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Evaluation of Flash Point and Fire Point of Selected Edible Oil Blends - A Bio-Lubricant

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Abstract: Edible oils are good alternatives for petroleum oils as lubricants or lubricant additives in environmentally sensitive industrial applications. Development of economically feasible new industrial lubricant is highly desirable with high petroleum price. As environmental concerns grow, vegetable oils find their way into lubricants for industrial and transportation applications. They are renewable and biodegradable. Vegetable oils or triglycerides are associated with low temperature viscosities, oxidative instability, and hydrolytic instability. Apart from functionalization, lubricating properties of vegetable oils can be improved by blending different oils .Blended vegetable oils offer improved lubricating properties like pour point ,flash point ,fire point etc .The present work highlights lubricating properties like flash point and fire point in mixture of oils and attempts to identify mixture of vegetable oil as alternative lubricant for mineral oils and petroleum oils in environmentally sensitive areas like food and drug manufacturing industries

Keywords: *Lubricant, Flash Point, Fire Point, Viscosity*

I. INTRODUCTION

The property of reducing friction between two surfaces is known as lubricity. A substance which is usually organic, which is introduced between two surfaces to reduce friction is known as lubricant. Lubricants provide protection against wear, friction, corrosion and oxidation, dissipate heat and transfer power, are compatible with rubber and other sealing materials, as well as provide a sealing effect in some cases (1). Vegetable oils are good alternatives to petroleum oils or mineral oils in environmentally sensitive industrial applications (2, 3). The United States Department of Agriculture (USDA) suggests using food grade lubricants especially in food and drug manufacturing industries. The National Sanitation Foundation (NSF) has evolved globally to succeed the USDA. The purpose of the standard is to establish food safety evaluation criteria for food-grade lubricants used in food-processing, drug manufacturing packaging, handling and storage.

Vegetable oils include peanut oil, castor oil, sunflower oil, almond oil, olive oil and others. In their natural form, they consist of primarily triglyceride structures. Most of these natural oils have good lubricating qualities due to their polar nature. They provide good metal wetting attraction and also good solvents as they can keep dirt and debris off metal surfaces.

Their molecular structure shows high natural viscosity and viscosity index. Genetic modifications can overcome much of the thermal and oxidative stability problems. Vegetable oils are ideally suited to applications such as sawmill blade or chain drive lubrication where the lubricant is used on a "once through" basis and where low toxicity is required. They are also well-suited for use in low to medium pressure hydraulic systems, or lightly loaded gear drives where the operating temperature does not normally exceed 60ºC (140ºF) and where there is little chance of water ingress or high contamination. Biodegradable oils or bio lubricants should be maintained and monitored during use just like mineral-base oils (4). They must be kept cool, clean and dry (water-free) and their condition should be monitored on a regularly scheduled basis using readily available oil analysis techniques. Lubricant sector is currently facing energy security and global warming concerns. These, together with pollution issues, due to environment spills and disposal, can be mitigated by production of bio-based substances starting from Vegetable oil. Some of the characteristics of a good lubricant are high thermal stability, high flash point and fire point, high viscosity index, low freezing point, non- Inflammable and can be used over wide range of temperature (1).typically vegetable oils possess all the mentioned characteristics and are considered to be biodegradable (4). The lowest temperature at which an oil lubricant gives off enough vapors that ignite for a moment when flame is brought near to it is known as flash point and the lowest temperature at which the lubricant gives off sufficient vapor that ignite continuously for at least 5 seconds when a flame is brought near it is known as fire point. Flash and fire point tells us the maximum temperature up to which a lubricant can be used.

Low molecular weight constituents in lubricants tend to decrease the flash point (5). Volatile matter if present in lubricant gives irregular flashes can be observed by low flash point called **"**freaky flash point". Moisture in lubricants prevent oil vapor from igniting and hence raise the flash point (4).

II. MATERIALS AND METHODOLOGY

Test oils

In the measurement of lubrication properties, test vegetable oils used in this work were olive oil, Almond oil, castor oil, groundnut oil, cottonseed oil, coconut oil, sesame oil, sunflower oil and mustard oil and their blends in equal proportions with sesame oil which is amber colored with aroma, made from toasted and pressed sesame seeds. During blending process sesame oil blends with other oils stirred continuously to ensure uniform mixing.

Determination

Flash and fire point of lubricating oil was determined by Pensky – Marten's apparatus which consists of following parts:

1. **Oil cup:** made up of brass with a lid having four openings of standard size for a stirrer, thermometer, an air inlet and test frame.

2. **Shutter:** Present at the top of cup & has a lever mechanism when it is opened, a test flame comes in contact with oil vapor to check the flash a fire point.
3. **Air path:** Oil is placed in an air-bath which ensures very slow and uniform change in temp. It is heated either by a gas burner or electricity.
4. **Pilot burner:** It is always lighted to support the burning of test flame burner.
5. **Flame test burner:** Burner by which test flame is introduced into cup containing lubricating oil.

Procedure: The oil sample is filled up to the mark in the cup. It is heated with constant stirring at the rate of about 5^0C per minute. At every 1^0C rise in temp, test flame is introduced for a moment with the help of a shutter door. When test flame produces a distance flash in the oil cup, the temperature noted and recorded as flash point. The heating is continued after every 1^0C rise in temp, the oil vapors are tested for fire points. The temperature at which the experimenting lubricating oil catches fire at least 5 sec. is recorded as its fire point.

III. RESULTS AND DISCUSSION

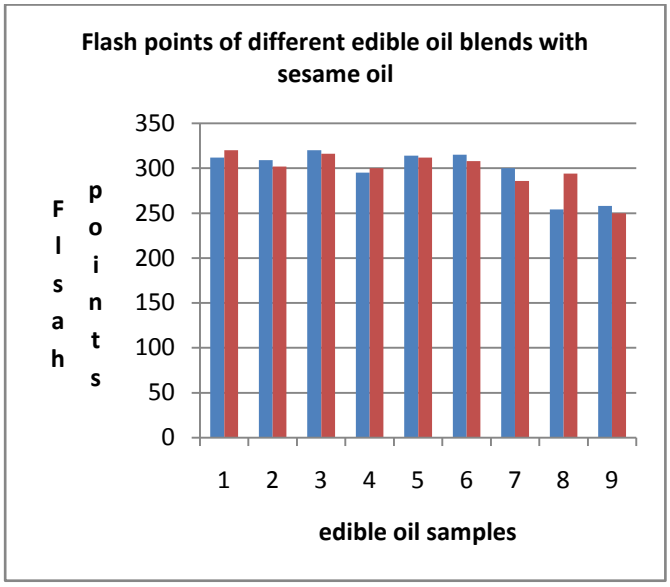
In the present study flash point and fire points of different edible oils (Table:1) were determined .Flash points and fire points of blends in equal proportions of sample oil with sesame oil was determined (Table -2) to check the difference in their values before and after mixing. All observations are expressed in degree Celsius. Serial numbers of edible oils was mentioned in the plots of flash point vs. edible oil samples shows difference in flash points used in the study as shown in Figure-1. Serial numbers of edible oils was mentioned in the plots of fire point vs. edible oil samples shows difference in fire points used in the study as shown in Figure-2.

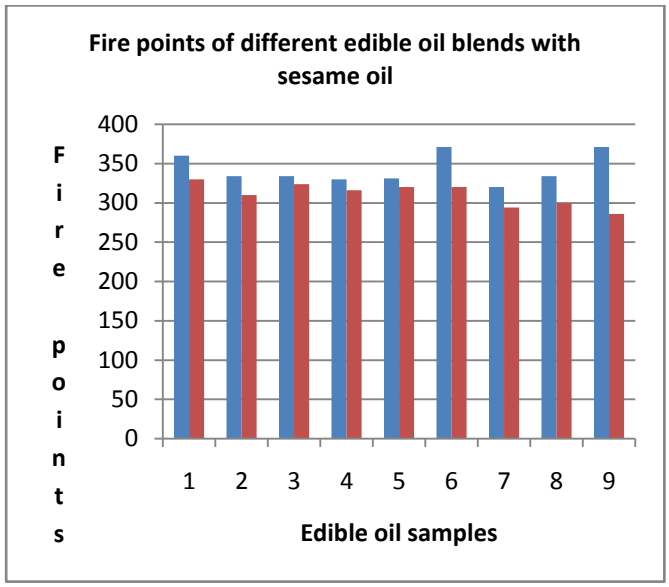
Table: 1 Characteristics of edible oils used

No	English name	Common name	Botanical name
1	Sesame oil	Sesame oil	Sesamumindicum
2	Cotton seed oil	Cotton seed oil	Gossypiumhirsutum
3	Sunflower oil	Sunflower oil	Helianthus annuus
4	Groundnut oil	Groundnut oil	Arachishypogaea
5	Coconut oil	Coconut oil	Cocosnucifera
6	Palm oil	Palm oil	Elaeisguineensis
7	Olive oil	Olive oil	Oleaeuropaea
8	Castor oil	Castor oil	Ricinuscommunis
9	Mustard oil	Mustard oil	Brassica nigra
10	Almond oil	Almond oil	Prunusdulcis

Table: 2 Flash points and Fire points of various edible oils and their blends with sesame oil

S.No	Test Samples	With Out Blending		After Bleding In Equal Propotion With Sesame Oil	
		Flash Point (^{O}c)	Fire Point(^{O}c)	Flash Point (^{O}c)	Fire Point (^{O}c)
	Sesame oil	315	371	--------	----------
1	Cotton seed oil	312	360	320	330
2	Sunflower oil	309	334	302	310
3	Groundnut oil	320	334	316	324
4	Coconut oil	295	330	300	316
5	Palm oil	314	331	312	320
6	Olive oil	315	371	308	320
7	Castor oil	300	320	286	294
8	Mustard oil	254	334	294	300
9	Almond oil	258	371	250	286





CONCLUSIONS

Flash point and fire point is a matter of manifest importance as they show the degree to which an oil or fat may be heated without undergoing undue breakdown(6,7).Evolution of volatile substances determines not only the temperature range within which it may be effectively used, but also the fire hazard attendant upon its use(6,7). The fundamental reason for the requirement of fire point and flash point measurements is to assess the safety hazards with regard to its flammability. Lower the flash and fire points greater is the risk(8).Products with flash point less than 38^oC will usually require special precautions for safe handling. The fire point for lubricant is usually 8 to 10% above the flash point (9). Flash points of blends with sesame oils are almost found to be same as flash point of pure sesame oil. Flash point of cotton seed oil with

sesame oil blend (320 ^{o}C) is found to be slightly higher than flash point of pure sesame oil (315^{o}C) . Sesame oil alone can be utilized as lubricant base stocks in formulation of high added value based bio lubricants for special and environmentally sensitive applications (10) Fire points of edible oil blends with sesame oil were found to be lower than their pure oil fire point values. Hence the blends considered for study are not a better choice as lubricating oil.

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