Physical and mechanical properties of coffee waste composites and viselin fabrics as alternative base materials for manufacturing products in the interior field

Purwanto
Duta Wacana Christian University Product Design Study Program, Yogyakarta, Indonesia

Email: pur@staff.ukdw.ac.id

Abstract. The results of coffee plantations and the growth of coffee shop entrepreneurs in Indonesia are increasing so that coffee shops (angkringan) have sprung up in various cities. World coffee consumption averages 1.7 kg per capita per year, in Indonesia it has increased by an average of more than 7% per year with the consumption of 4.55 million bags of coffee measuring 60 kg, a growth of 1.8% until the 2018/2019 period. In the city of Yogyakarta and its surroundings there are 1,200 coffee shops in 2017, this figure is much higher than the big cities around it. Yogyakarta is famous for its “jos” coffee in a lot around the Malioboro street. As a student city, many young people also enjoy coffee and produce a lot of coffee dregs waste. For this reason, this research raises about the use of coffee dregs waste into composites with viselin fiber reinforcement based on its physical and mechanical properties as an alternative base material for making products in the interior sector. The composite composition consists of coffee dregs ranging from 10, 20, 30, 40, and 50 gr, 120 ml water, 3 gr alginate, glycerol 2, 3, 4, and 5 drops, so the elements varied are coffee and glycerol. The ingredients are mixed and heated then printed measuring 10 cm x 15 cm, then aerated for 24 hours. Composite results were tested for tensile, tear test, flexibility test and observation of surface texture. The results of the composite test with the composition of 30 gr of coffee and 3 drops of glycerol have the greatest tensile strength of 34.9 kg / mm and the tear resistance of receiving a load of 30.4 kg. For physical testing, it is obtained that a smooth surface can be bent and can even be formed into a tube so that the resulting composite can be used as an alternative material for making a product, especially in the interior field.

1. Introduction
Indonesia is one of the fourth major coffee producing countries after Brazil, Vietnam and Colombia, this is inseparable from the geographical position of Indonesia which is a fertile agricultural country with a tropical climate. For that it is very suitable to be used as agricultural land and plantations, including in the breeding of coffee plants. Based on existing data, coffee is one of the leading commodities in the plantation sub-sector, it is only natural that coffee is Indonesia’s second largest trading commodity after gas and oil. In terms of coffee consumption in the world when it has increased quite sharply, namely an average of 1.7 kg per capita per year, meanwhile in Indonesia it has increased by an average of more than 7% per year [1].
Indonesia as the second largest coffee consuming country, namely 4.55 million bags of coffee measuring 60 kg, and this number continues to increase until the period 2018/2019 with positive growth of 1.8% [2]. The higher the coffee consumption, the higher the amount of waste from coffee dregs either produced from each shop or cafe or household. In Yogyakarta, which is a student city, there are so many coffee shops that have sprung up, in 2017 the number of coffee shops reached 1,200, this figure is much higher than the closest big cities in the vicinity, namely Semarang which has reached approximately 700 coffee shops and in the city of Solo which is only 400 coffee shops [3]. The segmentation of coffee lovers in Yogyakarta is young people aged 20-40 years with the work of students, employees, journalists and artists, both women and men with medium economic conditions [4]. The impact that arises from the large amount of coffee waste is an unpleasant odor that quickly appears, especially when it rains if it is not handled properly, resulting in environmental pollution. For this reason, this study is an effort to overcome coffee dregs waste which is processed into composite materials with viselin fiber reinforcement which is a fiber material derived from environmentally friendly cotton. Visetin is an environmentally friendly fabric because it is made of environmentally friendly cotton, which waste is often found from the cutting of tailors, where this type of fabric is often used as a shaper so that the fabric becomes stiff, for example on the neck, the ends of the sleeves and the buttons. clothes. Composites are currently being developed to obtain the type of material with the desired characteristics, including sheet-shaped manufacturing.

In utilizing coffee waste into a composite with a viselin fiber reinforcement, it can be used as an alternative base material, besides that it can also reduce waste, and it is hoped that it can get added value from the waste. By conducting this research, it is hoped that new materials will be found that are environmentally friendly, so that they can help overcome one of the environmental problems in terms of pollution from coffee dregs waste. Meanwhile, for the long term the resulting composite can be used as an alternative material for craftsmen in making design products in the interior field. The problem that exists is how the physical properties and mechanical properties of the composite board or sheet produced from the coffee waste composite and viselin fiber meet the quality as an alternative material.

2. Literature Review

Currently, many coffee shops have sprung up because of the many coffee plantations in Indonesia. Coffee plantations in Indonesia are divided into State Large Plantation (SLP), Private Large Plantation (PLP) and Community Plantation (CP). The development of People's Plantation (PP) coffee production from 2016 to 2018 has fluctuated but tends to increase, in 2016 coffee production reached 632 thousand tons and in 2017 to 685.80 thousand tons or an increase of 8.51%. In 2018 coffee production reached 685.79 thousand tons or decreased by 0.002 percent compared to 2017 as shown in Figure 1 [5]. Based on the coffee-producing provinces in 2018, the largest number of People's Plantation (PP) came from South Sumatra which reached 184.17 thousand tons or around 25.80 percent of the total national production.

Figure 1. Indonesian Coffee Production 2016-2018 (000 tonnes).

With the large number of coffee production and the increasing number of coffee connoisseurs in various big cities, more and more coffee dregs waste either generated from home consumption or from various coffee shops that have sprung up. This also attracts various parties to conduct research by utilizing coffee dregs waste as raw material as an alternative material such as being used as a composite material. The definition of composite material comes from the verb "to compose" which means to compile or combine two or more materials with different mechanical properties and characteristics from the forming material so that the desired strength of the composite material can be planned by adjusting the composition of the material.
combination of the two materials has their respective functions, the matrix functions as a binder while the fiber functions as a reinforcement, so that the composite is a number of multi-phase systems with a combination that produces new materials with new properties with better properties of each characteristic constituent materials.

There are two properties of composites, namely advantages and disadvantages, the advantages of which are lighter and stronger, resistant to corrosive environments, high strength to weight ratio, good electrical insulation and can be made in several forms. While the disadvantages include, it is not resistant to shock loads (shock) and impact (impact) compared to metal [6]. Furthermore, based on the research results of coffee dregs waste can also be made a composite in the form of a board by mixing with used plastic with a ratio composition of the matrix ratio: filler 50:50, based on SNI 03-2105-2006 has a perpendicular tensile strength of 5.33-19.46 kgf/cm$^2$ [7]. The use of coffee dregs waste into composites is also carried out by mixing with resin into a plane-shaped material which can be used as a substitute for particle wood which can be used as material for interior products, but only for interior decoration products, and can only be made by printing (moulding) [1]. As well as a global automotive company, Ford, in an effort to fight climate change, recycles coffee waste from McDonald's fast food restaurants into auto parts including coffee dregs lampshade. Reporting from a Ford representative explained that the materials for making auto parts take a different approach, in the laboratory coffee wastes are engineered into bioplastic [8]. Even the Ford auto industry plans to use coffee dregs composites as a component of car interiors and car undercoats. With this innovation, auto parts will be 20 percent lighter, more fuel efficient, and save up to 25 percent energy during spare parts printing. This was done in order to make Ford car components lighter, more environmentally friendly, while reducing waste [9]. Every year, millions of tons of coffee dregs and dry skin are changed into charcoal in North America. Ford discovered that pulp could be converted into a durable material to strengthen parts specific vehicle. How to process it by heating coffee waste at high temperatures under low oxygen and mixing it with plastics and other additives [10]. Then the material is converted into pellets so that it can be converted into various shapes. The thermal properties of the coffee waste components are significantly better than materials currently used [11].

With various research results that have been carried out, in this study the use of coffee dregs waste, especially in the city of Yogyakarta, which is a city of students with a large number of coffee lovers and a large number of coffee shops, can be processed into alternative raw materials for making products. The waste material for coffee dregs is taken from Mbak Siska’s coffee shop or angkringan, which is located around Malioboro street. In this study, coffee dregs waste powder as a matrix that has a function as a binder, as a protective composite structure, gives strength to the composite and acts as a stress transfer medium received by the composite and protects the fiber from abrasion and corrosion. The reinforcement of the composite is used viselin fiber, which is made from environmentally friendly cotton. Viselin/vislin is the name or term for hard fabric which is often used as a coating to reinforce the main fabric. The way to use it is by affixing it to the main fabric by ironing it. Usually used by tailors to simplify the sewing process and give shape to certain parts, for example the collar or cuffs of clothes. The composites produced from this study are expected to have many advantages and benefits including lighter weight, higher strength, corrosion resistance and cheaper manufacturing costs and can reduce waste of coffee dregs and residual viselin from cutting clothes from tailors.

3. Research Methods

The method in this research is to conduct experiments in the laboratory by making composites from waste coffee dregs and viselin fibers. In the manufacture of composites, coffee dregs are used as a matrix and a filler in the form of viselin fibers. The composition of coffee dregs waste starts from 10, 20, 30, 40 and 50...
gr, while one sheet of viselin, 3 gr of alginate and 2, 3, 4 and 5 drops of glycerol and 120 ml of water. The ingredients for coffee dregs start from 10 gr alginate, glycerol are put in a pan mixed with water that is heated on the stove while stirring at 80° C until homogeneous for 5 minutes. After that, the composite was poured into a 10 x 15 cm plastic mold which had been arranged with a viselin sheet with the same size as the print. The results of the mold are aerated to dry for 24 hours, then tested to determine their physical and mechanical properties. To determine the mechanical properties, a tensile test was carried out using the ASTM D3039 standard [12], and a tear test using the SNI 08-0108-2006 standard [13]. To determine the physical properties of the composite surface texture, direct observation of each composite surface was carried out. Meanwhile, the flexibility test is carried out by bending the composite sheet to how much it can be bent without cracking or breaking.

4. Results and Discussion

After making a composite from coffee dregs and viselin fiber, the mechanical properties test results in the form of a tensile test as shown in Figure 3. In the graphic image, the tensile strength of the coffee waste composition starts from 10 gr to 30 gr of composition, the tensile strength increases but then for the composition 40 gr and 50 gr have decreased. The maximum tensile strength of the composite to withstand the load occurs in the composition of 30 gr of coffee dregs and 1 sheet of viselin with 3 drops of glycerol, which is 32.6 kg. With the addition of the coffee dregs composition and the increase in glycerol as a flexible agent, it was not significant to the tensile strength of the composite in receiving the load. Composites with a viselin fiber reinforcing material began to decrease with the addition of 4 and 5 drops of glycerol, this is possible because the addition of glycerol composition will increase its flexibility but from the strength side decreases. This is also inseparable from the influence of glycerol, which is a vegetable ingredient made from soybeans or coconut with properties as a thickening and stabilizing agent in the mixture. Thus the composite composition that has the maximum tensile strength at the composition of 30 gr coffee dregs with 3 drops of glierol material. In addition to the composition of coffee dregs starting at 40 gr, it turns out that the tensile strength decreases, this is the effect of glycerol which has a binding property but will affect its flexibility and hardness, resulting in decreased tensile strength.

The tensile strength of the composite with viselin reinforcement has a higher tensile strength with the composite tensile strength research results composite cotton cloth (70%) and abaca fiber (30%) which has a tensile strength to withstand a load of 18.40 kg, even has the advantage of being stronger in mechanical properties compared to georgette fabric made of 100% synthetic polyester fiber in the tensile strength test parameter withstand loads of 7 kg which refers to SNI 08 - 0108 - 2006 [14]. The results of the composite tear test are shown in Figure 4 with the lowest tear resistance at 10 gr coffee composition, 28.3 kg and the maximum tear resistance at 30 gr coffee composition with 1 sheet of viselin cloth and 3 drops of glycerol, which is 30.4 kg. This value shows that the composite results of the study have advantages in mechanical
properties when compared to georgette fabrics made of 100% synthetic polyester fiber in the 0.5 kg tear strength test parameter which refers to SNI 08 - 0108 - 2006. Besides that, it also has advantages. from the results of a composite study of banana stem fiber (70%) and cotton (30%) which have a tear strength of 6.67 kg [14]. Likewise, the tear resistance strength of the results of this study is also higher when compared to the results of research on teak sawdust composite with corn husk fiber reinforced with a weight fraction ratio of 50%; 50% which only produces a tear strength of only 5.3 kg [15].

![Figure 4. Graph of Composite Tear Test Results Coffee Dregs and Viselin Fiber](image)

For the physical properties of the composite, namely the dense surface texture which has unique properties and high artistic value, there are several possible composite prints as shown in Figure 5 a, where for the composition of 30 gr coffee with 1 sheet of viselin fiber reinforcement with 3 drops glirol an even and smooth finish with an even color too. Meanwhile, the composition of 10 gr and 20 gr coffee resulted in an uneven and slightly rough surface texture (Figure 5b). Likewise, for the coffee composition of 40 gr and 50 gr the surface texture is even rougher (Figure 5c). This is because the composition between coffee and glirol does not have an appropriate balance, causing a coarse texture. With this uneven and smooth texture, it turns out that it also affects the level of flexibility.

![Figure 5. Resulted Composite Surface Texture](image)
Furthermore, for the flexural properties of the resulting composites, a bending test was carried out. To what extent the degree of curvature that can be formed in units of the degree of curvature that the composite is bent does not occur cracks or fractures. From the results of observations and testing of composites on the composition of 30 gr coffee dregs and 3 drops of glycerol material, it has the best flexibility because it can be bent and can even be shaped into a tube, besides that it can also be sewn and does not experience cracks (Figures 6a, 6b).

Meanwhile, composites with a coffee composition of 10 gr, 20 gr can only be curved. Even if it is curved it can only reach corners below 180° and is only suitable for sheet products only, if made into a tube will experience cracks. This will be more visible in the form of cracks as happened in the composition of 50 gr coffee dregs with 5 drops of glycerol mixture. In this composition, the composites are quite brittle and easy to crack (Figures 6c, 6d, 6e).

![Figure 6](image)

Figure 6. Flexibility Level of Coffee Dregs Waste Composite and Viselin Fabric Fiber.

5. Conclusion

- From the results of research on the manufacture of composites, when it is formed or bent as well as when it is sewn for the manufacturing process of a product it does not experience damage or breaks easily, it means that it has good physical and mechanical properties.
- Composite compositions that have good physical and mechanical properties, namely 30 gr coffee waste, 1 sheet of viselin fiber and 3 drops of glycoline.
- The maximum tensile strength of the resulting composite is 34.9 kg/mm and the maximum tear resistance is 30.4 kg.

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