JOJOBA AND CASTOR OILS AS FLUID OF BIOBASED GREASES: A COMPARATIVE STUDY

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Abstract

The search for environmentally friendly materials that have the potential to replace mineral oil in various industrial applications is considered a priority research in the lubricant, fuel and energy sectors. Accordingly, vegetable oils seem to be a significant potential base fluid and a substitute for mineral oil as grease formulation. The aim of this paper is to study the comparison of jojoba and castor oils as base fluids for producing lithium lubricating greases. In this respect, the sulfurization of jojoba and castor oils was carried out at temperatures ranging from 110 to 170°C. The physicochemical properties of Sulfurized jojoba and castor oils are found better than non- Sulfurized oils. The flow and viscoelastic properties of these oils have been studied by programmable Rheometer HADV-III ultra system that operates in either a steady rotation or in an oscillatory mode. The obtained data reveal that the flow behavior depends to a large extent on the nature of the aforementioned oils. Jojoba oils exhibit properties close to castor oil except for oxidation stability which is better in case of jojoba oil. The influence of these oils and their Sulfurized products on the properties of the prepared biogreases was studied. The data obtained in this investigation indicate that the prepared biogreases from Sulfurized oils had superior properties with respect to dropping point and consistency compared to non- Sulfurized oils. The prepared greases from jojoba oil and its sulfurized product showed improvement in oxidation stability than corresponding grease based on castor oil or its sulfurized product. An opposite trend was observed concerning the consistency and flow properties. It is concluded that the jojoba and castor oils showed appropriate properties to be used as fluids for bio-lubricating greases. In addition, performance characteristics of the obtained greases are largely dependent on the type of base fluid.

Key words*: jojoba oil, castor oil, sulfurization, biogrease*

Jojoba oil may be considered a low-energy replacement for conventional fats and oils. The nutritional properties of jojoba oil have been evaluated by several investigators (1-8). Jojoba oil was found to be highly resistant to rancidity and was poorly digestible, characteristics that suggest that it may have potential benefits in reducing fat-related energy intake. The chemical composition of jojoba oil is unique in that it contains little or no glycerin and that most of its components fall in the chain-length range of C36-C 42. Linearity and close-range composition are probably the two outstanding properties that give jojoba oil its unique characteristics. Jojoba oil molecules contain two double bonds separated by an ester bond. These three active centers have been proven to be the source of a very large number of intermediates or final products (9).

The castor oil plant (*Ricinus communis*), a member of the large spurge family (Euphorbiaceae), is a native of tropical Asia and Africa. Castor oil has long been

known as medicinal oil and was primarily used as purgative or laxative to counter constipation [10]. Moreover, it possesses nauseate properties and is classified as non-edible oil. The plant was already grown for its oil in Egypt some 6000 years ago. Nowadays, it is naturalized and cultivated on commercial scale all around the world in temperate zones. Asia can be considered as the main player for oils and fats used for the oleochemical industry (11-13)

Lubricating greases are basically composed of gelling or thickening agent, lubricating oil and various kinds of additives. It looks like a gel or a solid. The accepted definition of lubricating greases, published by the American Society of Testing Materials (ASTM), is “a solid to semi-fluid product of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may be included.” Though the amount of lubricating greases used in industry is relatively small compared with the amount of lubricating oil, it is widely used in mechanical components. The main advantages of greases to lubricating oils are; long interval of lubricant supply, small amount for sufficient lubrication, and simple mechanism of sealing system. On the contrary, disadvantages are; large energy loss caused by friction force, lower limit of shear velocity, or little cooling capacity.

Lubricating greases are widely used in mechanical components of various kinds of machines. Greases are solid or semi-fluid lubricant. They basically consist of liquid lubricant and thickening agent which constructs fibrous microstructures in lubricant. Other ingredients which produce special properties may be included (14-16) . Because of this two-phase system, the special features of greases such as the long interval of lubricant supply or the simple sealing mechanism are induced. In addition, greases may be classified into two types in reference to the kinds of thickening agent: soap or non-soap type greases. Further classification of non-soap type greases may be made by urea, organic, and inorganic type greases. Mineral oils and synthetic lubricants are used as the base oil for greases.

Environmentally friendly lubricants and greases are already on the market (*17*). These products are very desirable in total loss lubricants such as railroads. Certain synthetic greases, which are based on low molecular weight poly ά –olefin, polyglycols, polyol esters, and diesters, are biodegradable and environmentally friendly, but their higher cost limits their applications only in niche areas such as aerospace, computer, and medical applications(*18*).

In this respect, vegetable oil based greases have poor thermo-oxidative stability and thus cannot be used at high temperatures. **Dwivedi et al**. (*19*) described the preparation of total vegetable oil based grease using castor oil. **Florea et al.** (*20*) have studied the effect of different base fluids on the properties of biodegradable greases. In most applications, a suitable composition of grease is desired with good

performance properties capable of use in multifunctional products. Despite the overwhelming importance of biodegradable greases, very little is known about the relationship between their composition and performance properties (*18*). Soybean oil has also been used by American researchers for manufacturing soy grease for lubrication heavy duty truck. Unfortunately, research and or manufacturing of such a biogrease from jojoba and castor oils are rarely reported. This paper is an attempt to understand how the composition of jojoba , castor oils and their sulpharization in biobased grease affects on their properties

Experimental

Materials and techniques

Jojoba and castor oils were obtained locally as the biodegradable fluids for preparing biogrease under investigation. Jojoba oil was supplied by the Egyptian National Oil Company, but castor oil and was supplied by El-Nasr pharmaceutical chemical Co. Jojoba and castor oils are designated as JO and CO, respectively. Lithium stearate was kindly supplied by Morgan Co.

Oxidation assessment for jojoba and castor oils were determined according to the method describe by **Tod et al** (21). In this respect, a sample of oil was heated at 100°C, while air is bubbled through it, and the volatiles created are transferred to a water trap where conductivity is measured .The induction period endpoint was determined by the time it takes for the sample to begin a rapid increase in conductivity. The time required for the sample to reach its induction period endpoint is termed the Oil Stability Index (OSI). Peroxide value for jojoba and castor oils were determined using the International standard method. (22). But, iodine value was carried out using standard method ASTM D5554-95.

The average molecular weight was measured by gel permeation chromatography (Water 600E) equipped with styagel column operated at 40ºC and a flow rate of 0.4 ml/min. The refractive index instrument model Water 4110 and toluene (HPLC grade) used as a mobile phase.

Thermogravimetric analysis for oils under investigation was carried out in a TA Instruments SDTQ 600 simultaneous TGA-DSC Thermogravimetric analyzer. The analysers were conducted for a total sample mass of 16.0 ± 0.4 mg. A known amount of sample was loaded and evenly spread on the alumina microcrucible. The samples were heated under nitrogen flow (100 ml min-1) from 50 to 550°C, at 5 °C min^{-1}.

Rheological characterization for the samples under investigations was performed on a Brookfield programmable Rheometer LV DV-III UITRA used in conjunction with Brookfield software, RHEOCALC V.2. Through RHEOCALC, all Rheometer functions (rotational speed, instrument % torque scale, time interval, set temperature) are controlled by a computer. The corresponding shear stress, shear rate, dynamic viscosity and consistency index were also recorded through the

software. The temperature was controlled by connection with bath controller HT-107 and measured by the attached temperature probe. Before carrying out measurements, Rheometer DV-III UITRA should be turned on, leveled and autozeroed. .Eight grams of tested sample were put in the cup (chamber) of the apparatus. The spindle used was SC4-18 Controlling in cooling and heating through refrigerating /heating circulating bath.

The rheological behavior and flow properties of the jojoba and castor oils were carried out at different temperatures namely, 40 ºC, 60 ºC, 80 ºC and 100 ºC; while for the prepared greases were carried out at temperatures, 110 ºC.

Fatty acid analysis for locally JO and CO were identified using Agilent 6890 series GC apparatus provided with a DB-23 column (60m×0.25µm). Fatty acids were transformed in to methyl ester and directly injected in to the GC. Carrier gas was N_2 with flow rate of 2.2 ml/min, splitting ratio of 1:80. The injector temperature was 250ºC and that of FID detector was 270ºC .The temperature setting were as follows: 150ºC to 225ºC at 50ºC/min, and then held at 225ºC for 20min

Synthesis of sulphurized JO & CO

Jojoba molecules contain two double bonds, also, castor oil contain three double bonds in its glycerides molecules. These bonds are considerd active sites for many reactions. Accordingly, sulpharization for jojoba and castor oil were carried out by addition 4%, 6%, 8% and 10% weight of elemental sulphur; The obtained sulphruised jojoba are designated SJ4, SJ6, SJ8 and SJ10 respectively; While sulphruised castor oil are designated SC4, SC6, SC8 and SC10 respectively .

Total sulphur for each test to be added was divided into four portions. Each portion was added at temperatures 110, 130, 150, and 170ºC followed by stirring and nitrogen gas flushed. To ensure that the all sulphur was reacted; the product samples were tested using wetted filter paper with lead acetate. The physicochemical properties of the obtained sulphurized jojoba and castor oils were carried out according to ASTM methods. The sulphur content in each sample was determined by X-ray fluorescence model spectro phoenix II.

Greases preparation

To evaluate the effect of jojoba and castor oils and their sulphruised product as fluid on the characteristics of the biobased grease. Four grades from biobased greases were prepared based on Jojoba oil, Castor oil, Sulphurized jojoba (SJ8) and Sulphurized castor (SC8) designated as G1, G2, G3 and G4, respectively. These greases were prepared according to a procedure described elsewhere (22).The physicochemical properties of the obtained biogreases were determined according to ASTM methods.

Results and discussion

There has been a lot of interest in using vegetable oils as renewable raw materials for new industrial products including lubricants. This emphasis on environmentally friendly lubricants is largely due to the rapid depletion of world fossil fuel reserves and increasing concern for environmental pollution from excessive mineral oil use. Jojoba and castor oils are promising candidates in this study as base fluid for prepared biobased grease. Jojoba is unique among plants in that its nuts contain about 50% by weight of a practically odorless, colorless oil compound mainly of the straight chain monoesters of C_{20} and C_{22} alcohols and acids, with two double bonds, one at each side of the ester bond. The almost complete absence of glycerin indicates that jojoba differs radically from all other known seed oils: it is not a fat but a liquid wax **(23)**

In this respect, physicochemical properties of jojoba and castor oils were determined using ASTM/IP standard test methods and are summarized in Table 1.Generally, the peroxide value and total acid number are used as an index of the degree of oxidative rancidity of vegetable oils. The experimental data in Table 1, show that the jojoba oil has lower value for both peroxide value and total acid number compared with castor oil. In addition, oxidation stability index for JO and CO are 51 and 19, respectively. This reveals that the degree of oxidative rancidity of jojoba oil is lower than in case castor oil. This is due to the role of chemical structures of jojoba oil and its natural antioxidants such tocopherol (24,25). On other hand, the density of jojoba oil is low compared to castor oil because jojoba oil is actually a wax comprised of fatty alcohols and acids. Based on this finding jojoba oil has high viscosity index compared with castor oil .Inspection of the data of physicochemical properties shown in **Table (1**), reveal the possibilities for development of the oils under investigation and their suitability to produce lubricants for use in the preparation of lubricating greases.

Chemical compositions of jojoba and castor oils were investigated using GC model. Analysis was used to determine the fatty acids. Obtained data in Table 2, show that the identified fatty acids in jojoba oil are lauric, palmetic, palmitoleic, stearic, oleic, linoleic, linolenic, eicosenic, and deocosenoic with percentage, 0.03,1.62, 0.6, 0.17, 10.11, 0.19, 0.25, 57.13 and 11.36, respectively. This indicates that the main components were eicosenic and docosenic acids. The results obtained agree with those reported by Miwa (26,27).

Table (1) : physico-chemical properties of jojoba and castor oils

Characteristics	Jojoba oil	castor oil	Test
Density, g/ml @ 25/25, ºC	0.863	0.965	D.1298
Refractive index, n_D^{20}	1.4652	1.4665	D.1218
.Kinematics viscosity, c St **at 40ºC** **at 100ºC**	 26 7.5	 317.96 20.23	 D.445 D.445
Viscosity index	257	68.69	D. 189
Dynamic Viscosity, @ 50 ºC (rpm 30), cP	13	175.3	D.97
TAN, mg KOH/gm @72h	0.89	1.85	
Average Molecular weight	604	1350	GPC
Iodine value	82.1	87.5	D-5554
Oxidation stability index	51	19	Cd 12b-92
Peroxide value	0.9	5.5	ISO 3960

This proves that the chemical composition of jojoba oil is unique in that it contains little or no glycerin and that most of its components fall in the chain-length range of C36-42. Linearity and close-range composition are probably the two outstanding properties that give jojoba oil its unique characteristics. Jojoba oil molecules contain two double bonds separated by an ester bond. These three active centers have been proven to be the source of a very large number of intermediates or final products (23).

In addition, Table 2 shows that the identified fatty acids in castor oil are ricinoleic, palmitic, stearic, oleic, linoleic, linolenic and eicosanoic with percentage 83.6, 2.2, 1.92, 4.11, 6.76, 0.65 and 0.5, respectively. In general, the obtained data show that the fatty acids compositions in the jojoba and castor oils depend on the origin of the planting oil.

The rheological behavior of jojoba and castor oils have been determined viscometric shear stress-shear rate measurements at 40, 60, 80, and 100°C, are shown in Figures 1 & 2. These figures Show that the flow behavior for the above mentioned oils are Newtonian. With respect to the variation in shear stress corresponding to shear rate. Castor oil shows higher variation than jojoba oil, indicating that the force applied to shear and yield stress of castor are higher. This view is an agreement with the dynamic viscosity data for jojoba and castor oils in Tables 1. It may be explained that the shear applied in castor oil breaks down the internal structure within the bulk (triglycerides) rapidly and is temperature dependent. Also, the increase in temperature tends to increase molecular motion and reduce the attractive forces between the molecules.

Table (2): Fatty acid composition of jojoba and castor oils

Chemical name	Common name	Structure	Jojoba oil	Castor oil
Tetradecanoic acid	Myristic acid	C14:0	0.03	-
Hexadecanoic acid	Palmitic acid	C16:0	1.62	2.2
Hexadecenoic acid	Palmitoleic acid	C16:1	0.6	-
Octadecanoic acid	Stearic acid	C18:0	0.17	1.92
Octadecenoic acid	Oleic acid	C18:1	10.11	4.11
Octadecadienoic acid	Linoleic acid	C18:2	0.19	6.76
Octadecatrienoic acid	α-Linolenic acid	C18:3	0.25	0.65
Reconolic acid	Reconolic acid	C18:1		83.61
Ecosanic acid	Arachidic acid	C20:0	---	0.1
Eicosenoic acid	Eicosenoic acid	C20:1	57.13	0.5
Docosenoic acid	Docosenoic acid	C22:1	11.63	----
Tetracosenoic acid	tetracosenoic acid	C24:1	10.6	----
Hexacosenoic acid	Hexacosenoic acid	C26:1	8.46	---

Accordingly jojoba is close to Newtonian behavior and is weekly dependent on temperature compared with castor oil.

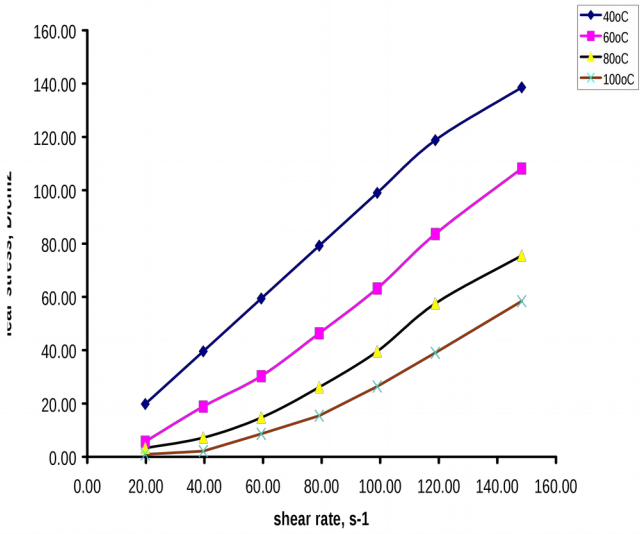

Fig (1): Shear stress-shear rate relation of jojoba oil at different temperatures

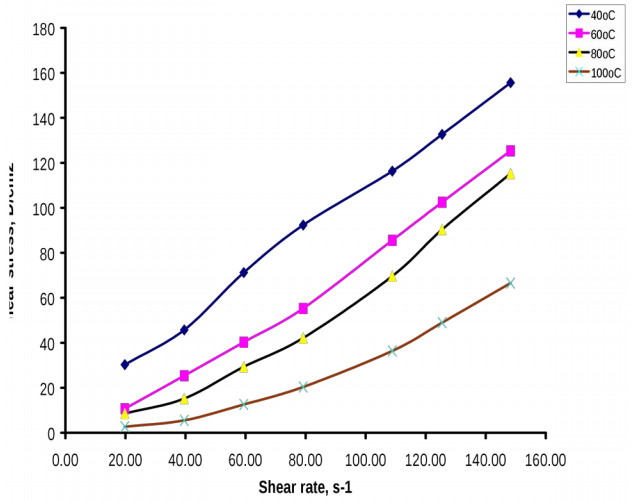

Fig (2): Shear stress-shear rate relation of castor oil at different temperatures

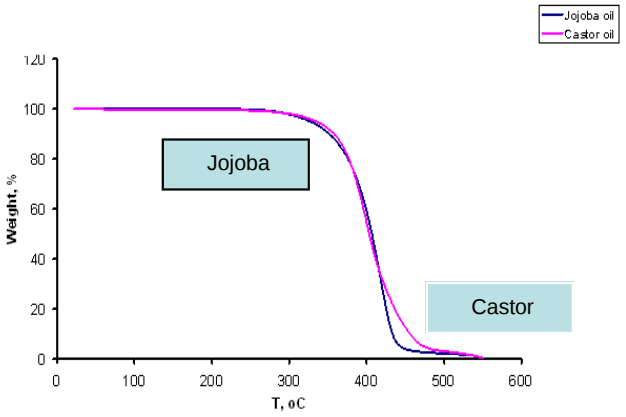

Fig (3): Thermal gravimetric analysis for jojoba and castor oils

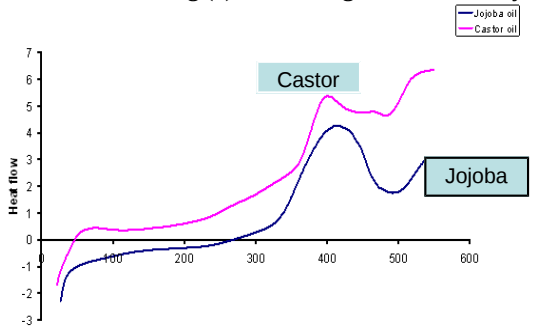

Fig (4): DSC analysis for jojoba and castor oil

Thermal stability and phase transition of the vegetable oils have attracted the attention of several studies (**28**-**29**). It was therefore of interest to investigate the thermal behavior of the jojoba oil compared with castor oil. TG\DSC thermograms of jojoba and castor oils are shown in Figures 5 & 6. Careful inspection in these Figures showed that weight changes and thermal activities in terms of exothermic or endothermic heat flows during the oxidative reactions.TG thermograms (Figure 3) did not clearly differentiate between jojoba and castor oils. But, DSC thermograms (Figure 4) provide better information on the oxidative performance and thermal transitions occurring within a temperature test ranging from zero to 500ºC of both oils under study. The behavior show in these Figures indicates that the isothermal TGA\DSC could be effectively used to compare the oxidative and thermal performance of such vegetable oils. In addition, Jojoba oil showed comparatively better oxidative and thermal performance than castor oil. This reveals that the role of the degree of unsaturation doubles bonds and structural configuration of both oils. This view agrees with the data presented in Table 2; jojoba oil contains low percentage of polyunsaturated fatty acids compared with castor oil.

The mechanism for the autoxidation of vegetable oils is well studied (30-31). Vegetable oil oxidation is initiated by formation of free radicals. Free radicals can easily be formed from the removal of a hydrogen atom from the methylene group next to a double bond. Free radicals rapidly react with oxygen to form a peroxy radical. The peroxy radical can then attack anther lipid molecule to remove a hydrogen atom to form a hydroperoxide and anther free radical, propagating the oxidation process. Two compounds are obtained from this process. They are containing primary oxidation compounds such as hydroperoxides and secondary oxidation compounds such as volatile organic compounds, which are formed following the decomposition of the triglyceride hydroperoxide. For this reason, the methods used to assess the oxidation stability of vegetable oil formulations must be carefully matched to the intended application in order to obtain realistic estimates.

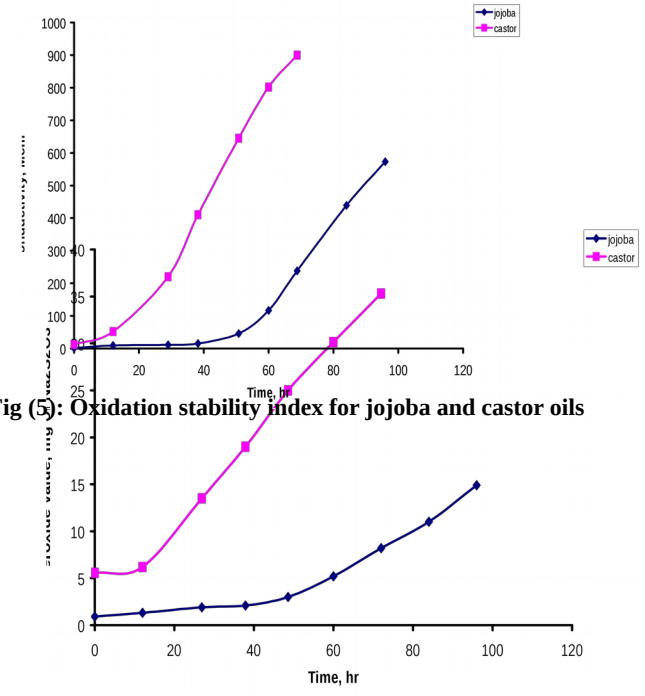

Fig (5): Oxidation stability index for jojoba and castor oils

Fig (6): Oxidation stability for jojoba and castor oils

In this respect, the changes in chemical composition of jojoba and castor oils caused by oxidation were analyzed according to the method reported (21). This method monitors the compounds resulting from the decomposition of highest molecular weight of hydroperoxides, short chain fatty acids and alcohols (primary oxidation products and secondary oxidation compounds). The effects of a variation in oxidative time on conductivity have been investigated from zero time to 100 hours incase of jojoba oil but from zero time to 75 hours in case of castor oil. Analytical data obtained are presented in Figures 7. This figure present an overview on the quantity of the volatiles compounds which resulting from oxidation reaction happend during test time. In case jojoba oil the end point observed is 51 hours, but in case castor oil the end point is 20 hours. In this respect, Figure 8 represents the effect of oxidation time on peroxide value of jojoba and castor oils; the results show that the peroxide values for castor oil are increased markedly after 10 hours. In contrast, in case jojoba oil peroxides values are almost stable until 35 hours and slightly increased after 70 hours.

Based on the above mentioned results (Figures 7& 8) and correlation of these results with the physicochemical properties (Table1), clearly indicates that the jojoba oil is, in general, effective in controlling the oxidative deterioration and efficient in preventing the formation of primary oxidation products and secondary oxidation compounds. This is attributed to the tocopherol isomers in jojoba oil which acts as antioxidants (24).

Comparative investigation between jojoba and castor oils through sulpharization reaction were carried out by the addition different concentrations of elemental sulfur, 4%, 6%, 8% and 10%; the obtained sulphurized jojoba are designated SJ4, SJ6, SJ8 and SJ10 respectively (Table 3), but the obtained sulphurized castor are designated SC4, SC6, SC8 and SC10, respectively (Tables 4). The tabulated data indicates that the viscosity index, dynamic viscosity and molecular weight increas with increasing sulphur content. On the other hand, the iodine number is decreasing with increases

sulphur content. This indicates that the sulpharization reaction temperature followed in the experimental section is suitable for such oils.

Careful inspection in the above mentioned Tables reveal that the molecular weights concerning sulphruised castor oil have higher values than the corresponding sulphruised jojoba oil in all concentrations. This is attributed to the chemical configuration of castor oil, three dimensional structure of the triglyceride (33), and its double bonds which tend to increase the degree of cross linking by sulphur atoms.

Table (3) : physico-chemical properties of sulfurized jojoba oil

Characteristics	SJ4	SJ6	SJ8	SJ10	Test
Density, g/ml @ 25/25, ºC	0.825	0.836	0.863	0.895	D.1298
Refractive index, n_D^{20}	1.4675	1.4685	1.4689	1.4723	D.1218
Kinematics viscosity, c St.					
at 40ºC	55	75.56	94.35	115.36	D.445
at 100ºC	14	20	25.4	32.25	D.445
Viscosity index	267	288.56	300.17	315.34	D. 189
Dynamic Viscosity, @ 50 ºC (rpm 30), cP	45.5	80.25	95.8	128.63	D.97
TAN, mg KOH/gm @72h	0.74	0.59	0.42	0.27	D-974
Average Molecular weight	1227	2002	2299	3250	GPC
Iodine value	66.8	51.5	33.6	21.2	D-5554
Sulfur content, %	3.11312	5.0191	7.4299	8.3171	D-2622

Table (4): Physico-chemical properties of sulfurized castor oil

Characteristics	SC4	SC6	SC8	SC10	Test
Density, g/ml @ 25/25, ºC	0.975	0.984	0.990	0.994	D.1298
Refractive index, n_D^{20}	1.4681	1.4716	1.4736	1.47558	D.1218
.Kinematics viscosity, c St at 40ºC at 100ºC	367.85 25.26	410.38 30.29	452.38 42.37	485.34 55.34	D.445 D.445
Viscosity index	90.112	104.09	144.95	181.1	D. 189
Dynamic Viscosity, @ 50 ºC (rpm 30), cP	212	254	288.36	315.85	D.97
TAN, mg KOH/gm @72h	1.57	1.24	1.01	0.88	D-974
Average Molecular weight	1980	2580	3196	4540	GPC
Iodine value	66.8	58.7	45.6	30.6	D-5554

Grease evaluation

The preparation of lubricating grease is a complicated trial-and error process in which the optimization of the ingredients the reaction scheme are to achieve the desired grease consistency. So, the development of lubricating grease with the right consistency requires stringent optimization of components and preparation scheme. Important performance properties such as rheology, oxidation, oil separations and dropping point are largely dependent on the grease hardness and its ability to maintain a stable lubricating film at the metal contact zone. Accordingly, Four biobased greases were prepared based on jojoba oil, castor oil, sulphurized jojoba with 8% sulphur and sulphurized castor with 8% sulphur by weight as designated G1, G2, G4 and G4 respectively (Table 5).

Table (5): Physico-chemical properties of bio greases based on jojoba, castor oils and their sulfurized derivatives

Test	Bio grease based on jojoba, castor oils and their sulfurized				Test method
	G1	G2	G3	G4	
Penetration at 25ºC **Un worked** **worked**	290 297	285 293	275 282	265 270	ASTM D-217
Dropping point, ºC	155	165	200	210	ASTM D-566
TAN, mg KOH/gm, @72h	2.1	2.7	1.65	1.75	ASTM D-664
%Oil separation, Wt	5	5.6	2.6	3	ASTM D-1724
Oxidation Stability 99ºC@ 96h, pressure drop, psi	3.5	6.9	1.5	3.4	ASTM D-942
Copper Corrosion 3h/100ºC	Ia	Ia	Ia	Ia	ASTM D-4048
Code grease according to NLGI	1	1	2	2	
Egyptian standard	LB	LB	LB	LB	
Apparent Viscosity, cP, @ 90 ºC	928	1420	3125	6456	ASTM D-189

It is worth mentioning that the specifications of all prepared bio greases meet with the NLGI-2. In the mean time, G3 and G4 have thickening power over G1 and G2. This indicates that the role of the sulpharization oils using in the preparation of biogreases. In general, data in Table 5 show that the biogreases preparation is complicated trial-error process in which the optimization of the fluids (vegetable oils) and the chemical compositions of these oils are critical to achieve the desired grease property. The type of vegetable oil and its composition are playing important roles in physicochemical characterization of the prepared grease.

Rheological behaviors for prepared greases (G1-G4) were explored. The apparent viscosity- shear rate profiles at temperature 110°C for these greases are presented as shown in Figure 7, from which it is seen that the apparent viscosity decreases approximately linearly in the order G4 > G3 > G2> G1, in the first region up to shear rate 2.0 S^{-1}, after that in the second region the viscosity almost remain constant with increasing shear rate for all greases with the same trend. It is apparent also, the rheological properties for the prepared greases G4 and G3 are improved with sulphurized oil. Such improving effect may be attributed to the high degree of cross linked of the sulphurized oil in case castor than jojoba. This observation was further supported by molecular weight for sulphurized castor and jojoba (Table 3 & 4), which leads to increasing both the compatibility and electrostatic forces between the ingredients of the prepared biogrease.

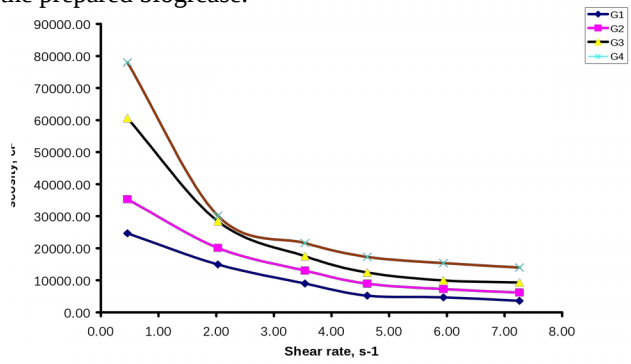

Fig (7): Relation between Viscosity-shear rate of bio greases based on jojoba and castor oils and their sulfurized

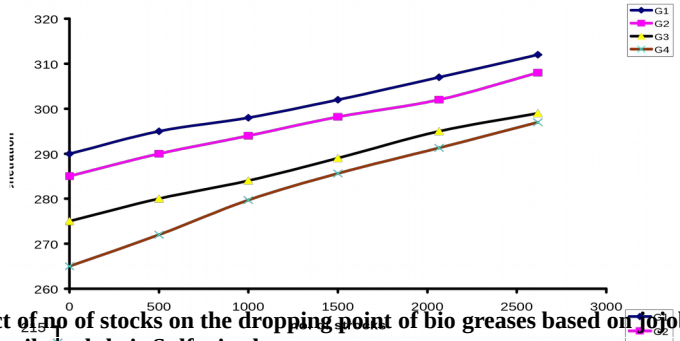

Fig (8): Effect of no of stocks on the dropping point of bio greases based on jojoba and castor oils and their Sulfurized

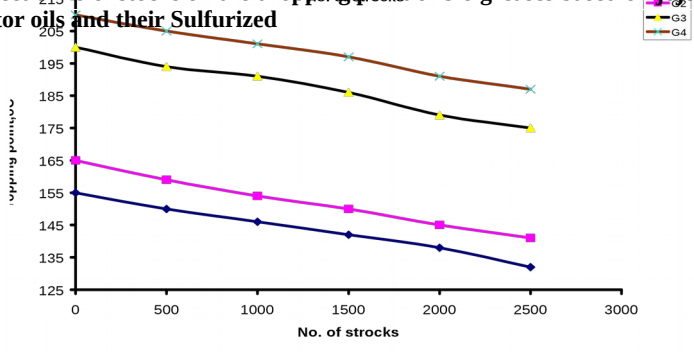

Fig (9): Effect of no of stocks on the Penetration of bio greases based on jojoba and castor oils and their Sulfurized

Experimental data graphically presented in Figures 8 and 9, show the variation of the dropping point and penetration with the different mechanical strokes from 60 to 2500 for prepared greases. It is obvious that the mechanical and thermal stabilities for prepared greases are in the order G4 > G3 > G2> G1, Figures 8 and 9, respectively. It is apparent from these Figures that the greases G2 and G4 based on castor and its sulphurized products are more efficient concerning thermal and mechanical properties than corresponding greases G1 and G3 based on jojoba and its sulphurized. This view agrees with the molecular weight data for CO, SC8, JO and SJ8 (Table 3 & 4), and reveal the chemical composition role for jojoba and castor oils.

Conclusions

The results presented in this investigation indicate the following

1- Fatty acids compositions of the jojoba oil are differ from in case castor oil

2- Sulpharization reaction for jojoba and castor oils was improved their properties as greases.

3- Biogrease based on castor oil and its Sulpharized products show better performance concerning mechanical stability compared with jojoba oil. However, the oxidation stability shows a reverse trend.

4- Both jojoba and castor oils are good raw materials for such synthesized biogreases.

References

1. Bracco, U., 1982. Hypo Caloric Food Composition. European Patent EP 067,358
2. Heise, C., Decombaz, J. and Anantharaman, K., 1982. Int. J. Vitam. Nutr. Res., 52: 216.

3. Yaron, A., Samoiloff, V. and Benzioni, A., 1982. In: Lipids, 17: 169-171.

4. Decombaz, J., Heise, C. and Anantharaman, K., 1985. Nutritional investigations on jojoba oil. In: J. Wisniak and J. Zabicky (Editors), Proceedings of the Sixth International Conference on Jojoba and Its Uses, Beer-Sheva, 1984, pp.323-331.

5. Ranhotra, G.S., Gelroth, F.H., Novak, EA. and Bogannon, F., 1986. Usable energy value of jojoba oil. Cereal Chem., 63: 459-461.

6. Stalder, R., Marchesini, M. and Bexte, A., 1985. Effects of feeding jojoba waxes to rats. A 90-day study. J. Am. Oil Chem. Sot., 62: 600.

7. Verschuren, PM., 1989. Evaluation of jojoba oil as a lowenergy fat. Food Chem. Toxic., 27: 35-44.

8. Verschuren, PM. and Nugteren, D.H., 1989. Evaluation of jojoba oil as a low-energy fat, 2. Intestinal transit time, stomach emptying and digestibility in short-term feeding studies in rats. Food Chem. Toxic., 27: 45-48.

9. Jaime Wisniak, Potential uses of jojoba oil and meal - a review Industrial Crops and Products 3 (1994) 43-68

10. A. Scarpa, A. Guerci: Various uses of the castor oil plant (Ricinus communis L.) – a review. J Ethnopharmacol. 1982, 5, 117–137.

11. M. F. Ali: Edible oils, fats and waxes. In: Handbook of Industrial Chemistry: Organic Chemicals.

12. O. D. Onukwlo, P. K. Igbokwe: Production and characterization of castor oil-modified alkyd resins. J Eng Appl Sci. 2008, 3, 161–165.

13. Hatice Mutlu1 and Michael A. R. Meier: Castor oil as a renewable resource for the chemical industry. Eur. J. Lipid Sci. Technol. 2010, 112, 10–30

14. Braithwaite, E.R.: Lubrication and Lubricants, Elsevier Publishing Company (1967) 197-240

15. Cameron, A.: Principles of Lubrication, Longmans Green (1966) 528-541

16. Hoshino, M.: Theory of Grease Lubrication, Journal of Japanese Society of Tribologist, Vol.47, No.1 (2002) 8-14

17. Sullivan, T. Soy Grease on Track for Sales Boom. Lube Report 2003, July 22.

18. Bessette, P. A.; Stone, D. S. Synthetic Grease (Chapter 23). In Synthetic Lubricants and High Performance Functional Fluids;

19. Dwivedi, M. C.; Sapre, S. Total Vegetable-Oil Based Greases Prepared from Castor Oil. J. Synth. Lubr. 2002, 19 (3), 229.

20. Florea, O.; Luca, M.; Constantinescu, A.; Florescu, D. The Influence of Lubricating Fluid Type on the Properties of Biodegradable Greases. J. Synth. Lubr. 2003, 19 (4), 303.

21. “Collaborative Study of the Oil Stability Index Analysis”. Tod A. Jebe, Mark G. Matlock and Ronald T. Sleeter. JAOCS, vol. 70, #11, pp1055-1061, 1993

22. Refaat A. El-Adly, A. H. Bedier, Enas A. Ishmael and Modather F. H, A Study on preparation and evaluation of biogrease based on jojoba oil and its derivatives. The 14th. International Conference On Petroleum Mineral Resources and Development ,EPRI,Nasr city, Cairo, Egypt. March, 2011

23. Wisniak, J. (1994). Potential uses of jojoba oil and meal- a review. Industrial Crops and products.3.43-68.

24. Kono, Y.; Tomita, K.; Katsura, H. & Ohta, S. (1981). Antioxidant in Jojoba Crude Oil, In: Puebla, (Editor), Proceedings of the Fourth International Conference on Jojoba, Hermosillo, pp 239-256.

25. Miwa, T.K. (1971). Jojoba Oil wax Esters and Derived Fatty Acids and Alcohols, Gas Chromatographic Analysis , J.Am.Oil Chem., Vol.48, pp 299-264.

26. Miwa, T.K., J. Am. Oil Chem. Soc.48:259(1971).

27. Miwa, T.K., Cosmetics Perfumery 88:39 (1973).

28. Jayadas N. H.(2008) Evaluation of the oxidative properties of vegetable oils as base stocks for industrial lubricants using spectroscopic and thermogravimetric analyses, J. Synthetic Lubrication 2008; 25: 105–113

29. Dweck J, Sampaio CMS. Analysis of the thermal decomposition of commercial vegetable oils in air by simultaneousTG/DTA. Journal of Thermal Analysis and Calorimetry 2004; 75:385–391

30. Frankel EN. Prog Lipid Res 1985;23:197.

31. Hamilton RJ, Kalu C, Prisk E, Padley FB, Pierce H. Food Chem 1997;60(2):193.

32. Stachowiak, N.J. Fox, G.W. Vegetable oil-based lubricants—A review of oxidation, Tribology International 40 (2007) 1035–1046

33. Official methods of analysis of the association of Agricultural chemists. 15th ed., published by A.O.A.C, (2000).