ANALYSIS OF DIFFERENT FEED STOCKS FOR BIODIESEL PRODUCTION

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ABSTRACT: *Biodiesel is spreading its charm in modern era. World is moving towards resources which can be reused to conserve energy. Biodiesel is a renewable and an environmental friendly source. However, it is not fully commercialized due its cost and non-awareness in the society. The issue of cost can be solved by using a mixture of waste cooking oil (wco) up-to 60-90%. A thorough analysis was performed on various samples of feed stocks. Properties of each sample like moisture content, free fatty acid, kinematic viscosity and saponification value were determined. Also some properties of biodiesel produced from each sample were analyzed like cloud point, cold filter plugging point, carbon residue and flash point. In Pakistan, up-till now no attempt has been done to commercialize biodiesel and no articles came in print that described the optimum conditions of doing so. Further research on a larger scale can help gather more information on how the properties of waste cooking oil can impact the production of biodiesel.*

Keywords: Biodiesel, Trans-esterification, Waste Cooking Oil, Free Fatty Acid

I. INTRODUCTION

Biodiesel was first brought into play in world war two. It was a time of industrial revolution and the world was thinking of new innovations. Since fuel is now the basic necessity of life with its growing demand. World is now moving toward the other sources of its production. Firstly this concept was suggested by the Rudolf diesel (1858-1913). He made the first engine to run on peanut oil which was demonstrated at the World Exhibition in Paris in 1900 [1]. Currently, diesel engines need changes to clean burning and stable fuel that will operate under a variety of conditions. Some countries hold seminars for using biodiesel by addressing their benefits and utilization of the renewable resources. Some cars were used to run this biodiesel. However due to high viscosity, the gasket of the engines would be damaged and wear and tear was very high.

Our main objective is to create a greener environment as the world is trending towards the use of renewable sources. Biodiesel is one of these sources which can bring a revolution again in the industrial world. Recently, the production of biodiesel from waste cooking oil has led to the decrease in its production cost about 60-90% [2].

The growing production of biodiesel is depicting the popularity of this idea. A number of feed stocks are available throughout the world from which biodiesel can be produced but still production from waste cooking oil stands out due to a number of advantages.

II. MATERIAL AND METHOD

In this paper, the collected samples of biodiesel from sources were analyzed and their properties were studied.

Five types of feed stocks were used to prepare biodiesel, followed by a study of properties of biodiesel from each feed stock.

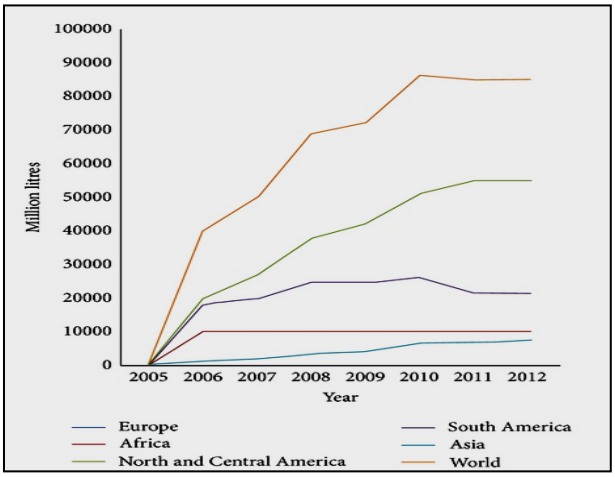


Figure.1. Production of Biodiesel annually

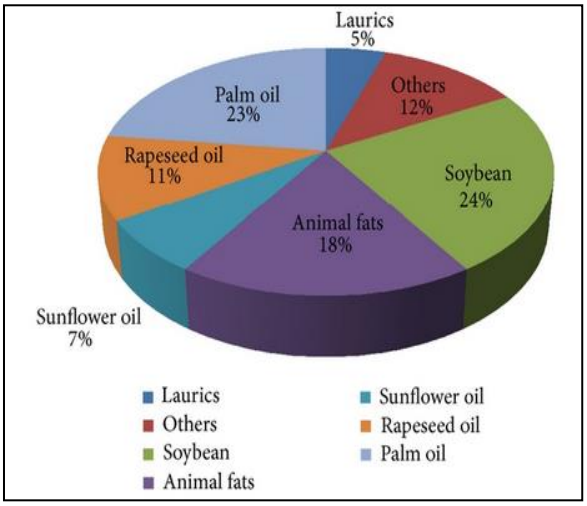


Figure.2. Feedstock for Biodiesel

Table 1. Samples obtained

Sr. No.	Name	Source
1.	Canola Oil	Commercially available source.
2.	Waste Cooking Oil	UET GT RD Restaurants
3.	Sunflower Oil	Commercially available source.
4.	Palm Oil	Local manufacturer.
5.	Soybean Oil	Local manufacturer.

III. PROPERTIES OF SAMPLES ANALYZED (METHOD)

The samples were categorized in categories on the basis of properties which include moisture content, free fatty acid amount, kinematic viscosity and saponification value. The testing methods applied for the determination of each property is given in Table 2.

Table 2. Properties of samples tested

Property	Testing Method
Moisture	ASTM E203[3]
Free Fatty Acid	AOCS Official Method Ca 5a-40[4]
Kinematic Viscosity	ASTM D445[5]
Saponification Value	AOCS Method Cd 3-25[6]

IV. PROCESS & OPERATING CONDITIONS

The samples were converted to biodiesel by base catalyzed trans-esterification technique. The ratio of alcohol to oil was kept 6:1 for acid-type trans-esterification. The catalyst used are listed in the table. Stirrer speed was kept 230 rpm[7]. 1L of sample after pretreatment with acid catalyst was heated to 65oC and maintained for 15 minutes. Standard procedure [8] for trans-esterification was carried out. The schematic diagram for Biodiesel for Large scale production is shown in Figure 3 [9].

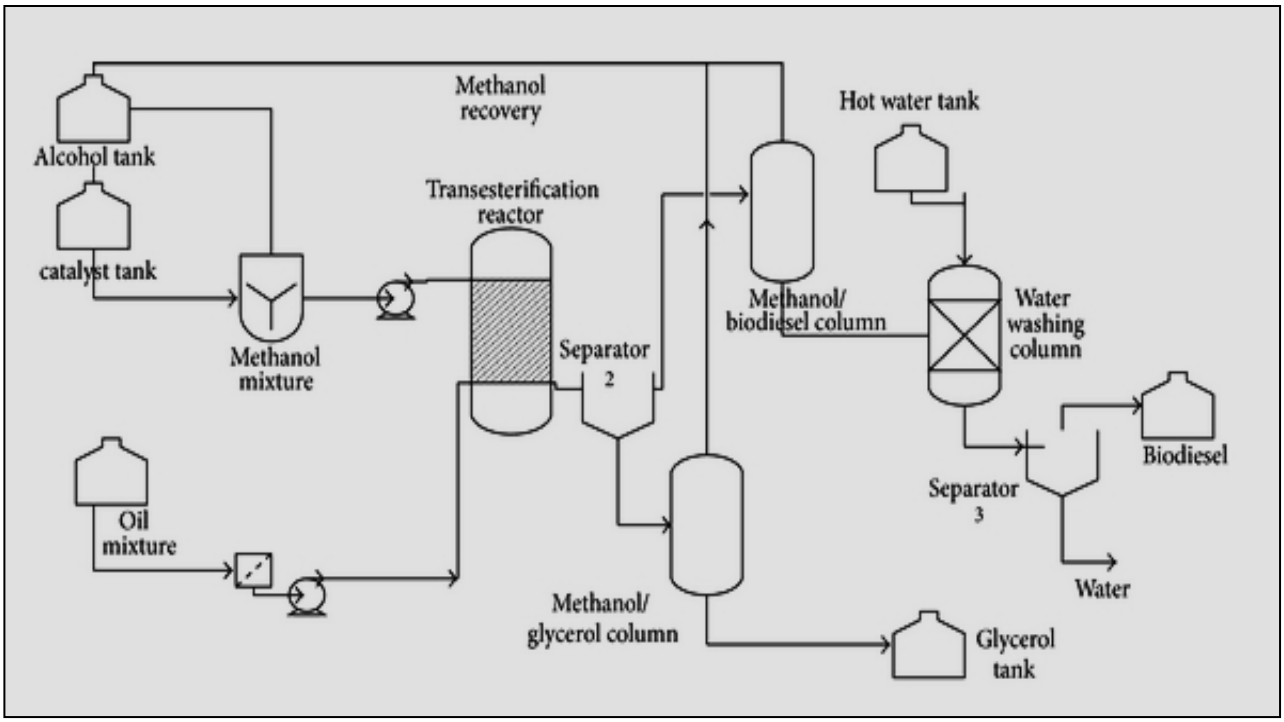


Figure.3. Schematic Representation for Biodiesel Production

Oil types	Type of alcohol	Process method	Parameters T°C	C (catalyst percentage) A (acid catalyst)%	B (base catalyst)%	M (alcohol to oil ratio and wt%)	Speed (rpm)	Time	Catalyst type
Palm oil	Ethanol	Acid-catalyzed transesterification	90°C	0.5, 1.0, 1.5, and 2.25 wt%	—	25, 50, and 100%	—	—	HCL, H_2SO_4
Waste cooking-oil collected from restaurant		Two-step catalyzed process	95°C & 65°C	0, 1, 2, 3, and 4 wt%	1%	3, 5, 7, 8, and 10 : 1, and 6 : 1	—	0.25 h, 0.5, 1, 2, 3 h, and 4 h	Ferric sulfate, KOH
Sunflower oil	Methanol	Base-catalyzed transesterification	25°C & 65°C	—	0.5 and 1.0%	3 : 1, 6 : 1, and 9 : 1	—	1–3 h	KOH, NaOH
Canola oil	Ethanol	Base-catalyzed transesterification	60°C	—	0.2, 0.4, 0.6, 0.8, 1.0, and 1.2%	—	—	25 min	NaOH
Sunflower oil		Base-catalyzed transesterification	40°C	—	0.5–2.0%	1 : 4.1 : 3, 3 : 1, 4 : 1, 6 : 1	350 rpm	3 h	KOH, NaOH
Soybean oil	Methanolethanol, butanol		50°C–65°C	—	0.5%	1 : 4, 1 : 3, 1 : 2, 1 : 1	—	2 h and 6 h	NaOH

Figure.5. Operating Conditions for Biodiesel Production

Table 3. Properties of Biodiesel tested

Properties	Testing Method
Cloud Point	ASTM D2500
Cold Filter Plugging Point	ASTM D6371
Kinematic Viscosity	ASTM D445
Carbon residue	ASTM D524
Free and total glycerin	ASTM D6584
Flash Point	ASTM D93

The properties of biodiesel made were tested using the standard testing methods used world-wide. The details are given below:

V. RESULTS AND DISCUSSION

The results of the properties of five samples were studied and analyzed. Thus, the best properties of sample were determined which are given in Table 4.

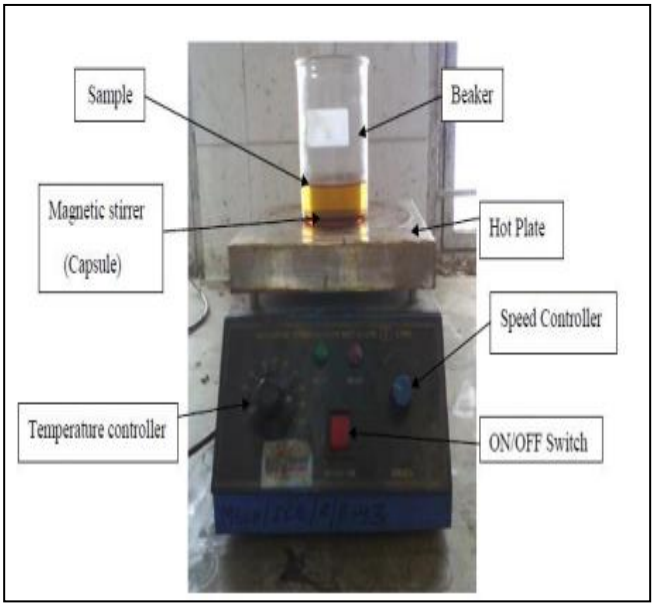
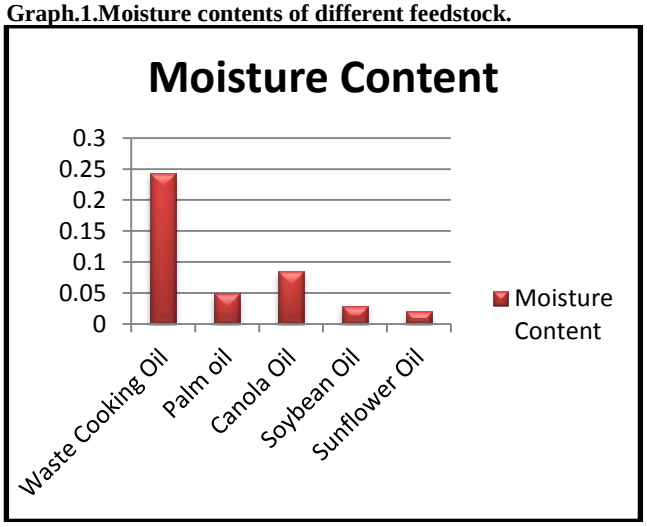


Figure.6. Apparatus Set-Up

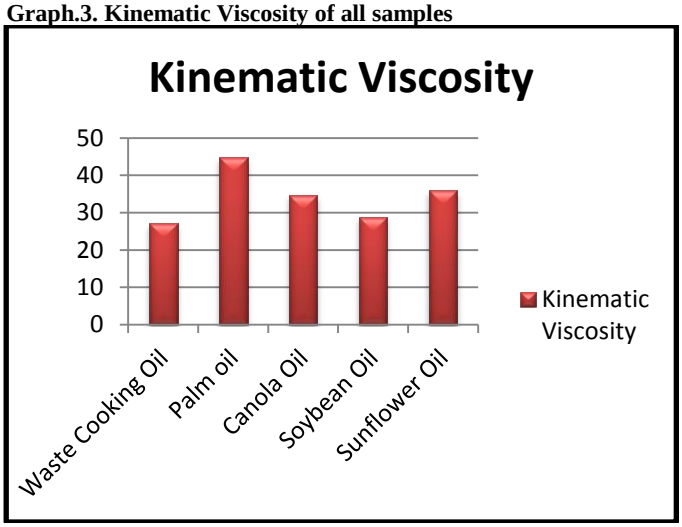
Table 4. Properties of sample

Property	Waste Cooking Oil	Palm Oil	Canola Oil	Soybean Oil	Sunflower Oil
Moisture	0.242 (wt %)	0.049 (wt %)	0.085 (wt %)	0.029 (wt %)	0.020 (wt %)
Free Fatty Acid	2.72 (wt %)	0.54	0.34	0.07	0.04
Kinematic Viscosity	27.00 mm^2/s at 40°C	44.79	34.72	28.87	35.84
Saponification Value	198.50 mg KOH/g	208.62	189.80	195.30	193.14

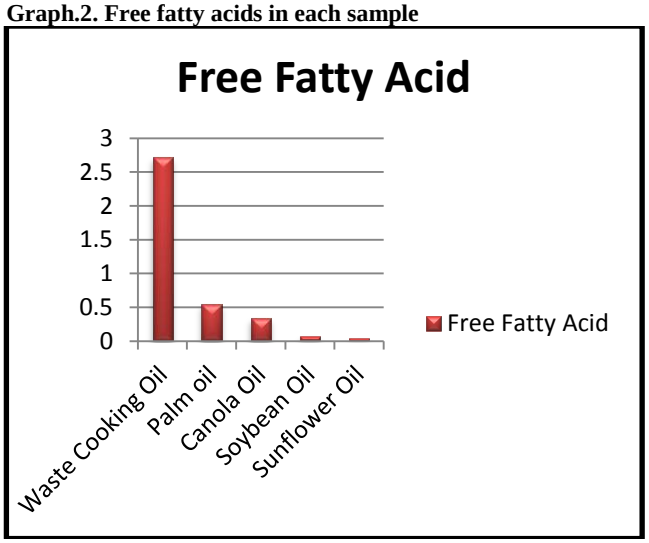
Graph.1.Moisture contents of different feedstock.



Graph.3. Kinematic Viscosity of all samples



Graph.2. Free fatty acids in each sample



Graph.4. Saponification Value of each sample

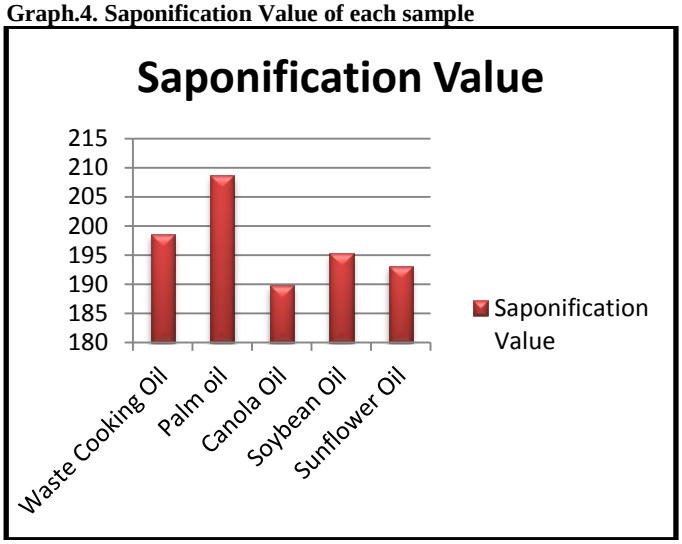
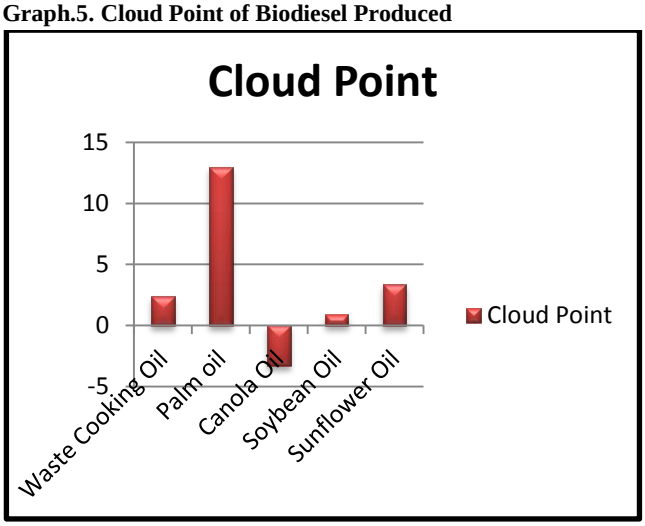


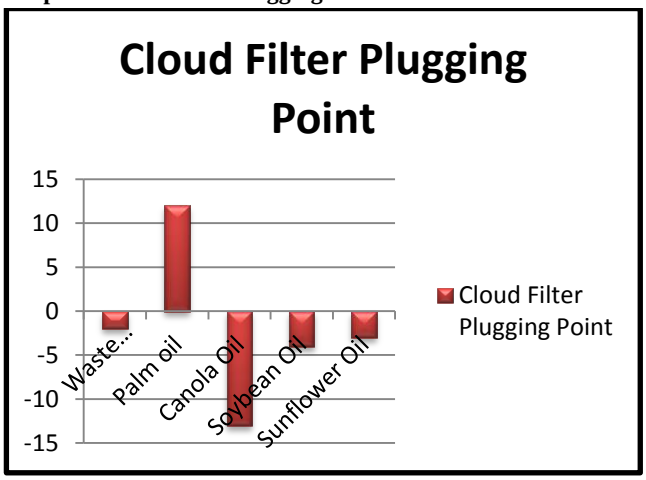
Table 5. Properties of Biodiesel

Properties	Waste Cooking Oil	Palm Oil	Canola Oil	Soybean Oil	Sunflower Oil
Cloud Point	2.4°C	13.0 °C	-3.3 °C	0.9 °C	3.4 °C
Cold Filter Plugging	-2°C	12 °C	-13 °C	-4 °C	-3 °C
Kinematic Viscosity	4.332 mm^2/s	4.570 mm^2/s	4.439 mm^2/s	4.039 mm^2/s	4.439 mm^2/s
Carbon residue	0.040 (% mass)	0.010 (% mass)	0.030 (% mass)	0.038 (% mass)	0.035 (% mass)
Free and total glycerin	0.012 (mass %)	0.003(mass %)	0.006(mass %)	0.012(mass %)	0.007(mass %)
Flash point	>160°C	>160 °C	>160 °C	>160 °C	>160 °C

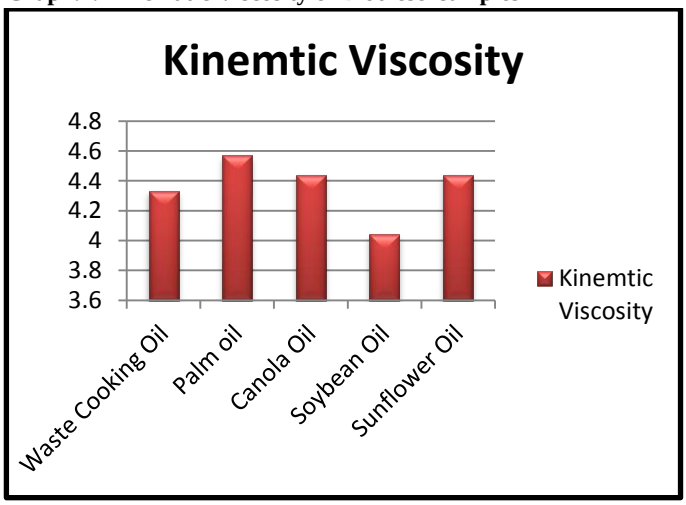
Graph.5. Cloud Point of Biodiesel Produced



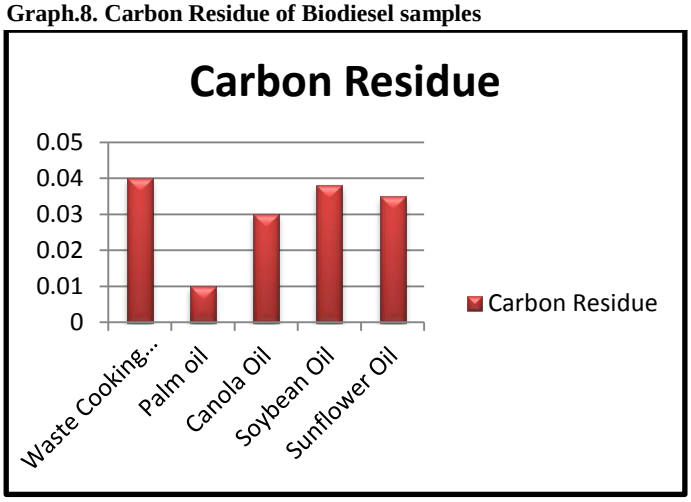
Graph.6. Cloud Filter Plugging Point of Biodiesel Produced



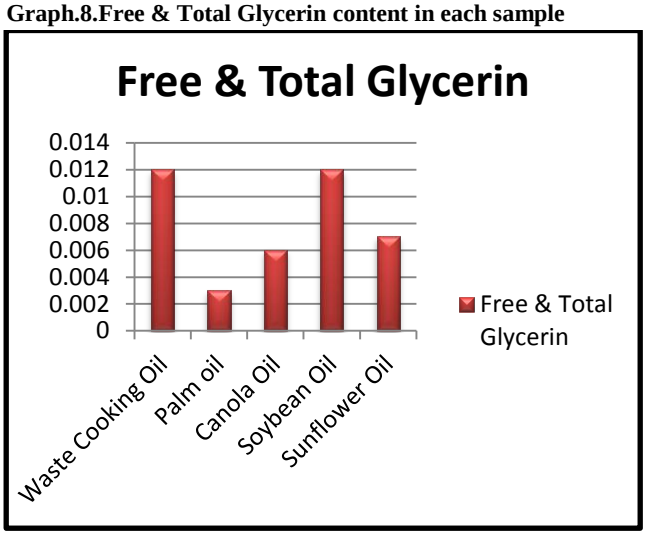
Graph.7. Kinematic Viscosity of Biodiesel samples



Graph.8. Carbon Residue of Biodiesel samples



Graph.8.Free & Total Glycerin content in each sample



VI. CONCLUSION

The results show that Biodiesel has a great potential to be used as a renewable fuel. It should be blended with diesel up to 20% and used as normal fuel without doing any changes in the engine. This research proves that different feedstock collected from different sources had varying properties. A detailed analysis and study by experimentation on lab scale has shown the appropriate properties that should be present in the sample as well as the properties that should be of biodiesel as per ASTM International D675. The results are positive and in line to a greener future. However, due to lack of resources some advanced tests could not be performed and the results cannot be said to be optimum. There is still a lot of scope of research on the topic.

VII. REFERENCES

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