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Assessment of the Wear Behavior and Surface Roughness of Epoxy / Date Seed's Powder Bio-composites

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Abstract The study looks at the effect of adding micro particles of date palm seed to epoxy resin to improve its wear resistance. Begin with an overview of some concepts before explaining the basic concept of wear resistance. It is a scientific experiment that focuses on the improvements that occur in the material and has the potential to provide many applications in the applied field. The aim of the current study is to use micro particles of date palm seed to increase the wear resistance of the epoxy. This study might be able to apply this in the future to improve wear resistance in biomedical applications or other fields that could benefit from this research. The mixing procedure is employed in this work to make epoxy composites. Composites are made with date palm seed powder particles with a particle size of 150 microns. There are four formulations with filler components of 5%, 10%, 15%, and 20%. To begin, 1 kg of weight to 5 kg has been applied at five different speeds to each of the four samples. The 20% sample had the best results of all, with a weight loss of 7.03% of the beginning weight, followed by the 10% sample with a weight loss of 9.4%, the 15% sample with a weight loss of 12.2%, and the 5% sample with a weight loss of 19.95%. After reviewing all of the samples that had been tested, the date palm seeds increased wear resistance and enhanced it to get superior outcomes.

Keywords: *bio-material, date palm seed, epoxy, wear resistance*

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1. Introduction

A polymer is a substance or material made up of very complex molecules, or macromolecules, that are made up of several repeating subunits. Both manufactured and natural polymers play important and pervasive roles in everyday life due to their extensive range of characteristics. Polymers are formed by polymerizing a large number of tiny molecules known as monomers. Because of their huge molecular mass in comparison to small molecule compounds, they have distinctive physical features such as toughness, high elasticity, viscoelasticity, and a proclivity to form amorphous and semicrystalline structures rather than crystals [1]. Because of the significant advancements in polymer research and technology that occurred throughout the twentieth century, the preceding century was called the “Century of Synthetic Polymers.” Because every synthetic polymer can be used as a basic organic binding material for the production of polymer materials, the synthesis and characterization of new polymers with specific properties is always a certain technological contribution for the advancement of polymer science and technology [2]. Epoxy resin is a class of thermoset polymer made from a monomer that contains at least two epoxide groups. Epoxy resins (ERs), which have strong adherence to all types of substrates and chemical activity for crosslinking processes, play a significant role among synthetic polymers. One of the most useful materials in the polymer sector is epoxy resin. These materials' cross-linking property produces materials with top qualities such great mechanical properties, high thermal stability, low shrinkage, wear resistance, chemical and solvent resistance, and low toxicity [3].

Molecular Formula of Epoxy is $C_{21}H_{25}ClO_5$.

A long-chain molecular structure with reactive sites at either end gives rise to epoxy resins. Additionally, the middle of the epoxy molecule has two ring groups that can absorb mechanical and thermal stresses better than linear groups, giving the epoxy resin much higher stiffness, toughness, and heat-resistant qualities FRF [4].

Application of Epoxy

Epoxy resins have a wide range of application including:

- Coatings
- Aerospace Industry
- Electronic Materials
- Biomedical Systems

Composite Materials: Materials are classed according to their crystal structure, bonding, and macrostructures. Each subgroup of materials has roughly similar qualities, and those materials can then be combined to examine their performance in various applications. When it comes to bonding materials, there are three basic groups to consider: metals, ceramics, and polymers. Metals are materials that are held together by metallic bonding. Ceramics are materials that are generally ionic and/or covalently linked. Polymers are materials that are built on a long carbon chain and are covalently bonded with some secondary bonding, where "Mers" or units are connected in the long range. A new class of materials known as composites is created when any three of these primary materials are combined without sacrificing any of their original properties [5]. A composite material is made up of two components that have distinct physical and chemical properties. When they are mixed, they form a material that is specialized to perform a specific function, such as becoming stronger, lighter, or electrically resistant. They can also help to increase strength and stiffness. They are preferred over traditional materials because they increase the qualities of their basic materials and are useful in a variety of applications. Modern companies have increasingly recognized the possibilities of organic materials like reinforced or composite materials. These materials are also used because they are inexpensive and have good mechanical qualities. Economic factors, environmental effects, and priority for renewable resources also influence the industrial usage of natural and organic-reinforced materials. Alternatives to organic fillers that are sustainable, and renewable are becoming more and more in demand. Major benefits of these fillers are low density, lower costs, and minimal mechanical wear during processing [6,7].

Uses of Composite Material

- Electrical equipment.
- Aerospace structures.
- Biomedical Applications.
- Infrastructure.
- Pipes and tanks.

Epoxy resin is available in liquid form as a Resin and a Hardener; when both are correctly mixed together, they can be set in a mold to achieve the desired shape. After mixing, epoxy typically takes one day to solidify. However, we intended to use varied ratios of epoxy resin with date palm seeds (as powder). So, depending on the shape, we will measure the mass and volume to determine exactly how much date palm seed powder to add with the needed percentage. The powder of palm date seeds can be easily blended with Epoxy resin, but it takes more effort than the usual one to ensure that it is spread evenly.

Designing the mold: Finding the appropriate mold can be simple if we create it ourselves, but there are other options for obtaining the desired shapes. There are different molds that can be utilized, such as the pipes that are used to cover the electric wires in homes, but it is difficult to remove the layer of the PVC pipe from the surface of the solid Epoxy. It is necessary to gently cut the pipe from three sides and then remove it, much as we would remove the skin of an orange. Because an insulating layer is formed when Epoxy resin cures, it is exceedingly sticky and resistant to abrasion and chemicals such as acids, bases, and solvents. Use as a mortar, coating, or adhesive. As a result, we require a mold that can be removed once the Epoxy resin has dried. We noticed that resin art uses a silicon mold, which makes it simple to produce and remove.

Date Palm Seed: The date palm (Phoenix dactylifera L.) tree is a flowering plant species that is widely farmed around the world, including dry and semi-arid areas, for its sweet, edible fruit. It's interesting to note that date palm trees may be found in large numbers throughout the Middle East, Northern Africa, India, and Pakistan. Date palm trees can withstand both cold and dry, hot temperatures well [8,9]. Due to the abundance of plants, the date seed is discovered as a biomass waste, thus its utilization is regarded as an economical value filler. The suggested materials are composites packed with date seed (DS); they are lightweight and simple to manufacture. Much work has been done to replace hazardous and polluted fillers with those made from bio-sources like eggshells as a result of growing awareness of the environment's effects and new regulations [10].

Date palm seeds can be found from any local company that concerned of the date palms. Seeds are from Medina which located on the west side of the Kingdom of Saudi Arabia. According to the most recent numbers from the General Authority for Statistics, the number of palm trees in the Medina region has exceeded 4 million, with an annual yield of 189 thousand tons.

The interaction of date seed powder with poly (butylene adipate-co-terephthalate) bio-polyesters was studied by Mittal et al. [11]. The study demonstrated the relationship between the pure polymer and the filler added to the composites. Phoenix dactylifera wastes from the processing of date palm fruit were investigated by Ruggiero et al. [12] to see if they might be used to enhance the mechanical qualities of the composite. The findings indicated that the date particle had no discernible impact on the resin's sticky properties. At particular bio-filler concentrations, the shear strength increased by up to 10.8%, and the wear resistance increased by up to 11%. The mechanical characteristics of polyester reinforced with aligned ramie fibers up to 30% by volume were studied by Simonassi et al. [13]. Results revealed that the toughness of polyester-ramie fiber composites had significantly improved. In comparison to clean polyester, the impact energy values for composites containing 30% ramie fibers were about two orders of magnitude higher.

Wear Resistance: In general, wear is defined as mechanically induced surface damage that causes material to gradually be removed as a result of relative movement between that surface and the substance or substances it is in contact with. Another surface, a liquid, or hard, abrasive particles suspended in a fluid or other solution, such a lubricant, can all be considered contacting substances.

Processes like machining, cutting, grinding, and polishing can all produce controlled wear (see Figure 1).

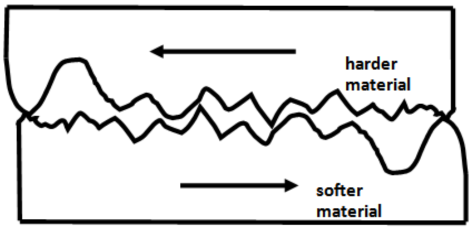

Figure 1. Example of two body abrasive wear

Wear is a very expensive problem since it causes components to degrade or fail, which is extremely undesirable in the majority of technological applications. Wear can result from mechanical such as erosion or chemical factors such as corrosion. Tribology is the study of wear and associated processes. Functional surfaces deteriorate as a result of wear in machine components and other processes like fatigue and creep, which finally result in material failure or functionality loss.

Types of Wear.

- Adhesive
- Abrasive
- Corrosive
- Surface-Fatigue
- Cavitation Erosion
- Fretting
- Galling
- Spalling

Nanoparticles: NPs are very small materials that range in size from 1 to 100 nm. They can be divided into many categories based on their features, forms, and sizes. The different groups include fullerenes, metal NPs, ceramic NPs, and polymeric NPs. Because of their large surface area and nanoscale size, NPs have unique physical and chemical characteristics. They are appropriate intrants for a wide range of commercial and domestic applications, including catalysis, imaging, medicinal applications, energy-based research, and environmental applications.

Literature Reviews of Epoxy and Date Palme Seed:

By combining G-E composites with organic reinforcement components, the mechanical properties of the materials can be improved. In this study, they examine the usage of date seeds (DSs) as a G-E composite reinforcement material. By using a semiautomatic approach, a DS filler has been introduced to G-E hybrid composites as a powder. The mechanical properties of G-E reinforced DS composites, including hardness, tensile strength, and impact strength, were examined. At various parameter values, the impact of the DS filler on wear volume loss (VL) was examined. The results revealed that the addition of a 10% DS reinforcement to G-E composites enhanced the wear resistance and increased toughness and hardness. Finally, G-E-DS composite optimization was carried out by minimizing the wear VL. This resulted in an optimum DS reinforcement of 10% at a normal load of 10 N, an abrasive size of 1200 mesh, and an abrading distance of 420m [14].

Date palm stem fibers (DPF)/epoxy composites were made in this study at varied loadings (40, 50, and 60% wt.%), and their tensile, impact, and morphological characteristics are described. Scanning electron microscopy was used to analyze the interfacial bonding in composite samples that had undergone tensile fracture (SEM). The mechanical strength, modulus, impact strength, and elongation at break with regard to pure epoxy resin were all enhanced by an increase in DPF loading up to 50%, according to the findings of tensile and impact tests. With the addition of DPF filler, pure epoxy resin's nsile strength, modulus, impact strength, and elongation t break rise from 20.5 to 25.7657 MPa, 0.5123 to 1.546 GPa, 45.81 to 98.71 J/m, and 0.91 to 1.412%, respectively, but energy absorption dramatically drops from 50 to 32% [15].

Due to their reasonable pricing, appropriate mechanical characteristics, and reduced environmental impact, natural materials are suggested for use as polymer fillers in a variety of sectors. This research aims to investigate the mechanical properties of date seed-filled glass fiber (G-E) as a suitable polymer filler. Investigated were the effects of DS filler on wear rate (Ks) and impact energy at various effective parameters. SEM was used for surface inspection, and Fourier-transform IR light was used to look into the type of reinforcement (FTIR). The outcomes showed that adding 10% DS reinforcement to G-E increased toughness by around 80% and improved wear resistance rate by about 71%. The organic DS filler contact surfaces and G-E interacted physiochemically, according to FTIR measurements. The final step in optimizing G-E reinforcement was limiting wear rate, choosing the best filler load and type, normal load, and abrasive size [16-20].

2. Objective of the Present Study

- The main idea of this research is to study wear behavior and surface roughness of Epoxy / date seed's powder bio-composites.
- Investigation of Behavior of Date Palm Seeds under tests that shows the resistance of the material.

3. Material and Methods

There are many companies that sells the epoxy resin can be found on the market, but we had use one of the best and the one with the highest recommendations .

Grinding the date palm seeds was difficult and most grinders will break because of how hard the seeds are, however, I found one of the best grinders in the market which they say it can grinders the rocks.

Using a Silicon Mold was easy to shape and to be removed as shown in Figure 2.

Figure 2. Silicon Mold

Cups and Wood Sticks

Plastic cups to mix the materials and s wooden sticks to stir. Balance < 50g. It is small, scaled balance that reads three digits after the point. Example (0.001g). Balance < 5kg. It is scaled balance read one digit after the point.

Molding Method:

Economic factors, environmental effects, and priority for renewable resources also influence the industrial usage of natural and organic-reinforced materials. Alternatives to organic fillers that are sustainable, and renewable are becoming more and more in demand. Major benefits of these fillers are low density, lower costs, and minimal mechanical wear during processing. In our study, epoxy resin is used as the matrix material. Epoxy was chosen because its different physical and mechanical qualities outperform those of other polymers. Date palm seed powder in the form of micro-particulates is used as a filler. In this work, the mixing process is used to create epoxy composites. Date palm seed powder particles with a particle size of 150 microns are utilized in the production of composites. Four compositions are created with a filler component of 5%, 10%, 15%, and 20%.

We intend to improve the wear resistance of the epoxy by using nano particles of date palm seed. As a result, because of the ability of human body to response very well to the organic (natural) material specially date palm seed powder, we may be able to use this in the future to improve the wear resistance in biomedical application or any different fields that might get the advantages of this study.

Epoxy resin is available in liquid form as a Resin and a Hardener; when both are correctly mixed together, they can be set in a mold to achieve the desired shape. After mixing, epoxy typically takes one day to solidify. However, we intended to use four ratios of epoxy resin with date palm seeds (as powder), which are 5%, 10%, 15%, and 20%. Abrasive wear performances of different specimens were determined under identical wear conditions, abrasive of 2000P grit Sand abrasive paper which will be replaced for each speed and each weight to make sure it is effective, normal mass (Kg) of 1 kg to 5 kg, sliding speed (RPM) of 200 RPM to 750 RPM.

It will start by fixing 1 kg of weight at five different speeds which means five rounds for five different weights, and this will be repeated to each one of the four samples. Time will be 36 second for each round as well as 12cm diameter of the pin on the disc (where the sample contact with sandpaper). All wear tests were performed in an unlubricated (air) condition at room temperature (27 ℃).

Before and after wear tests, pin specimens were thoroughly cleaned. Wear rate was assessed by weight loss method. Weight of the sample before and after each test run was recorded using a high precision (g) balance.

Because at higher weight the speed needs to be increased so Figure 3 is describing the speeds for each weight for all four samples.

At the beginning of the work, we start by grinding the date palm seeds which was so hard and we did grind 1 kg of the date palm seeds. Then we tried to find a way to get the nano size but unfortunately, we were limited but the best we could found was the size of 150 micro-meter mesh. So, after the meshing process we got around 200 grams of the desired size which leads us to the fact that even if we tried to do the nano size, we need to get a better grinder.

Secondly, finding the best ratio of the resin to hardener is quite hard but after some experiments work on different ratios, we found that 1:1 is the best ratio. Moreover, we decided to measure the percentage of the date palm seed powder in grams. So, we chose a fixed amount which is 100 grams which means for the 5% we substitute 5 grams to add the date palm powder, for 10% we substitute 5 grams to add the date palm powder and so on.

Thirdly, using four cups marked with the ratio in order to be arranged. So, we started by mixing the resin, hardener and the date palm seed powder together by using hand with the help of the crafted mixer to make sure they mixed together completely.

For the 5%, I measured 47.5 g of resin, 47.5 g of hardener and 5 g of date seed powder.

For the 10%, I measured 45 g of resin, 45 g of hardener and 10 g of date seed powder.

For the 15%, I measured 42.5 g of resin, 42.5 g of hardener and 15 g of date seed powder.

For the 20%, I measured 40 g of resin, 40 g of hardener and 20 g of date seed powder.

Finally, pouring the mixture of each percentage on the mold with well-defined written marks to identify the samples. Then we left it to solidify for 24 hours.

Testing:

Wear Test: The Pin-on-Disc machine can test wear resistance and seems to be simple to use. Pin-on-Disc measurement entails pressing an indenter or pin (often flat or sphere in shape) against a test sample. As the test sample rotates, the engagement mechanism imparts a precise force to the indenter. A strain gage sensor is used to measure the resulting friction forces. Material lost during the test is used to calculate wear coefficients for the pin and sample. Pin-on-disc testing can assist measure a coating's wear resistance as well as the coefficient of friction, lubricity, and adhesion qualities of the surface. A surface with a low coefficient of friction and high lubricity will allow the pin to roll more readily on the surface, reducing material loss and improving wear resistance. A coating with inadequate adhesion, on the other hand, would be strained by the pin, resulting in coating bond failure and coating loss. Even if the covering were hard, this would suggest inadequate wear resistance. Although the test's basic methodology was covered above, for our research we used a machine that was available in the workshop at Umm Al-Qura University. Emery papers well adhered to heavy steel discs were used as the horizontally revolving counter body, while Cuboid-shaped specimens were employed as static pins [17]. The study's test setup is schematically shown in Figure 4.

Figure 3. Describing the speeds for each weight for all four samples

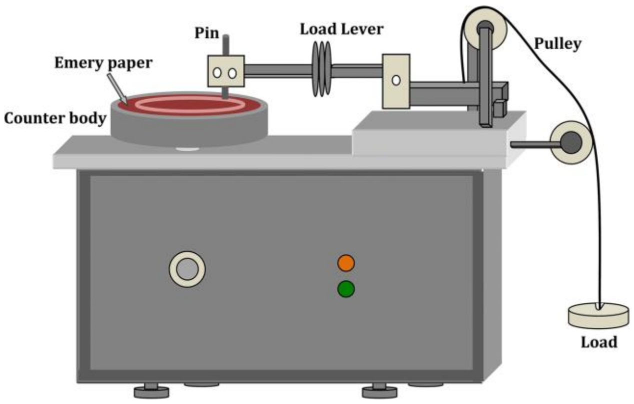

Figure 4. Pin on disc

Hardness Test: In mechanical engineering, indentation hardness tests are used to quantify a material's resistance to plastic deformation (which is the permanent change of a material's shape resulting from the applied of mechanical stress, similar to what happens when you hit a wood piece with a hammer). Hardness test measurements are often performed by contacting the material of concern whose mechanical properties are not known with another material whose properties are defined. The original Mohs' hardness scale, for example, specifies diamond as having a maximum value of 10 on the scale, and element A is ranked harder than element B if A can leave a lasting scratch in B. Later methods, such as Brinell, Knoop, Vickers, and Rockwell, added refinements, but they all follow the same fundamental concept. Indentation hardness tests are classified into three types based on the length scale of the penetration: macro, micro, and nanoindentation, in which the penetration length is measured in millimeters, micrometers, and nanometers, respectively. Figure 5 showing the schematic diagram of the hardness test in general [18-26].

The hardness test is easy to use and may be carried out without seriously damaging the components. It is frequently used to estimate or predict various mechanical parameters, such as ultimate tensile strength, tensile yield strength, fatigue limit, fracture toughness, etc. because of its advantages.

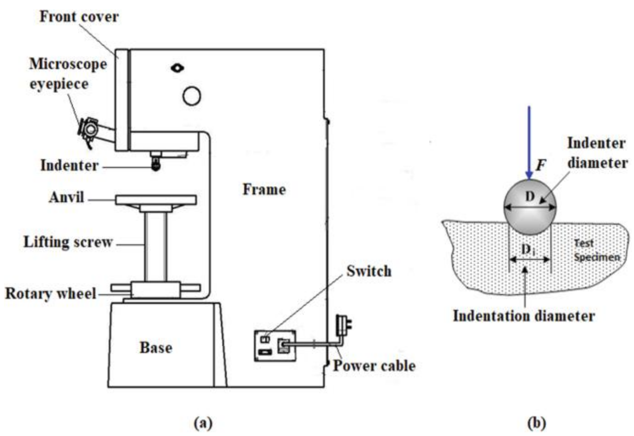

Figure 5. Schematic Diagram of The Hardness Test

speed (RPM)	200	250	300	350	400
Weight (g)	7.081	7.077	7.069	7.057	7.044

Surface Roughness Test: Although no surface is absolutely smooth, the higher the surface quality, the longer a product normally lasts and performs. Surface texture is generally difficult to quantify. Technological improvements in manufacturing technology and metrology equipment have enabled the specification and measurement of surface quality. Surface quality is important when it comes to lubrication, wear resistance, tool life, corrosion, and noise reduction.

There are several methods for measuring surface roughness:

- Observation and Touch: The human finger has a good sensitivity to surface roughness.
- Stylus-based equipment is widely used.
- Interferometry: This technique makes use of light wave interference patterns.

Stylus-based approach, in general, this method follows significant changes in surface height with a skid and tracks minor changes using a stylus. Combining the two reduces the effects of uneven surfaces on surface roughness measurement. A magnetic circuit and induction coils are used to measure the relative motion between the skid and the stylus. A recorder that indicates stylus position and a digital readout that shows the Center Line Average (CLA) / Arithmetic Average (Ra) value are both driven by an amplified signal after that. To make the scale visible to the human eye, the paper chart that is being recorded is multiplied in height by 100000:1 and in length by 82:1. The schematic of the Stylus Based Equipment Method is shown in Figure 6.

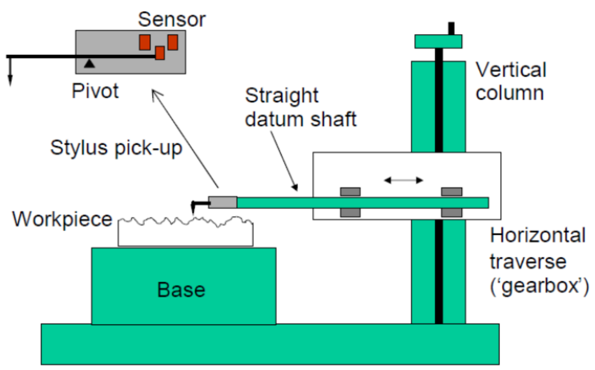

Figure 6. Schematic of Stylus Based Equipment

4. Results

5% of the date palm seed powder The weight of the specimen before we start applying the test was 7.096g.

Starting by the weight of 1 kg at five different speeds. The weight loss for the five speeds at load of 1 kg is 7.096 – 7.044 = 0.052 g. The weight of the specimen before we start applying the test was 7.044g. The weight loss for the five speeds at load of 2 kg is 7.044 – 6.925 = 0.119 g. The weight of the specimen before we start applying the test was 6.925g. The weight loss for the five speeds at load of 3 kg is 6.925 – 6.641 = 0.284 g. The weight of the specimen before we start applying the test was 6.641 g. The weight loss for the five speeds at load of 4 kg is 6.641 – 6.291 = 0.350 g. The weight of the specimen before we start applying the test was 6.291 g. The weight loss for the five speeds at load of 5 kg is 6.291 – 5.680 = 0.611 g.

10% of the date palm seed powder. The weight of the specimen before we start applying the test was 7.441 g. Starting by the weight of 1 kg at five different speeds. The weight loss for the five speeds at load of 1 kg is 7.441 – 7.400 = 0.041 g. The weight of the specimen before we start applying the test was 7.400 g. The weight loss for the five speeds at load of 2 kg is 7.400 – 7.335 = 0.065 g. The weight of the specimen before we start applying the test was 7.335 g. The weight loss for the five speeds at load of 3 kg is 7.335 – 7.190 = 0.145 g.

The weight of the specimen before we start applying the test was 7.190 g. The weight loss for the five speeds at load of 4 kg is 7.190 – 7.000 = 0.190 g. The weight of the specimen before we start applying the test was 7.000 g. The weight loss for the five speeds at load of 5 kg is 7.000 – 6.740 = 0.260 g. 15% of the date palm seed powder The weight of the specimen before we start applying the test was 7.043 g. Starting by the weight of 1 kg at five different speeds. The weight loss for the five speeds at load of 1 kg is 7.043 – 7.000 = 0.043 g.

The weight of the specimen before we start applying the test was 7.000 g. The weight loss for the five speeds at load of 2 kg is 7.000– 6.942 = 0.058 g. The weight of the specimen before we start applying the test was 6.942 g. The weight loss for the five speeds at load of 3 kg is 6.942 – 6.809 = 0.133 g. The weight of the specimen before we start applying the test was 6.809 g. The weight loss for the five speeds at load of 4 kg is 6.809 – 6.610 = 0.199 g. The weight of the specimen before we start applying the test was 6.610 g. The weight loss for the five speeds at load of 5 kg is 6.610 – 6.184 = 0.426 g. 20% of the date palm seed powder The weight of the specimen before we start applying the test was 7.975 g. Starting by the weight of 1 kg at five different speeds. The weight loss for the five speeds at load of 1 kg is 7.975 – 7.940 = 0.035 g. The weight of the specimen before we start applying the test was 7.940 g. The weight loss for the five speeds at load of 2 kg is 7.940 – 7.886 = 0.054 g. The weight of the specimen before we start applying the test was 7.886 g. The weight loss for the five speeds at load of 3 kg is 7.886 -7.815 = 0.071 g. The weight of the specimen before we start applying the test was 7.815 g. The weight loss for the five speeds at load of 4 kg is 7.815 – 7.655 = 0.160 g. The weight of the specimen before we start applying the test was 7.655 g. The weight loss for the five speeds at load of 5 kg is 7.655 – 7.414 = 0.241 g.

4.1. Comparison the Results

We can notice that the total weight lost is getting increased when the load is increase as well as speed increased. For the 5% the weight lost is 0.052 g at the beginning then increased to 0.119 g while the third load is 0.284 g and the fourth is 0.350 g and finally 0.611 g. Which makes the different as total lost for the sample of the 5% of date palm seed is 1.416 g. Fig.7 shows diagram of the 5% of date palm seed showing the relation of the speed to the weight lost.

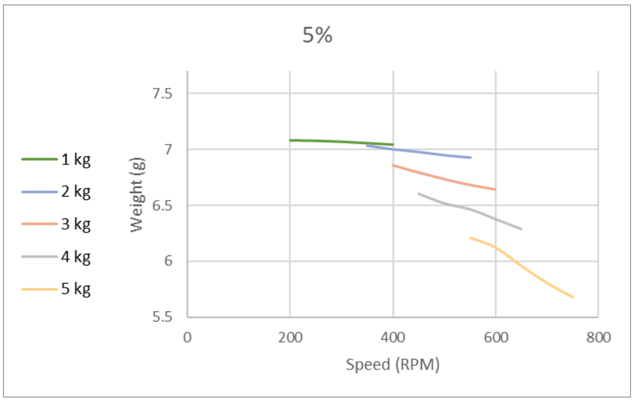

Figure 7. Diagram of the 5% of date palm seed showing the relation of the speed to the weight lost.

Next the 10%, the weight lost is 0.041 g at the beginning then increased to 0.065 g. Third load is 0.145 g and the fourth is 0.190 g and finally 0.260 g. Which makes the different as total lost for the sample of the 10% of date palm seed is 0.701 g. Fig.8 shows diagram of the 10% of date palm seed showing the relation of the speed to the weight lost.

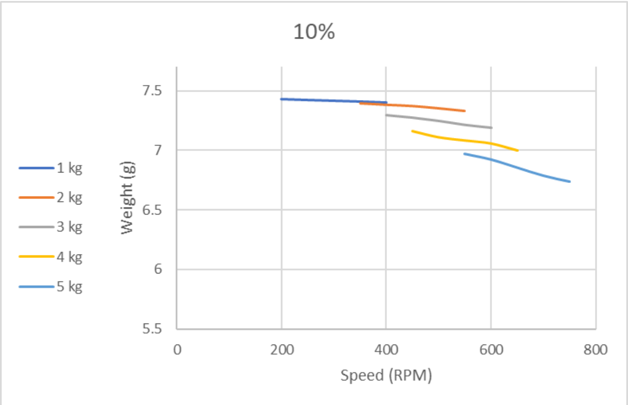

Figure 8. Diagram of the 10% of date palm seed showing the relation of the speed to the weight lost

Next the 15%, the weight lost is 0.043 g at the beginning then increased to 0.058 g. Third load is 0.133 g and the fourth is 0.199 g and finally 0.426 g. Which makes the different as total lost for the sample of the 15% of date palm seed is 0.859 g. Fig.9 shows diagram of the 15% of date palm seed showing the relation of the speed to the weight lost.

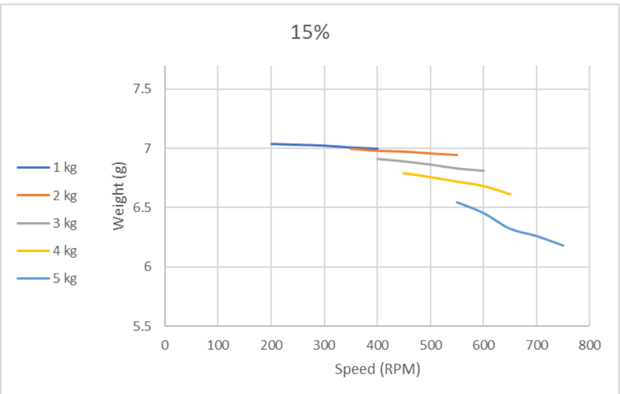

Figure 9. diagram of the 15% of date palm seed showing the relation of the speed to the weight lost

Next the 20%, the weight lost is 0.035 g at the beginning then increased to 0.054 g. Third load is 0.071 g and the fourth is 0.160 g and finally 0.241 g. Which makes the different as total lost for the sample of the 20% of date palm seed is 0.561 g. Figure 10 shows diagram of the 20% of date palm seed showing the relation of the speed to the weight lost.

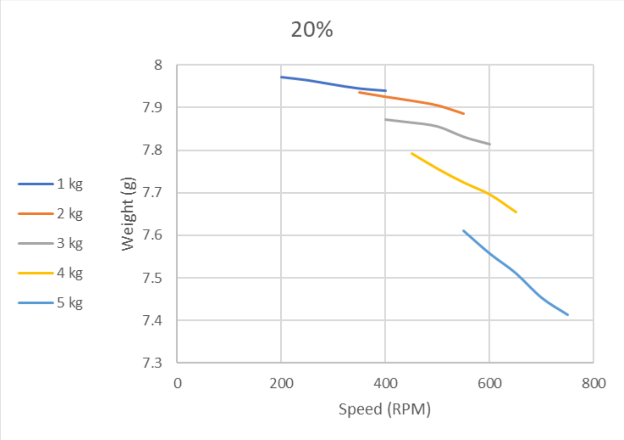

Figure 10. Diagram of the 20% of date palm seed showing the relation of the speed to the weight lost

4.2. Surface Roughness Test Results

By using Taly-surf® (from Taylor Hobson Precision, Inc.). The most frequently used roughness parameter applied for the evaluation of machined surface materials is the amplitude parameter (Ra). The parameters Rq is the root mean square RMS to Ra. Lastly, the Rz is the average max height of the profile. The surface roughness parameters when it is increase, the surface roughness is increase (see Table 1).

Table 1. Results of the hardness and surface roughness tests

speed = 0.5 mm/s	data length =15mm			
	Ra	Rq	Rz	HVD
5%	12.35	15.948	58.765	66
	11.848	16.341	60.707	
	11.462	15.866	59.744	
AVG	11.88667	16.05167	59.73867	
	Ra	Rq	Rz	HVD
10%	8.806	11.628	48.238	68
	9.391	11.891	48.08	
	9.524	11.669	44.776	
AVG	9.240333	11.72933	47.03133	
	Ra	Rq	Rz	HVD
15%	11.521	14.458	59.069	71
	10.872	14.047	55.921	
	10.067	12.89	53.593	
AVG	10.82	13.79833	56.19433	
	Ra	Rq	Rz	HVD
20%	14.363	17.366	65.642	72
	16.391	19.428	68.389	
	16.354	20.939	70.199	
AVG	15.70267	19.24433	68.07667	

4.3. Hardness Test Results

Hardness test done by using the Vickers Hardness Test, the number defined as indentation resistance and is determined by measuring the permanent depth of the indentation. Simply said, when a constant force (load) is applied to a specific indenter, the smaller the indentation, the harder the material. Furthermore, durometer was the method we used for the hardness Vickers test, which is for soft materials (shore D).

The results of the hardness test demonstrate that the higher the percentage of date palm seed, the harder the sample.

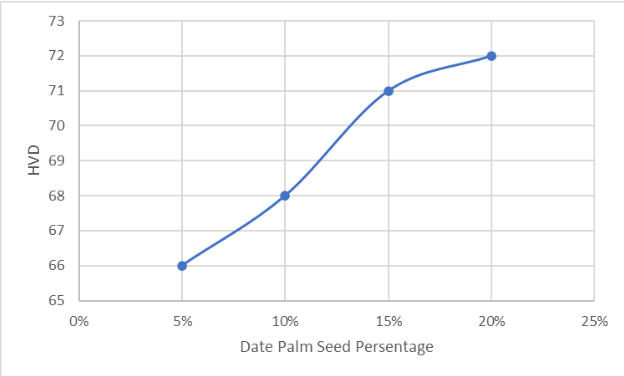

Figure 11. variation of HVD with % DPT seeds

5. Conclusion

We noticed that the wight loss of the 5% sample has reached a 19.95% of the beginning weight which mean that almost 1/5 of weight of the sample has gone because of the wear test. On the other hand, the 10% sample has shown a better result on the resistance of the wear test by the weight loss that reached 9.4% from the beginning weight and that shows the date palm seed is giving the material a better wear resistance when it reached the 10% of the original mass. Also, we found that there are some difference results that appears on the 15% sample, but it might be caused by some other effects, nevertheless the result of the weight loss reached 12.2% which was not expected to be weaker than the 10% sample. Finally, the 20% sample had shown the best results of all with weight loss of 7.03% of the starting weight. In conclusion, after we see all the result of samples that had been on the tests, we found that the date palm seed increased the wear resistance and enhance it to get better results.

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