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Research Article

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Study on physicochemical properties of vegetable oils and their blends use as possible ecological lubricant

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ABSTRACT

Vegetable oils due to high biodegrability, low toxicity, renewability and excellent lubricating performance, have immense potential to replace petroleum oils as feedstock for lubricants. In these study vegetable oils like soybean oil, castor oil, groundnut oil, and cottonseed oil was purchased from local super market. The physicochemical properties like viscosity, acid value, saponification value, iodine value of four different vegetable oils and there blends in 10:90 to 90:10 proportion were studied. From this study, it was found that viscosity of pure vegetable oils and there blends regularly decreased with increased in temperature and viscosity of soybean oil blends with castor oil found to be higher than other blenders. Also acid value of same blends found to be lower than other blends. Higher viscosity and lower acid value of castor oil blends in soybean oil suggest that these blends directly use an alternative lubricant for mineral oil based lubricants.

Keywords: Vegetable oils, blends, viscosity, acid value, lubricant

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INTRODUCTION

One of the principal objectives of an engineer is to achieve the transfer of energy and its utilisation under the available circumstances with a little loss as possible. While attempting this, relatively moving surfaces are often pressed together with considerable force and have to slide over each other at considerable velocities. Under such a circumstances, a considerable amount of frictional heat is evolved at the rubbing surfaces. This result is high large scale seizure or welding of two surfaces. In order to reduce frictional resistance and damage to rubbing surfaces, substance introduced called as lubricant. The worldwide consumption of lubricant in 2005 was around 40 million metric tonnes and approximately 30% of lubricant consumed ended up in the ecosystem. Present production of biodegradable lubricant is only 1% of the total production. A lubricant consists of base oil (≥90%) and additive package (≤10%). The base oil used for the formulation of most lubricant is environmentally hostile mineral oil. Because mineral oil based lubricant consist of high percentage of carbon, nitrogen and sulphur, which reacts with atmospheric oxygen to form oxide of carbon sulphur and nitrogen. Oxides of carbon produce global warming and oxide of sulphur and nitrogen react with rain water produce acid rain which becomes hazardous to environment and human health. Formulation of environmentally friendly lubricant depends upon primarily on the biodegrability of base oil. Thus search for environment friendly substitutes to mineral oils as base oil in lubricant has become a frontier area of research in the lubricant industries. The demand for biodegradable lubricant is due to growing concern for the impact that technology is making to the environment.

Vegetable oils are perceived to alternative to mineral oil for lubricant base oil because of certain inherent technical and their ability for biodegrability. Compared to mineral oils, vegetable oil in general possesses high viscosity index, high flash point, high lubricity and low evaporation loss. Elaborate literature survey revealed that many technical solutions such as chemical modification and additivation have been suggested to overcome the poor oxidative and

hydrolytic stability and high temperature sensitivity of tribological behaviour of vegetable oils when used as base oil for lubricant.

When vegetable oils use as a lubricant, blending is a feasible option for improving lubricant properties such as viscosity index, acid value, saponification value and iodine value because when vegetable oil blends use as a lubricant shows higher boundary lubrication mechanism due to presence of long hydrocarbon chain which gets oriented towards in almost a perpendicular direction in the monolayer of adsorbed oil.

In this research paper, author studied the physicochemical properties such as viscosity, acid value, saponification value, iodine value of different vegetable oils and their blends for the evaluation of such a blends which shows enormous lubrication properties.

EXPERIMENTAL SECTION

2.1 Determination of viscosity of pure oils and viscosity of soybean oil blends with vegetable oils

The viscosities of pure refined soybean oil, sesame oil, coconut oil, sunflower oil were determined. The soybean oil-vegetable oils blends were prepared in 10:90 to 90:10 proportions and again viscosities were measured. A Redwood viscometer No.1 was used for measurement of viscosities.

Table I: Shows viscosity (in Redwood second) at different temperature of pure vegetable oils

Sr.No.	Temperature	Viscosityof soybean oil	Viscosityof castor oil	Viscosityof groudnut oil	Viscosityof cottenseed oil
1	30	78.83	609.22	81.92	75.73
2	40	62.21	405.76	57.74	55.53
3	50	48.20	201.40	44.56	39.63
4	60	38.20	120.30	34.28	32.81
5	70	32.34	93.49	26.16	28.27
6	80	26.28	89.67	22.21	24.28

Table II: Shows viscosity (in Redwood second) at different temperature of soybean oil blends with vegetable oils

Soybean oil: castor oil						
Mixture ratio	Viscosity at different temperature					
	30	40	50	60	70	80
10:90	477.65	265.71	181.97	116.62	84.40	45.30
20:80	401.73	252.99	154.25	85.91	69.30	42.25
30:70	293.57	201.24	122.45	69.93	98.30	48.30
40:60	250.97	164.21	105.57	71.90	97.30	43.10
50:50	174.46	127.28	68.61	54.45	42.90	37.80
60:40	129.20	97.16	71.64	54.25	41.26	36.20
70:30	120.42	90.64	60.50	44.45	37.41	29.10
80:20	93.20	68.10	58.10	43.98	35.10	28.90
90:10	90.10	88.30	61.30	46.20	34.20	29.10
Soybean oil: Groundnut oil						
10:90	82.32	56.95	41.17	37.12	31.29	27.29
20:80	75.19	57.20	43.73	35.67	30.20	28.10
30:70	80.15	57.42	43.10	34.56	28.30	24.18
40:60	75.42	55.95	43.16	34.56	28.30	24.18
50:50	70.26	54.25	40.62	31.45	24.23	21.20
60:40	74.72	50.34	36.24	33.19	27.28	23.22
70:30	69.76	55.96	37.42	31.44	28.28	26.29
80:20	64.20	47.50	37.50	33.10	28.90	23.80
90:10	63.21	46.20	34.76	31.30	29.21	22.14
Soybean oil: cottonseed oil						
10:90	68.34	52.30	40.20	31.80	26.70	23.90
20:80	68.95	54.47	38.86	32.13	27.11	24.90
30:70	74.50	54.21	39.52	31.40	28.10	26.20
40:60	68.16	51.51	40.42	32.39	30.30	29.10
50:50	68.13	53.46	39.30	31.80	30.90	28.81
60:40	71.13	52.30	39.15	30.88	29.89	26.63
70:30	67.90	52.43	40.43	39.81	37.20	36.38
80:20	69.80	51.50	38.31	35.35	34.30	32.90
90:10	70.72	50.26	36.30	31.35	29.31	28.30

Table III: Shows acid value, saponification value, iodine value of pure vegetable oils

Sr.No.	Vegetable oil	Acid value	Saponification value	Iodine value
1	Soybean oil	1.8	197.90	128.12
2	castor oil	2.3	182.76	85.87
3	Groundnut oil	4.0	193.91	106.74
4	Cottonseed oil	2.8	190.64	104.85

Table IV: Shows acid value, saponification value, iodine value of soybean oil blends with vegetable oils

Soybean oil: castor oil				
Sr.No.	Mixture ratio	Acid value	Saponification value	Iodine value
1	10:90	1.1	187.90	87.29
2	20:80	0.7	189.98	88.89
3	30:70	0.9	190.98	93.24
4	40:60	1.2	188.87	98.28
5	50:50	0.8	186.85	115.96
6	60:40	1.8	194.98	107.78
7	70:30	2.2	197.88	128.90
8	80:20	2.5	196.83	119.85
9	90:10	2.1	198.20	126.28
Soybean oil: Groundnut oil				
1	10:90	3.2	198.80	191.28
2	20:80	3.1	199.20	193.40
3	30:70	1.5	196.86	189.18
4	40:60	1.6	195.83	188.10
5	50:50	2.0	190.86	185.89
6	60:40	2.1	190.50	167.86
7	70:30	0.5	192.32	155.28
8	80:20	1.6	192.10	143.29
9	90:10	2.5	192.88	135.66
Soybean oil: Cottonseed oil				
1	10:90	1.6	189.90	103.38
2	20:80	1.3	191.20	106.88
3	30:70	1.1	189.88	102.98
4	40:60	0.8	190.82	107.88
5	50:50	2.2	188.87	125.10
6	60:40	2.3	194.25	115.26
7	70:30	0.6	195.29	111.65
8	80:20	1.4	193.27	125.87
9	90:10	0.9	196.76	129.15

Figure I: Shows viscosity at different temperature at different vegetable oils

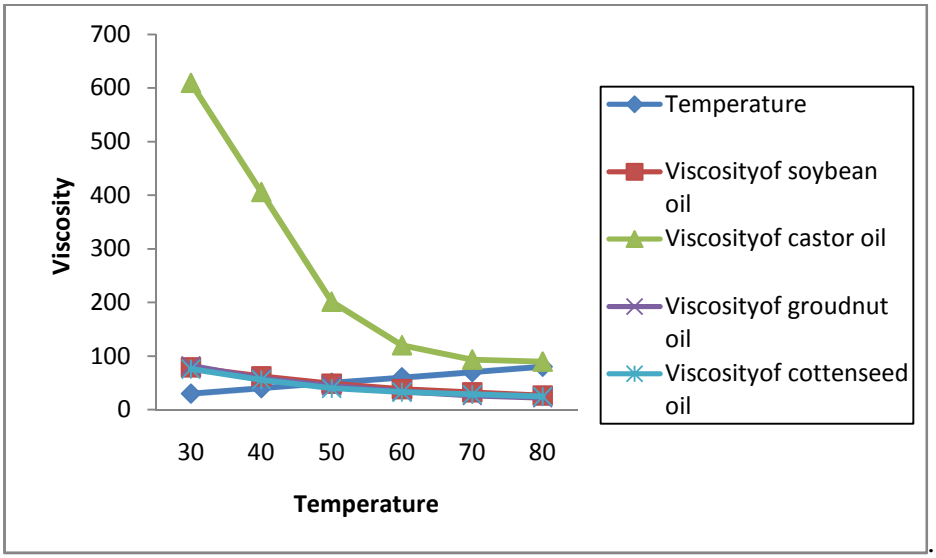


Figure II: Shows acid value at different ratio at different vegetable oil blends

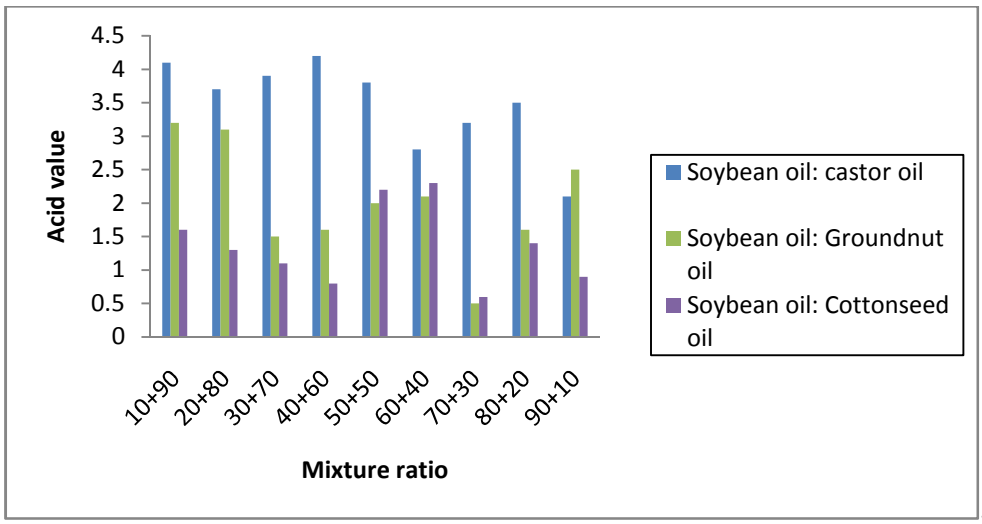


Figure III: Shows saponification value at different ratio at different vegetable oil blends

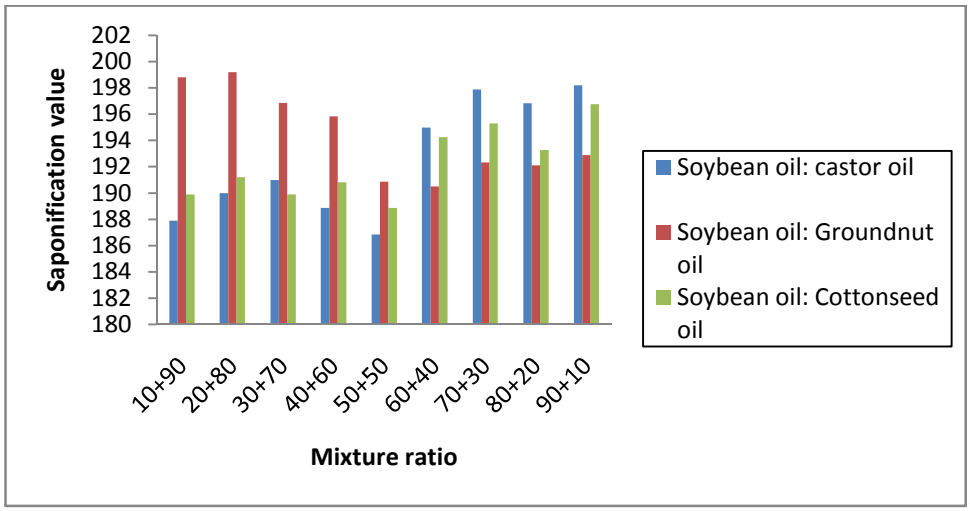
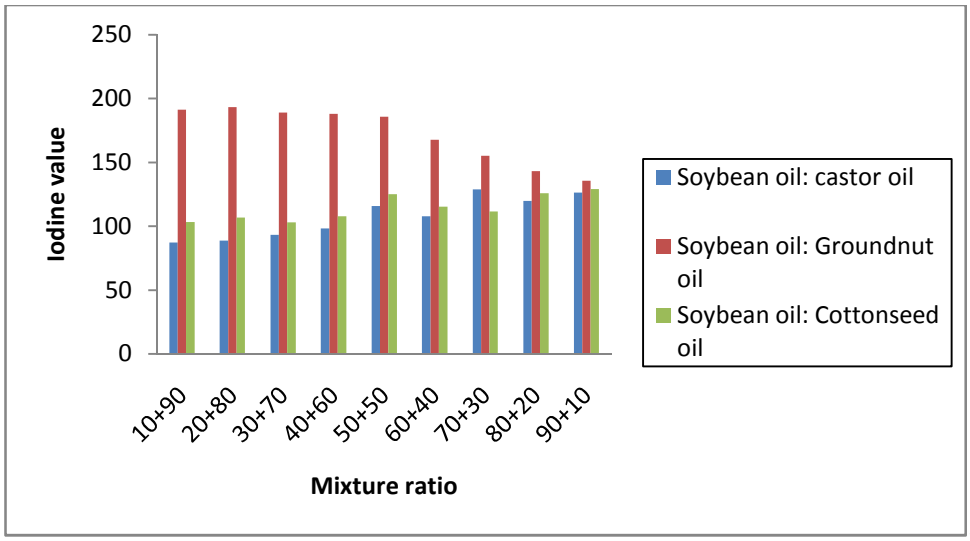


Figure IV: Shows iodine value at different ratio at different vegetable oil blends



2.2 Determination of acid value, saponification value, iodine value of pure oils and soybean oil blends with vegetable oils

The acid values, iodine value, saponification value of pure oils were measured. The soybean oil-vegetable oils blends were prepared in10:90 to 90:10 proportion and again same parameter were measured. The acid value, saponification value, iodine value was determined by the titrametric methods of Pearson, 1970.

RESULTS AND DISCUSSION

3.1 Viscosity

Viscosity is one of the most important properties of lubricating oil. The formation of fluid film of lubricant between the friction surfaces and the generation of frictional heat under particular condition of load bearing speed and lubricant supply mostly depend upon the viscosity of lubricant and to some extent on its oilness. From the given table and figure it can be observed that the viscosity decrease with the rise in temperature as usual therefore variation of viscosity with respect to temperature found in vegetable oils and their blends. From the above data, viscosity of soybean oil blends with castor oil was found to be higher among this other vegetable oil blends. This is due to rise in temperature enhances movements of molecule and reduces intermolecular forces so the layer of liquid easily pass over one another and thus contribute to reduction in viscosity. This phenomenon also verified by other researcher since oil viscosity depends on molecular structure and decreases with unsaturation of fatty acid.

3.2 Acid value

The presence of mineral acid in lubricating oil is so rare that it is almost unnecessary to look for it, unless the oil is refined in faulty manner. Free organic acid or acidic bodies are always found in lubricating oils compounded oils with fatty oils. In good lubricating oil acid value should be low because increase acid value should be taken as indicator of oxidation of oil which may lead to gum and sludge formation beside corrosion. From above table and figure, acid value of castor oil was found to be greater but after blending with soybean oil, acid value decreases. Thus lower acid value of soybean-castor oil blends, its act as a best lubricating oil blends than other cited oil blends.

3.3 saponification value

The animal oil and vegetable oil undergoes saponification but mineral oil does not. Further most of the animal oil and vegetable oil possesses their own characteristic saponification value. Hence determination of saponification value helps to ascertain the presence of fixed oil in lubricant. According to third global oil and fat business forum USA and Interfacing with the global oils and fat business by Ilija gawrilow saponification value of vegetable oil designed for lubricating base oil is 186-198. Thus from above data, saponification value of soybean oil blends in castor oil is similar to this. Thus above blends act as good lubricants than other cited blends.

3.4 Iodine value

Iodine value is intended as a measure of unsaturation and at times it is used as quick alternative to oxidation test of mineral oils. Iodine value indicates drying quality of oil, the drying oil having higher iodine values. According to third global oil and fat business forum USA and Interfacing with the global oils and fat business by Ilija gawrilow iodine value designed for lubricating base oil is 94-126. Thus from above data, iodine value of soybean oil blends in castor oil similar to this value hence this blends act as a good lubricant than other blenders.

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