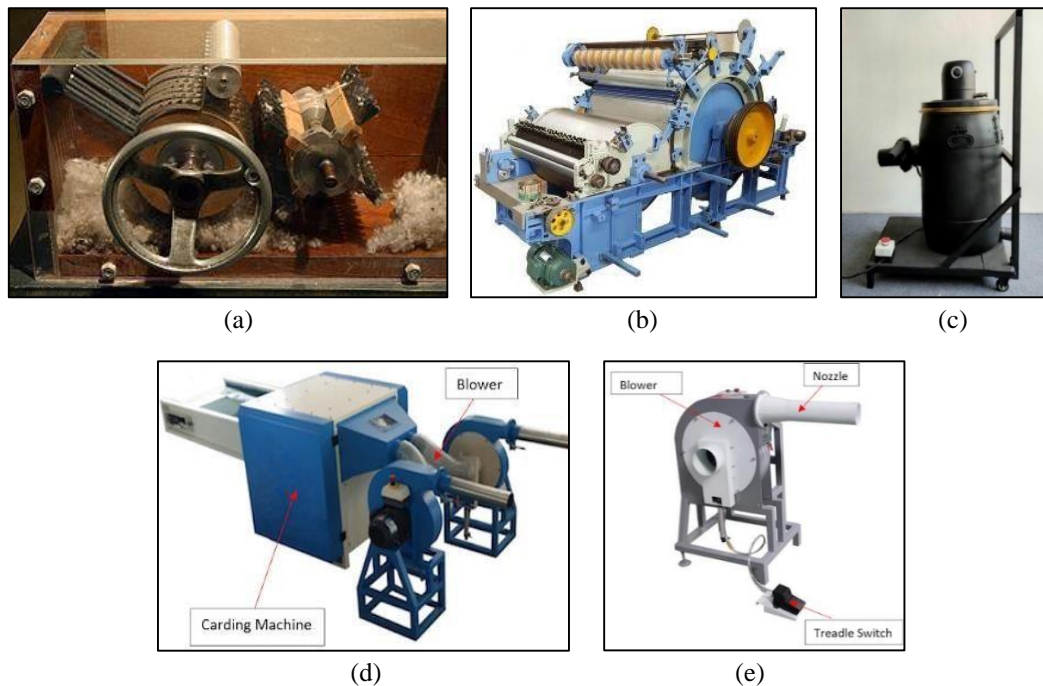
## 2.2 Available Kapok Machine in the Market

Due to the health issues that related to traditional methods, inventors came up with new ideas to solve the problem. Therefore, nowadays, the majority of machines on the market are invented electrically powered and designed for industrial use. Despite saving time, it is not regarded as cost-effective because it is expensive and requires a lot of electricity. Due to these characteristics, a kapok machine is created to help small-business applications, speed up the process of separating the seeds from the kapok, and increase pillow production.

There are a number of various methods to separate seed from kapok, including saw ginning, roll ginning, beating, shaking, and crumpling. Eli Whitney (1765) designed the Gin Machine as shown in **Figure 3(a)**, a huge size machine for separating kapok seeds. To ensure that the kapok produced is seed-free, it uses the crumpling method by crimping the processed kapok with a roll [5]. The gin will start by rolling the cylinder roller and using the teeth of rotating saws to pull the kapok through a series of ginning ribs, which pull the fibers from the seeds that are too large to pass through the ribs. The cleaned seed is then removed from the gin and goes into the seed collector box.

**Figure 3(b)** shows the kapok seed separating machine designated by Lewis Paul of Birmingham in 1748. It employs the shaking method on the barrel to separate the seeds from the kapok, and then it uses the crumpling method by crimping the processed kapok with a roll to verify that the kapok is seed-free. This machine has the benefit of being seedless and producing a large quantity of kapok but there are no user-friendly safety features since there is no emergency switch in the case of an emergency, and the motor lacks a cover, which might result in damage to the user throughout the procedure, such as hands becoming caught in the motor [6]. **Figure 3(c)** shows that a machine called Pro-filler designated by Muhammad Amir Irasyaruddin bin Irawan in June 2020 is used in the process of kapok seed separation. The method of beating is used in separating the seed from the kapok process. At the same time, it can also be used to fill the kapok into the pillowcase. This machine required a large amount of hard work and produced small production [7].

A machine with two nozzles called a Fibre opening and pillows filling machine is depicted in **Figure 3(d)** and was designated by Qingdao Tokays Machine in 2010. This machine is purposely designed to conduct the suctioning of the kapok into the pillowcase process. Kapok will be added to the conveyor and the carding will individualize the fibers from the kapok and proceed to the process of filling the kapok into a pillowcase. This machine is capable of increasing the speed of production as it can operate 2 nozzles at the same time [5]. The Small Type Polyester Fiber Filling Machine designated by Shenzhen Zhonglida Machinery in 2006 is shown in **Figure 3(e)**. This machine only contains just one function which is to fill the kapok into the pillowcase and the separating process must be done manually [8].

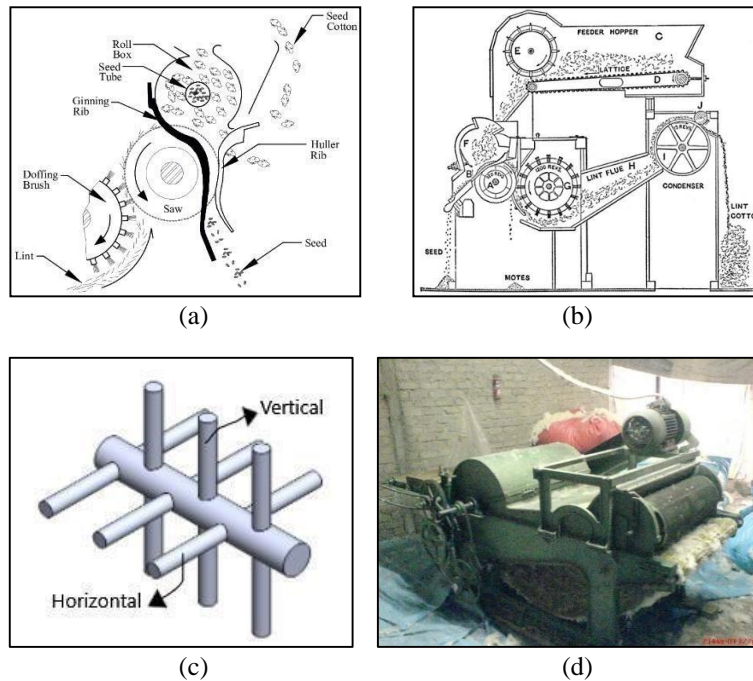


**Figure 3: (a) Ginning Machine [5] (b) Kapok seed separating machine [6] (c) Pro-Filler [7] (d) Fiber opening and pillow filling machine with two nozzles machine [5] (e) Small Type Polyester Fiber Filling Machine [8]**

### 2.3 Technique of Separating Seed from Kapok

In order to conduct the process of separating seed from kapok, there are four types of techniques that can be used which are saw ginning, rolling gin, beating, shaking, and crumpling methods. These four techniques were particularly invented and designed for handling a silky material like kapok. **Figure 4(a)** shows that the ginning is a kapok gin in which the lint is drawn by the teeth of revolving circular saws through a grating of vertical ribs and spaced for the seeds to pass with the lint being removed from the saw teeth by rotating brushes or a blast of air. Rolling Gin is a separation of kapok fibers from their seeds by using the rollers to separate the seed from kapok as shown in **Figure 4(b)**. The gin stand uses the teeth of rotating saws to pull the cotton through a series of ginning ribs, which pull the fibers from the seeds that are too large to pass through the ribs. The cleaned seed is then removed from the gin via an auger conveyor system [9]. **Figure 4(c)** shows the beating method, which is one of the modernist methods that is still in research. The blade that is connected to the electric motor will rotate until the sound of the seed is away. The position of the blade can either be horizontal or vertical. As the speed of rotation is adjustable it can help users to increase the cleanliness. From **Figure 4(d)**, the machines use shaking and crumpling methods to separate seeds from kapok. The barrel will be shaken at different speeds to remove the seeds from the kapok and the roller cylinder will crumple the excess seed.





**Figure 4: (a) Saw Ginning (b) Rolling Gin (c) Beating Rod (d) Kapok seed separating machine**

### 3. Kapok Machine Prototype Design

**Figure 5** shows an exploded drawing of the Kapok Machine. An operation box in **Figure 5(a)** is a place used for separating the seed from the kapok process. This operation box is a component that is made from aluminum zinc which can prevent corrosion from occurring. The dimension of this operation is (45 x 45 x 45) cm. The dimension is estimated to fit 1 kg unprocessed kapok that can fill in the operation box for a one-time separation process. The operation box is installed with an electric motor, blower, and beating rod. **Figure 5(b)** shows blower is used to transfer the kapok into the pillowcase box and dry the kapok. When the kapok is inserted into the operation box, the blower will blow the air and dry the kapok. The circulation of airflow will remove the moisture and make the kapok dry. Dried kapok will make the process easier for seed and dust separation. After the seeds are fully well separated from the kapok in the operation box, the blower will transfer all the kapok into a pillowcase box. A blower requires a higher wattage of electricity to run efficiently. As for this design, the power for this cordless blower is 1200 W.

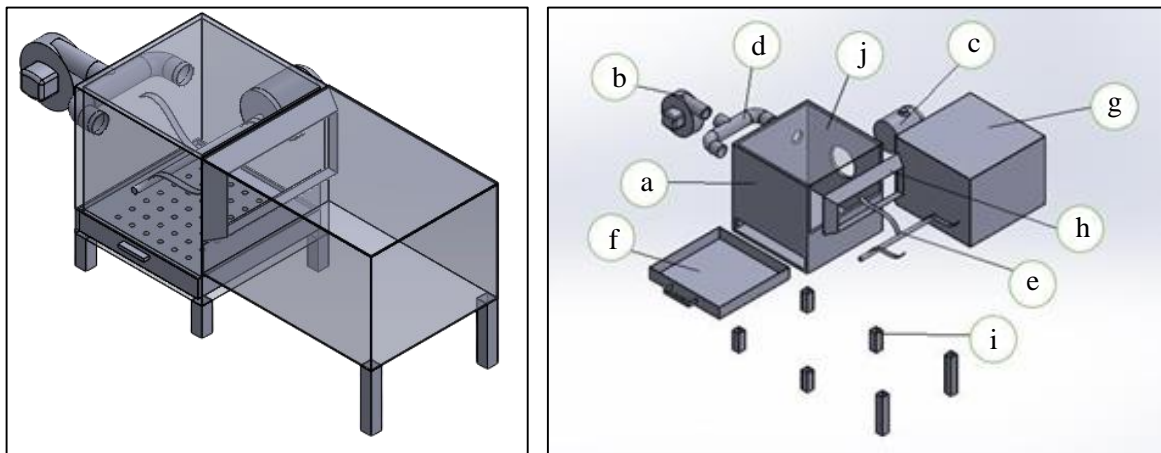
**Figure 5(c)** shows an electric motor with the power of 180 W is used to rotate the blade during the seed separation process. The motor will transmit the power for the blade to rotate. The electric motor has less vibration, high durability, a long lifespan, and is safe to use. The estimated speed for the electric motor is 1800 rpm to 3600 rpm as users can choose a large torque to match the frequency of AC power. When the kapok is added to the operation box, the user can switch on the Electric Motor and adjust the rod rotation speed to increase the cleanliness of the Kapok. In order to connect the blower to the operation box, pipe 1, curved pipe, and T pipe in **Figure 5(d)** are used. These pipes are made from PVC pipe which is corrosion resistance and chemical resistance. The diameter for these parts is 6 cm and the length for pipe 1 is 5cm. Two pipes and a hose are used to reduce the time to complete the drying kapok process.

**Figure 5(e)** shows a rod with curvy blades used to separate the seeds from the kapok. The curved blades in the rod are able to be drawn across the target easier than straight blades. Both of the components are made from plate metal. Because plate metal is easier to weld with hollow shafts it is heavy for the beating process to separate the kapok and the seed. The rod will be installed horizontally, and the blade will be arranged horizontally and vertically. The total number of blades that are used for

this machine is 3. The diameter of the rod is 2 cm while the length is 45 cm. As for the rod, the length is 12.5 cm, and the thickness is 0.5 cm. The blades will be arranged vertically and horizontally and each of the rods will be placed alternately. The electric will rotate the blade in a clockwise direction. This choice of rod arrangement is to make sure the rod can beat the seeds at the same time separate it from the kapok. This arrangement is to make sure that every surface of the kapok inside the operation box will be hit by the rods to make sure that the seeds are 100% separated from the kapok. The rotation of the rod is adjustable as users can adjust the speed to increase the cleanliness of the Kapok and transfer the kapok into the pillowcase box.

After the separating and drying process, all the separated seeds will drop into the seed collector box in **Figure 5(f)**. The dimension of the Seed Collector Box is (43.5 x 43.5 x 6) cm. An aluminum zinc that has been drilled holes and is also known as a net is attached to the operation box. The hole size is 0.5 cm in diameter. The net is designed to be curved to allow the seed to drop into the seed collector box. The net will make sure the kapok stays inside the operation box while the seed will drop into the seed collector box. All the kapok that has been processed will be transferred into the pillowcase box. **Figure 5(g)** shows a pillowcase box that is used to store the processed kapok and for the process of filling kapok into the pillowcase. This component is made from aluminum sheets which will be the case for the process to operate. The dimension that will be measured for this pillowcase box is (45 x 45 x 35) cm. The material contains a high toughness. The pillowcase box will be covered by a PVC net on the top and the bottom of the body to let the air flow throughout.

**Figure 5(h)** shows a connector for the process of transferring the kapok into the pillowcase, which is a component that is made from welded plate metal, as it has good mechanical strength and toughness. The connector will connect between the operation box and pillowcase box to transfer the kapok from the operation box to the pillowcase box and the kapok will be filled into the pillowcase. **Figure 5(i)** shows there are four pieces of a hollow square with the dimension of (2.4 x 2.4 x 8.5) cm and two pieces of (2.4 x 2.4 x 16.5) cm hollow bar are used to support the load of the kapok machine. The material for these parts is aluminum as it has good strength properties. **Figure 5(j)** shows the cap for the operation box that is used to prevent the kapok from getting out of the boxes. For the operation box, acrylic is purposely utilized to observe the process of separating kapok from seed and drying the kapok. Acrylic is a lightweight material that the user can easily open and close the operation box and it is transparent. The dimension of the cap is (45 x 45 x 0.2) cm.



**Figure 5: The exploded drawing of Kapok Machine (a) operation box (b) blower (c) electric motor (d) dual hose PVC pipe (e) beating rod (f) seed collector box (g) pillowcase box (h) connector (i) hollow bar (j) cap**

#### 4. Experimental Setup

After the prototype is made, it needs to be tested to ensure that it can work properly for the purpose of its improvement. The first test, which is the evaluation of the cleanliness of kapok after its separation. The process is carried out to identify the effect of the different duration to produce the cleanliness of kapok quality. 300 g of kapok will be combined with 50 pieces of green peas. Then, the kapok will be inserted in the operation box of the Kapok Machine and will be run to separate the seed from kapok. The duration of the time taken will be measured by stopwatch. The motor at the speed of 300 rpm and blower will be run for 3 minutes. All the kapok will be taken out and checked for its cleanliness. Then the kapok will be labelled as Kapok Sample A. Repeat steps with a new kapok for 6 minutes - labelled as (Kapok Sample B). Repeat steps with a new kapok for 9 minutes - labelled as (Kapok Sample C). All the kapok samples will be observed their cleanliness by checking the quantity of seed that is still inside the kapok, observing by eyes regarding the cleanliness of the kapok. The second testing, time taken to fill 150 g of kapok in the pillowcase. This process is conducted to identify the time taken to fill 150 g of kapok in the pillowcase. After Test 1 is completed, 300 rpm will be used as the constant speed for Test 2. 300 g of kapok is added into the machine and time will be recorded to fill up the kapok into the 150 g pillowcase. The third test is to calculate the number of pillowcase production for 1 kg kapok and time taken for the filling kapok process. This process is carried out in order to calculate the number of pillowcase production for 1 kg kapok and the time taken for the filling kapok process. 1 kg of kapok will be inserted into the operation box of the Kapok Machine. The stopwatch started when the process of seed separation started. Time will be recorded from the seed separation process until the completion of the process of filling the kapok into the pillowcase

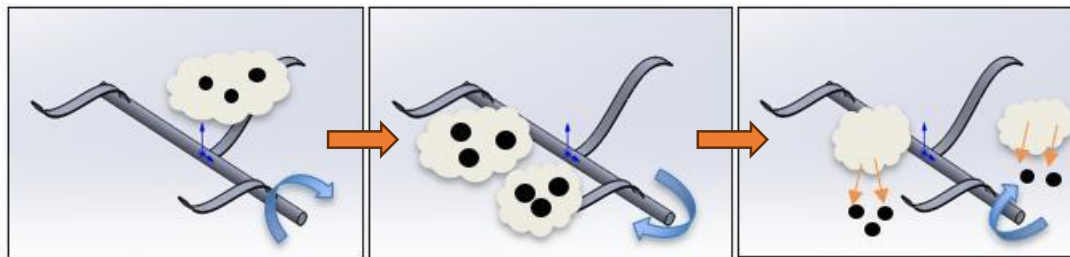
#### 5. Result and Discussion

Three different types of experiments are necessary for Kapok Machine to complete in order to meet the fabrication's goals. The first experiment is the evaluation of the cleanliness of kapok after its separation. The second experiment is to calculate the time is taken to fill 150 g of kapok in the pillowcase. The third experiment is to calculate the number of pillowcase production for 1 kg kapok and time taken for the filling kapok process.

##### 5.1 Working principle of Kapok Machine

**Figure 6** shows the prototype of Kapok Machine. The kapok will be placed inside the operation box in **Figure 6(a)**. Then, user is required to turn on the switch for the electric motor in **Figure 6(b)** to rotate the blade. The blade will rotate by the electric motor and hit the kapok to separate the kapok seeds. Detached kapok seeds will pass through the net and fall into the seed collector box in **Figure 6(c)**. Wait until the sound of kapok seeds stops to make sure all kapok seeds have fallen into the seed collector box. In order to remove moisture in the machine, user need to turn on the blower in **Figure 6(d)** to dry the kapok and instantly transfer the kapok into the pillowcase box.

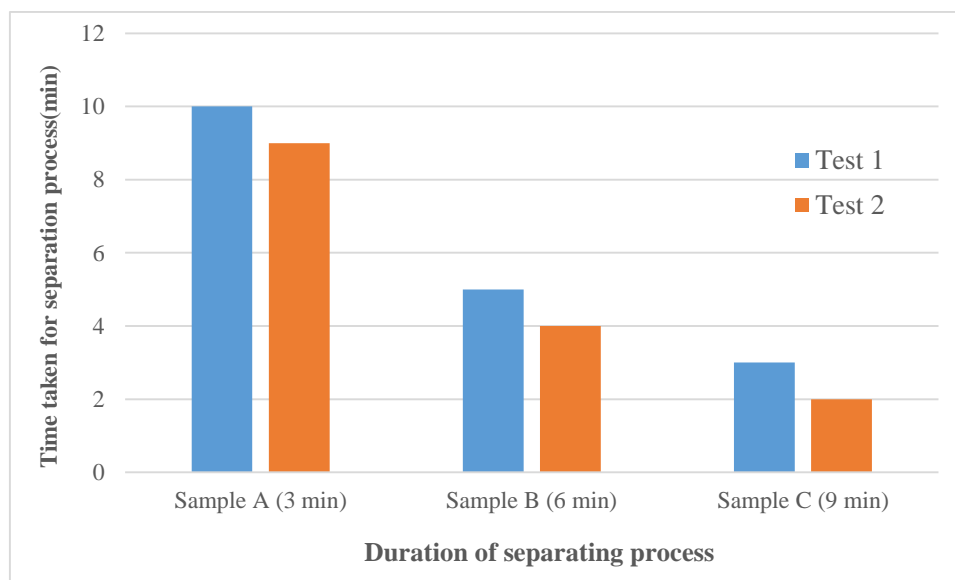
**Figure 6(e)** shows how the blade function in the operation box. The main purpose of the blade design is to ensure the seeds are separated from kapok, able to rotate the kapok in the operation box and instantly transferred into the pillowcase by using the blower. There are three blades will be fabricated on the rod in the operation box. From the appearances of the blades which are purposely design to be curved. As a consequence of the area of surface blade is larger to enable the kapok to rotate up and down in the operation box. Based on the process of separating the seed from the kapok, the method of beating was chosen as the blades will hit the surface of the kapok. The seeds from the kapok will drop to the bottom and instantly collected into the seed collector box.



**Figure 6: The prototype of Kapok Machine (a) operation box (b) blade (c) seed collector box (d) blower (e) the process of separating seed from kapok**

### 5.2 Analysis on Kapok Machine

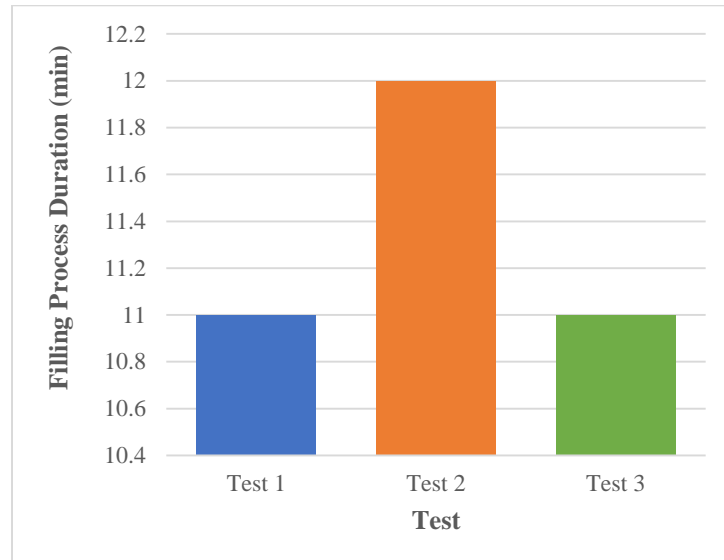
The analysis toward Kapok Machine is made to approve the first objectives which is the evaluation of the cleanliness of kapok after the separation process and drying kapok process. **Figure 7** shows the result of the result of cleanliness of kapok for three different set time of separating process used. To prove the cleanliness of the kapok, similar seed which is green peas are used to replace the kapok seed due to the shortage of kapok seed. 50 pieces of green peas are added into the kapok. The time taken for the test is 3 minutes (Sample A), 6 minutes (Sample B) and 9 minutes (Sample C). 300 g of kapok will be used, and test needed to be repeated to get an accurate result. As a result, for the test 1, the seed left after the separation process for 3 minutes, 6 minutes and 9 minutes are 10 pieces, 5 pieces and 3 pieces respectively. While for the test 2, the seed left after the separation process for 3 minutes, 6 minutes and 9 minutes is 9 pieces, 4 pieces and 2 pieces respectively.



**Figure 7: Evaluation on cleanliness of kapok**



**Figure 8** shows the time taken to fill 150 g of kapok in the pillowcase. This process is conducted to identify the time taken to fill 150 g of kapok in the pillowcase. 300 g of kapok is added into the machine and record time to fill up the kapok into the 150 g pillowcase. For the Test 1, time taken for the process is 11 minutes. For the Test 2, time taken for the process is 12 minutes. For the Test 3, time taken for the process is 11 minutes.



**Figure 8: Time taken to fill 150 g of kapok in the pillowcase**

For the third test which is the quantity of pillowcases produced from 1 kg of kapok and the time required for the kapok filling process. This procedure is used to determine how many pillowcases can be produced from 1 kg of kapok and how long the process of filling kapok takes. 1 kg of kapok will be inserted into the operation box of the Kapok Machine, the total pillow produced for 1 kg of kapok is 6 pieces and time taken for the complete process is 40 minutes.

## 6. Conclusion and Recommendation

The Kapok Machine can operate according to the intended purpose. The experiment which is the evaluation of the cleanliness of kapok after the separation process is being carried out successfully. As the a result, the kapok grade A is achieved as it has the least number of seed in the kapok with the speed of 300 rpm for 9 minutes. As for the second test which is to calculate the time taken to fill 150 grams of kapok into the pillowcase. The best time taken to fill the kapok is 11 minutes including the process of seed separation. The third test is to calculate the number of pillowcase production for 1 kg kapok and time taken for the filling kapok process. As a result, 1kg of kapok able to produce 6 pieces of pillow and time taken for the entire process is 40 minutes. Based on the tests conducted, there are few innovations are needed for the future fabrication. The vibration occurred when the tests are conducted. The reason is the material that were used is aluminium zinc as it is not strong and incapable to support the electric motor when it is rotating. In order to overcome this problem, replace the material with metal plate as it is steadier and stronger enough to reduce the vibration on the machine. In addition, the material for the operation box wall needed to be replace with a smoother material to prevent the kapok from hanging on the wall.

## Acknowledgement

The authors would like to thank the Centre for Diploma Studies, Universiti Tun Hussein Onn Malaysia for its support.

## References

- [1] Britannica, The Editors of Encyclopaedia. “Kapok,” Encyclopedia Britannica, February 23, 2017. [Online]. Available: <https://www.britannica.com/topic/kapok>. [Accessed January 6, 2022].
- [2] Perusahaan Bonda, Bonda Bantal Organik, Jan 2021. [Online]. Available: <https://kekabubonda.com/blogs/blog/benefits-of-bonda-kapok-pillow>. [Accessed January 6, 2022].
- [3] Hillman, J.. (2004). Plant Resources of South-East Asia No 17. Fibre Plants. Edited by M. Brink and R. P. Escobin. Leiden, The Netherlands: Backhuys Publishers (2003), pp. 456, Eu 120.00. ISBN 90-5782-129-X. Experimental Agriculture. 40. 271 - 272. 10.1017/S0014479704281790.
- [4] Muhammad A., “Proses membuat kebabu secara tradisional”, March 7, 2020. YouTube. [Online]. Available: [https://www.youtube.com/watch?v=0\\_FtBR90vzs](https://www.youtube.com/watch?v=0_FtBR90vzs). [Accessed January 6, 2022].
- [5] Eli Whitney. In Wikipedia, The Free Encyclopedia. 2021. [Online]. Available: [https://en.wikipedia.org/w/index.php?title=Eli\\_Whitney&oldid=1060770540](https://en.wikipedia.org/w/index.php?title=Eli_Whitney&oldid=1060770540). [Accessed January 5, 2022]
- [6] Iyer, Vijayan. (2007). Eco-Friendly Rubberized Cotton Fabric Roller for Ginning Machines. Journal of agricultural safety and health. 13. 33-43. 10.13031/2013.22310.
- [7] Mohammad, A. I. I., Abdul, R. A. J. and Nurul, Z. R. Pro-Filler, Diploma in Mechanical Engineering, Mechanical Engineering Department, Politeknik Sultan Salahuddin Abdul Aziz Shah, 2020.
- [8] Shenzhen Zhonglida Machinery Co., Ltd, “Small Type Polyester Fiber Filling Machine for Stuffing Pillows”, 2000. [Online]. Available: <https://zhonglida2020.en.made-in-china.com/product/JwExysnOCPcq/China-Small-Type-Polyester-Fiber-Filling-Machine-for-Stuffing-Pillows.html>. [Accessed January 6, 2022].
- [9] Motghare, S., Mansuri, J. and Rambhad, K. Component Design Verification and Modification of Double Roller Ginning Machine. *International Journal of Analytical, Experimental and Finite Element Analysis (IJAEEFA)*, Issue. 4, Vol. 1, Dec 2014.e-ISSN: 2394-5141, p-ISSN: 2394-5133, pp 22-26.