UGC-SAP SPONSORED NATIONAL WORKSHOP ON FRONTIERS OF NMR SPECTROSCOPY AND MRI

Training Program Delivered By Experts

25-29, SEPTEMBER, 2017

Department of Chemistry, Center of Excellence,
Saurashtra University, Rajkot

Fee Structure *

Industries	Faculties (Govt. and Grant in Aid)	Faculties (Management Appointees)	Student
₹ 3000	₹ 3000	₹ 1500	₹ 1000

* Including Lunch

* Excluding Dinner, Boarding and Accommodation

* Fees should be paid through DD in favour of "chem.dept.sap"

* Last date of registration is 20/09/2017

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Center of Excellence, NFDD Complex, Department of Chemistry, Saurashtra University, Rajkot

UGC – SAP SPONSORED NATIONAL WORKSHOP ON FRONTIERS OF NMR SPECTROSCOPY AND MRI

25th September 2017

9:00 - 9:30 INAUGURATION FUNCTION

Lecture 1	09:30-10:15	Principles of NMR Spectroscopy	N. Suryaprakash
Lecture 2	10:15-11:00	NMR Interaction Parameters	N. Suryaprakash
	11:00-11:30	Tea	
Lecture 3	11:30-12:15	Analysis of ^{1}H Spectra : Representative examples	N. Suryaprakash
Lecture 4	12:15-13:00	Decoupling and NOE	N. Suryaprakash
	13:00-14:30	Lunch	
Lecture 5	14:30-15:15	Multinuclear NMR and their Analysis	N. Suryaprakash
	15:15-15:45	Tea	
Lecture 6	15:45-16:30	T1/T2: Mechanisms & Measurements	N. Suryaprakash

26th September 2017

Lecture 7	09:30-10:15	Multiple Quantum NMR	N. Suryaprakash
Lecture 8	10:15-11:00	Polarization Transfer Techniques	N. Suryaprakash
	11:00-11:30	Tea	
Lecture 9	11:30-12:15	2D NMR Techniques	N. Suryaprakash
Lecture 10	12:15-13:00	Analysis of 2D Spectra, COSY, TOCSY, HSQC, etc. with representative examples	N. Suryaprakash
	13:00-14:30	Lunch	
Lecture 11	14:30-15:15	Chemical Applications of NMR: Study of Hydrogen Bonding	N. Suryaprakash
	15:15-15:45	Tea	
Lecture 12	15:45-16:30	Chemical Applications of NMR : Chiral Analysis	N. Suryaprakash

27th September 2017

Lecture 13	09:30-10:15	Solid State NMR : General Concepts, MAS and CP	K.V. Ramanathan
Lecture 14	10:15-11:00	2D Techniques in Solid State	K.V. Ramanathan
	11:00-11:30	Tea	
Lecture 15	11:30-12:15	Applications of Solid State NMR	K.V. Ramanathan
Lecture 16	12:15-13:00	NMR based Metabolomics	H.S. Atreya
	13:00-14:30	Lunch	
Lecture 17	14:30-15:15	3D NMR Techniques	H.S. Atreya
	15:15-15:45	Tea	
Lecture 18	15:45-16:30	Isotope Labelling Techniques	H.S. Atreya

Note: Venue from 26th September will be, Shree M & N Virani Science College Rajkot.

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28th September 2017

Lecture 19	09:30-10:15	NMR In Biology - I	H.S. Atreya
Lecture 20	10:15-11:00	NMR in Biology - II	H.S. Atreya
	11:00-11:30	Tea	
Lecture 21	11:30-12:15	Heteronuclear 2D of Biomolecules	H.S. Atreya
Lecture 22	12:15-13:00	Fast NMR Methods	H.S. Atreya
	13:00-14:30	Lunch	
Lecture 23	14:30-15:15	3D NMR and Protein Structure Determination-I	RV Hosur
	15:15-15:45	Tea	
Lecture 24	15:45-16:30	3D NMR and Protein Structure Determination-II	R.V. Hosur

29th September 2017

Lecture 25	09:30-10:15	Nucleic Acids NMR -I	R.V. Hosur
Lecture 26	10:15-11:00	Nucleic Acids NMR -II	R.V. Hosur
	11:00-11:30	Tea	
Lecture 27	11:30-12:15	Basics of Magnetic Resonance Imaging	N.R. Jagannathan
Lecture 28	12:15-13:00	Applications of MRI, including functional MRI	N.R. Jagannathan
	13:00-14:30	Lunch	
Lecture 29	14:30-15:15	In-vivo MR Spectroscopy in clinical research	N.R. Jagannathan
	15:15-16:15	Tea followed by valedictory	

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Eco-friendly process for preparation of biodiesel from WFO over MTSA-Si catalyst: An innovative approach for the utilization of side product

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ABSTRACT

Present work aimed for the synthesis of a promising MTSA-Si catalyst and its application for biodiesel preparation using WFO. It has been illustrated from the experimental results, the most favorable reaction conditions for the biodiesel preparation using WFO are (i) 1:10 oil to methanol molar ratio, (ii) 5% MTSA-Si catalyst *(w/w)*, (iii) 130 °C reaction temperature and (iv) 10 h reaction time, for the 98.22% yield of biodiesel. The side product raw glycerin was further transformed into the triglycerides over MTSA-Si catalyzed lauric acid esterification. The fuel properties of biodiesel were estimated and correlated fuel standards.

Introduction

Currently, alternative energy research community across the world is insisting for an exploration of alternative energy resources in order to minimize consumption of the traditional energy resources by virtue of their everlasting depletion and growing destructive concussion on the climate [1]. The manufacturing of second generation biofuel from non edible oils likes, Jatropha curcas, Sterculia foetida, Ceiba pentandra and Cerbera manghas, as well as waste frying oil has been become the key of energy insufficiency to counter any reduction in the supply of edible oil resources to the food manufactory [2–4]. Biodiesel is being produced from the reaction of vegetable oil or animal fats with a shorter chain alcohol like methanol or ethanol in presence of a relevant catalyst. The global energy insistence is increasing day-to-day, while the repertory of conventional fuels such as coal and petroleum are reducing constantly. Besides, the consumption of conventional fuels motives the global warming by raising the effects of greenhouse gases notably. Biodiesel is a non-toxic, biodegradable and green alternative by virtue of its lower emission figurations. Contradictory to these dominance, the most significant disadvantage of biodiesel is its higher cost than conventional fuels [5,6]. Such alternative fuel has received considerable attention due to its being produced from non-conventional sources and it potentially lower down the climatic impact in association to conventional diesel fuel [7]. Biodiesel synthesis is mainly executed by the transesterification of oils over homogeneous, heterogeneous and enzymatic catalysts [8]. The currently well established manufacturing facilities for biodiesel synthesis are mainly based on homogeneous base catalysis [9]. The noncorrosive, eco-friendly and reusable nature of heterogeneous acid and alkali [10] catalysts makes them more suitable for the biodiesel synthesis with respect to homogeneous acid catalysts. However, they are associated with some limitations for their commercial scale production likes, (i) complex synthesis process and (ii) difficulties in handling in application to commercial scale plants [11]. The booming production of WFO from domiciliary as well as industrial sectors is a maturing scrape globally by virtue of its oxidation and hydrogenation characteristics. Waste frying oil commonly abundant of free fatty acids, polymeric material and disintegration products, besides triglyceride, diglycerides and monoglycerides. This residue is habitually discharged into the water, arising the problems for drainage water treatment units and energy mislay, or is intersperse into the food cycle through animal feeds, hence, becoming a potential cause of human health problems [12].

There are considerable applications of waste frying oil, such as in the production of soap, in production of energy through anaerobic digestion, in thermal cracking [13], recently, in the synthesis of biodiesel fuel [14], and much more. Waste frying oil (WFO) is the provocative alternative resource for the biodiesel synthesis due to its inherent in shortening expenses and environmental percussion of biodiesel when correlated with traditional feedstocks. Therefore, waste frying oil as an adequate raw material for biodiesel preparation has attracted significant attention recently due to its reasonable price and smooth availability [15]. The physicochemical properties of WFO are tabularized in Table 1.

In recent times, the usage of solid acid catalysts were describe in literature as a most favorable key for biodiesel production, because it could potentially eliminate some reaction steps like complex isola-

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1226-086/

Table 1
Physicochemical properties of WFO [16–19].

Properties	Test standards	Value
Physical state	–	Liquid
Color	–	Deep oily
Calorific index (MJ/kg)	IS:1448:(P:33):1991	38.314
Peroxide index (O_2/kg)	AOCSCD8-53	10.00–25.25
Specific gravity (g/cm^3)	ASTM D854-10	0.92
Density @ 20 °C (kg/m^3)	ASTM D1298, ASTM D4052-91, IS:1448:(P:32):1992	897.0
Acid index (mg KOH/g)	ASTM D664	3.0
Iodine index (g I_2/100 g)	AOCS CD1-25 1993	102.3
Kinematic viscosity @ 40 °C (mm^2/s)	ASTM D 445, IS:1448:(P:25):1976	54.53
Saponification index (mg KOH/g)	AOCS CD3 2003	192
Average molecular weight of FFA (g/mol)	–	275.5
Mean molecular weight (g/mol)	–	864.5
Flash point (°C)	ASTM D92-94, IS:1448:(P:21):1992	Not less than 250
Pour point (°C)	ASTM D 97	−9.7
Cloud point (°C)	ASTM D 2500, EN 23015	−8.2
Fatty acid compositions	ASTM D1585-96	19.7%

tion, corrosion issue, toxicity and environmental contemplation [20]. Magnificently, a solid acid catalyst used for biodiesel production should offer a higher acidic density of active sites, admirable thermal stability, larger pore size and pore volume, lower cost and hydrophobic exterior [21]. The heterogeneous acidic catalysts have been reported and examined for biodiesel synthesis are the inorganic material based such as zeolite [22,23], niobic acid [24] and sulfated zirconia [25]. However, these catalysts offer smaller pore size and pore volume, which restrict the penetration of the longer chain fatty acid molecules, and hence they are unsuitable for the synthesis of biodiesel. Whereas, the strong acidic ion-exchange resins, i.e., Amberlyst-15 and Nafion-NR50 [26], offer a large fraction of sulfonic acid groups but their application is very limited by virtue of their higher preparation cost and lower thermal stability. While, solid acid catalysts prepared from polystyrene [27] and polyvinyl alcohol crosslinked with sulfosuccinic acid [28] also offer remarkable activity for the esterification of fatty acids using methanol regarding biodiesel production. But leaching of active site form catalysts into the reaction system is a major and uncleared concern. Hence, it is adorable to prepare solid acid catalysts with a higher thermal stability and higher density of active sites.

Currently, the considerable sense behind uncommercialization of biodiesel is its higher preparation expense than conventional diesel [29,30]. The higher preparation expense of biodiesel is principally in view of its being produced from refined oils with low levels of FFA contents. A potential approach for lessening down the biodiesel expense is to utilize lower expense oils composed of higher concentration of FFA, recycled or waste oil and side products of edible oils refineries [31,32]. The crude glycerol- a side stream of biodiesel synthesis is also spoiled with the unspent methanol, unspent glycerides, moisture and catalyst, that compulsorily be separated out to acquire its commercial assessment. As per the environmental protection Act, the raw glycerol must be dumping out in a shorter period of time or to be sold at minimum price, in addition the cost of dumping is also to much expensive [33]. Very insufficient experiments have been carried out to transform the raw glycerin to effective products [34].

In the view of reported studies, we have observed that melamine is a cheaper and commercially feasible chemical, its offers three primary amino ($–NH_2$) groups; hence, it could easily react with sulfurochloridic acid to yield melamine trisulfonic acid (MTSA) at ambient conditions. Besides, synthesized MTSA was sensibly added with silica gel to reinforce the MTSA-Si via formation of inter molecular hydrogen bonding with silica gel. Therefore, an attempt has been made to examine transestrification of waste frying oil to biodiesel over MTSA-Si catalyst. Besides, biodiesel based crude glycerol was also transformed into the TGLA via esterification of lauric acid using MTSA-Si catalyst. Usually, the activity of solid acid catalyst does not influence by the presence of higher levels of FFA contents. Hence, this advance may be helpful to synthesize biodiesel from waste oil based stocks with lower cost as well as feedstocks with higher levels of FFA contents. Generally, solid acid catalyst could show remarkable catalytic activity in esterification and transesterification of oils concurrently. Over and above, heterogeneous nature of MTSA-Si catalyst, it could be simply isolated from the reaction mass and reused for five successful cycles after smooth filtration and reactivation. It has been found from the experimental results, the optimum reaction conditions for the biodiesel preparation via transesterification of WFO are (i) 1:10 oil to methanol molar ratio, (ii) 5% MTSA-Si catalyst *(w/w)*, (iii) 130 °C reaction temperature and (iv) 10 h reaction time for the 98.22% yield of biodiesel.

Materials and method

Materials

Waste frying oil (single time used sunflower oil) was obtained as an open-handed gift from Jay Sardar Restaurant, Rajkot, Gujarat, India. Lauric acid (99% purity) and anhydrous dichloro methane (99.8% purity) were supplied by Sterling Lab care Pvt. Ltd, Surat, Gujarat, India. Methanol (AR grade) was purchased from Advent Chembio Pvt. Ltd. Sulfurochloridic acid, melamine and silica gel (99% purity) were supplied by Aashka Scientific Co., Surat, Gujarat, India. Methanol less crude glycerol was produced using current biodiesel synthesis procedure.

Analytical instrumental methods

The FT-IR analyses of fresh and regenerated MTSA-Si have been carried out on a (Model, Shimadzu FIIR-8400S) FT-IR spectrophotometer. However, the FT-IR analysis of biodiesel and TGLA were carried out on a (Model- RZX Perkin-Elmer) FT-IR spectrophotometer. ^{1}H NMR and ^{13}C NMR analysis were carried out on a (Model, Bruker Biospin, Switzerland 400 MHz liquid state NMR spectrometer) FT-NMR spectrometer. Large angle X-ray diffraction (XRD, Rigaku, Miniflex) study was carried out by using X-ray diffractometer. The surface area of the MTSA-Si was measured on a (Micromeritics ASAP 2020) porosimeter. The thermal stability of MTSA-Si was recognized by Thermogravimetric analysis (Model: Perkin Elmer TGA-7, IIT madras). Surface and structural morphologies of the fresh and regenerated MTSA-Si catalysts were predicted by scanning electron microscope (SEM, Model, Hitachi S3400N). The total acidity of the MTSA-Si was measured by neutralization titration. The biodiesel (%) yield was estimated by gas chromatography analysis. The SUPELCO C_8-C_{24} component FAME mixture was employed as a standard for recognition and determination of the peaks retrieved in the WFO based biodiesel in gas chromatography analysis (YL 6500GC).

Experimental

Preparation of MTSA-Si

A 250 mL three neck suction flask (FBF) was charged with sulfurochloridic acid (5 mL, 75.2 mmol). The melamine powder (3.16 g, 25.07 mmol) was charged in little fractions over a time slot of 45 min at ambient conditions under nitrogen atmosphere (g) and constant

stirring. As a result, the hydrochloric acid (g) was elaborated from the reaction flask immediately. On the completion of addition of melamine, the reaction mixture was rattled for 45 min and the remaining side product hydrochloric acid (g) was removed by vacuum. The mixture was triturated with dichloro methane (20 mL) and then filtered. The powdery residue was again treated with dichloro methane (20 mL) and dried under vacuum oven. The melamine trisulfonic acid (MTSA, 8.2 g, 90%) was obtained as an off-white powder. Then after, 15.2 g silica gel (200–400 mesh) was mixed with off-white MTSA and stirred for 30 min for the formation of an intermolecular hydrogen bond to support the MTSA-Si [35]. At last, a dried and grayish powdery material composed of MTSA-Si was obtained (23.1 g). The scheme for synthesis of MTSA-Si is given in Fig. 1.

Preparation of biodiesel

All the transesterification reactions were executed in a laboratory autoclave (Amar, close SS reactor), assembled with pressure indicator, temperature controller, internal cooling system, online sampling valve, automatic and manually chilling systems. The 289 g of WFO was transferred into the reactor of autoclave and preheated at 55 °C in order to reduce the viscosity of WFO, hence it could be homogeneously stirred in an autoclave. The MTSA-Si-methanol mixture was carefully transferred in an autoclave and stirred at 700 rpm with the interest to restraint the mass transfer constraint. The biodiesel synthesis experiments have been conducted at different oil: methanol molar ratio (1:6, 1:7, 1:8, 1:9, 1:10 and 1:11), reaction temperature (100, 110, 120 and 130 °C), catalyst (MTSA-Si) loading (3, 4, 5 and 6% *w/w*) and reaction time (4, 5, 6, 7, 8, 9, 10 and 11 h). All transesterification reactions were performed at endogenous pressure till the achievement of the optimum conversions. The reaction scheme for biodiesel synthesis is illustrated in Fig. 2.

On the completion of the transesterification reaction, the MTSA-Si was isolated from the reaction slurry by simple filtration. The unspent methanol was also completely removed by distillation and the mixture was thoroughly transferred to a separating funnel for a gravitational settling of biodiesel as well as glycerol, as demonstrated in Fig. S1.

From Fig. S1, it has been clearly observed that due to difference in the densities of biodiesel and glycerol, the biodiesel comes out at top layer and glycerin as well as traces of MTSA-Si catalyst settled

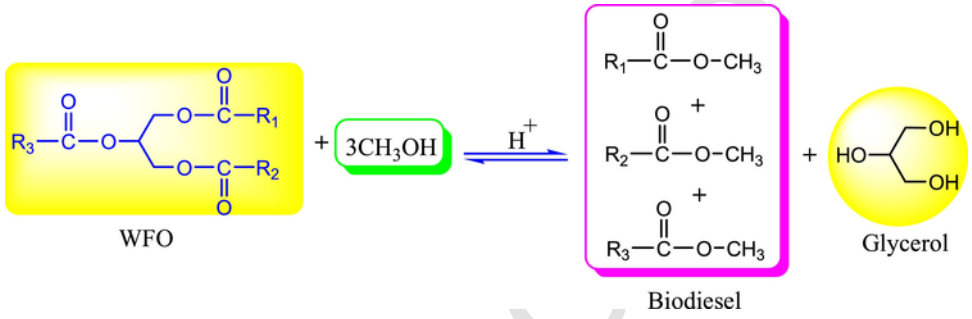

Fig. 1. Transesterification of WFO to biodiesel.

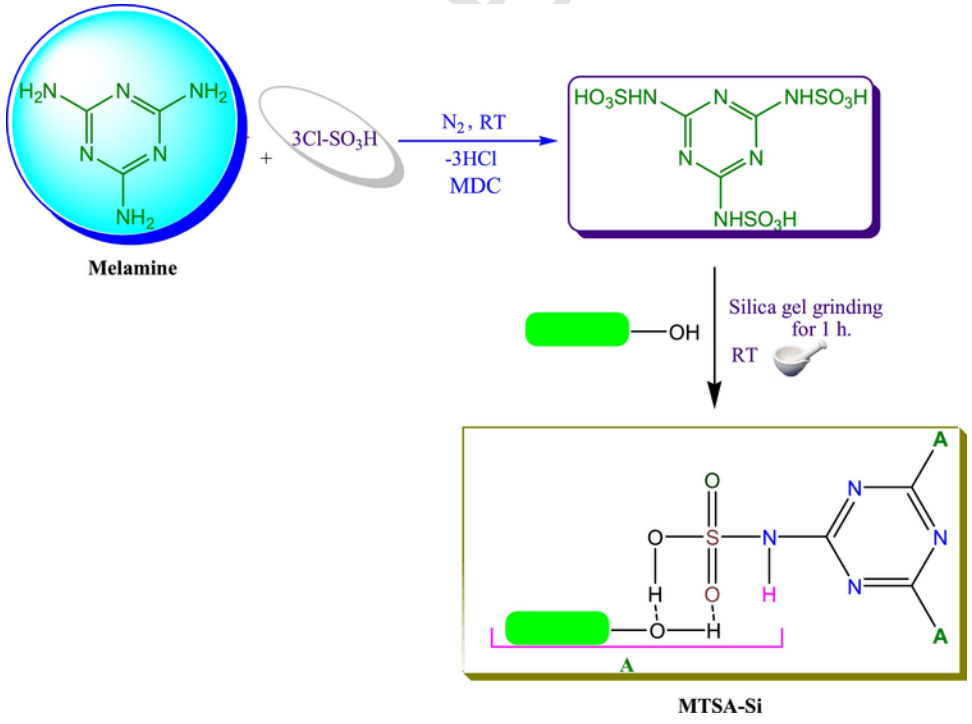

Fig. 2. Reaction scheme for the synthesis of MTSA-Si.

down at the bottom layer. The biodiesel layer was refined by using demineralised water and then treated with anhydrous Na_2SO_4 in order to make it free from moisture. Therefore, 100 mL of biodiesel was mixed with 1.0 g of anhydrous Na_2SO_4 and stirred for 30 min. Then after, the mixture was allowed for gravitational settling (24 h). The decanted moisture free biodiesel was isolated with the service of a vacuum pump for the expulsion of solid impurities traces. The resultant biodiesel has been stored in a glass bottles for further analysis and applications.

Esterification of raw glycerol to TGLA

Esterification is an equilibrium restrained reaction. In pursuance to reduce the equilibrium restrain, commonly an esterification of lauric acid is executed by taking alcohol in excess to enhance the forward reaction [36]. Besides, the expulsion of water during esterification is significantly required, as it is being produced as a side stream and will act as a poison for the catalyst as well as can also promote the reverse reaction. Hence, it could unnecessarily increase the reaction time for the optimal yield of desired esters. The esterification is an equilibrium constrained reaction. The required conversion of desired esters could be attained with the isolation of either water or esters. In order to rectify this problem of present study, an anhydrous sodium sulphate (0.1 mol) was charged in a reactor along with glycerol and lauric acid with a view to encounter water makeup during esterification.

Therefore, in the present work, a 100 mL three neck flat bottom flask was charged with a mixture of lauric acid (3 mol), crude glycerol (1 mol), anhydrous sodium sulphate (0.1 mol) and MTSA-Si (0.8 g) catalyst. The mixture was stirred at 100 °C for the 7 h. Finally, the reaction mixture was cooled down to an ambient temperature and MTSA-Si catalyst was filtered off from the reaction media. The filtrate was poured into a cold water to isolate the resultant triglycerides. Due to the density difference, triglyceride of lauric acid comes out at upper layer in water. In addition, the unspent lauric acid is further coming out at upper layer. Therefore, it was separated from the TGLA and 92.28% yield was reported. The reaction scheme for the preparation of TGLA is demonstrated in Fig. 3.

Biodiesel (%) yield estimation

The waste frying oil based biodiesel samples were preserved under N_2 (g) atmosphere at 4 °C in a glass sample vials for GC analysis. The heptadecanoate was selected as an internal standard for quantifiable determination. On the determination of FAMEs of the biodiesel samples, the peak areas were used to estimate the FAME content of each and every sample by Eqs. (1) and (2) [37].

$$\text{Conversion (C)} = \left[\frac{\sum A - A_{IS}}{A_{IS}}\right] \times \left[\frac{C_{IS} \times V_{IS}}{m}\right] \times [100] \quad (1)$$

where, $\sum A$ is the total peaks area, A_{IS} is the internal standard (methyl heptadecanoate) peak area, C_{IS} is the concentration of the compositional standard solution (mg/mL), V_{IS} is the volume of the internal standard solution used (mL) and m is the mass of the biodiesel sample (mg).

$$\text{Yield (\%)} = \left[\frac{M_{Biodiesel} \times C}{M_{Oil}}\right] \times [100] \quad (2)$$

where $M_{Biodiesel}$ is the mass of pure methyl esters obtained, M_{Oil} is the mass of waste frying oil used and C is the fatty acid methyl ester concentration determined as described in above Eq. (1). The gas chromatogram of WFO based biodiesel is given in Fig. S2. It has been recognized from the gas chromatograph of waste frying oil based biodiesel, the biodiesel mixture is composed of methyl esters of corresponding fatty acid likes, methyl oleate, methyl linoleate, methyl lenolenate and methyl behenate.

Results and discussion

Transesterification of WFO to biodiesel

The synthesis of biodiesel from the transesterication reaction using a suitable catalyst is a highly convenient process. The transesterication reaction for biodiesel synthesis can be carried using different methods and is widely described as the incorporation of shorter chain alcohol to lipids in the presence of acid or base catalyst [38]. Maneechakr et al. have synthesized biodiesel from waste cooking oil over a novel sulfonic modified carbon spheres catalyst under ultrasonic transesterification. From the experimental results, they found 90.8% biodiesel yield with 11.5 wt% catalyst loading, 8.8 min reaction time and 117 °C reaction temperature under ultrasonic conditions [39]. Therefore, in this study, the biodiesel preparation reactions were performed at diversified oil: methanol molar ratio (1:6, 1:7, 1:8, 1:9, 1:10 and 1:11), reaction temperature (100, 110, 120 and 130 °C), MTSA-Si loading (3, 4, 5 and 6% *w/w*) and reaction time (4, 5, 6, 7, 8, 9, 10 and 11 h). The results of (%) yield of biodiesel with varying reaction parameters are summarized in Table 2.

Effect of oil to methanol molar ratio

With a view to study the influence of oil to methanol molar ratio, all transesterification experiments have been carried out at different

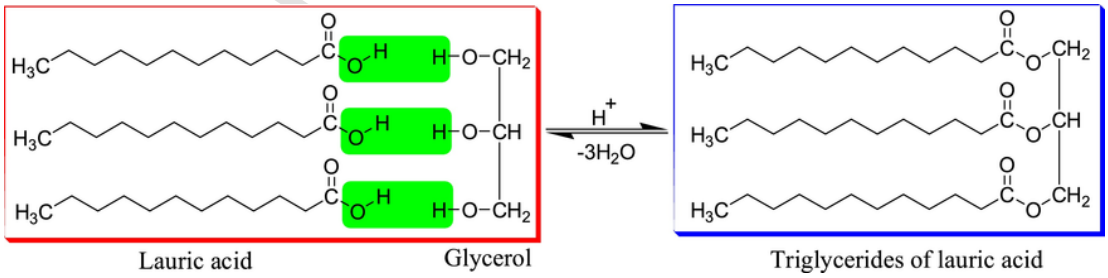

Fig. 3. Reaction scheme for the esterification of crude glycerol to TGLA.

Table 2
Result of (%) yield of biodiesel with varying reaction parameters.

Entry	O:M molar ratio	MTSA-Si loading (% *w/w*)	Reaction temp. (°C)	Reaction time (h)	Biodiesel yield[a] (%)
1	1:6	3	100	4	22.28 ± 0.99
2	1:7	3	100	4	31.24 ± 0.91
3	1:8	3	100	4	45.29 ± 1.19
4	1:9	3	100	4	61.21 ± 1.25
5	1:10	3	100	4	74.33 ± 0.66
6	1:11	3	100	4	69.44 ± 0.91
7	1:10	4	100	4	79.53 ± 0.98
8	1:10	5	100	4	83.48 ± 0.78
9	1:10	6	100	4	80.11 ± 1.33
10	1:10	5	110	4	83.50 ± 0.79
11	1:10	5	120	4	85.98 ± 0.99
12	1:10	5	130	4	87.11 ± 1.29
13	1:10	5	130	5	89.10 ± 1.11
14	1:10	5	130	6	91.58 ± 0.90
15	1:10	5	130	7	93.25 ± 0.97
16	1:10	5	130	8	95.59 ± 1.33
17	1:10	5	130	9	96.68 ± 1.39
18	1:10	5	130	10	98.22 ± 0.88
19	1:10	5	130	11	98.22 ± 0.69

[a] (n = 3) All experiments have been carried out in triplicates.

oil to methanol molar ratio (1:6, 1:7, 1:8, 1:9, 1:10 and 1:11). From Table 2, it has been realized that as methanol to oil molar ratio increases, it directly influence the biodiesel yield (%). The (%) yield of biodiesel is increased with the increasing in the methanol to oil molar ratio. The maximum (%) yield of biodiesel was noticed with 1:10 oil to methanol molar ratio. The oil to methanol molar ratio down to 1:10 directly enhances the reversible reaction. Therefore, the main sense behind decrement in the (%) yield of biodiesel down to 1:10 oil to methanol molar ratio is the reversible nature of the transesterification reaction. It has also been noticed that the decrement in the % yield of biodiesel beyond the 1:10 oil to methanol molar ratio. This may be associated with the polar feature of catalyst and methyl alcohol. Therefore, as the methanol to oil molar ratio increases, the polarity of the reaction is increases gradually. The reaction mechanism of transesterification clearly recommends that the protonation of oil takes place first. However, the polarity of the reaction is increases as the concentration of methyl alcohol increases. Therefore, instead of oil phase, the MTSA-Si directly moves to the methyl alcohol phase. Hence, interactions of methanol towards catalyst phase become quite stronger than interactions of methanol towards oil phase. Therefore, the diminishment in the (%) yield of biodiesel was observed beyond the 1:10 oil to methanol molar ratio. The graphical representation of the influence of oil to methanol molar ratio on the (%) yield of biodiesel has been illustrated in Fig. 4.

Effect of reaction time (h)

In order to study the influence of reaction time (h) on the (%) yield of biodiesel, all the transesterification reactions of oil were also studied using different length reaction time comprising 4, 5, 6, 7, 8, 9, 10 and 11 h. From, the experimental results, it has been perceived that 1:10 oil to methanol molar ratio shows maximum yield of biodiesel (74.33%). Therefore, 1:10 oil to methanol molar ratio was selected as an optimum ratio to study biodiesel synthesis using different reaction times. From the experimental result, it can be concluded that, in the case of 4 h reaction time, the highest (%) yield of biodiesel perceived was 87.11%. Whereas, in the case of 5 h reaction time, the maximum (%) yield of biodiesel sensed was 89.10%. In the case of 6 h reaction time, the maximum (%) yield of biodiesel recognized was 91.58%. In the case of 7 h reaction time, the highest (%) yield of biodiesel observed was 93.25%. In the case of 8 h reaction time, the highest (%) yield of biodiesel sensed was 95.59%. Whereas,

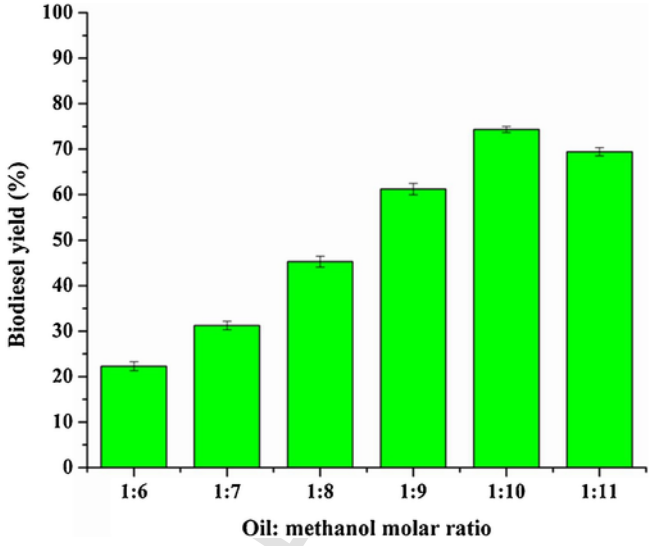

Fig. 4. Influence of oil to methanol molar ratio on the (%) yield of biodiesel.

in the case of 9 h reaction time, the maximum (%) yield of biodiesel recognized was 96.68%. In the case of 10 h reaction time, the highest (%) yield of biodiesel remarked was 98.22%. However, in the case of 11 h reaction time, the highest (%) yield of biodiesel observed was 98.22%. Therefore, the reaction time beyond 10 h does not show any remarkable enhancement in the (%) yield of biodiesel. The similar (%) yields of biodiesel were obtained using 10 h and 11 h reaction times at identical operation conditions. The graphical representation of the influence of reaction time (h) on the (%) yield of biodiesel has been illustrated in Fig. 5.

Effect of MTSA-Si loading (% w/w)

In order to study the influence of catalyst dosage (% *w/w*) on the transesterification, all experiments have been performed at varying catalyst dosages (3, 4, 5 and 6% *w/w*). From Table 2, it has been realized that as catalyst concentration (% *w/w*) increases, the (%) yield of biodiesel increases. In the case of 3% catalyst dosage *(w/w)*, the (%) yield of biodiesel was observed to be 74.33% at optimum oil to methanol molar ratio. Whereas, in the case of 4% catalyst dosage *(w/*

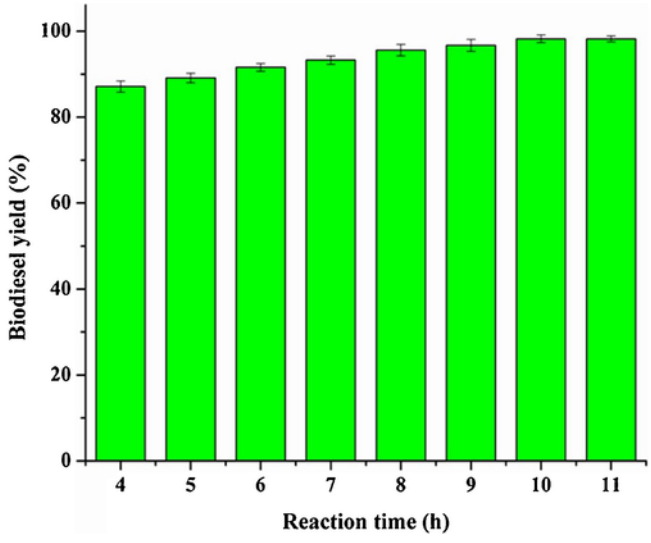

Fig. 5. Influence of reaction time (h) on the (%) yield of biodiesel.

w), the (%) yield of biodiesel was remarked to be 79.53% at optimum oil to methanol molar ratio. In the case of 5% catalyst dosage *(w/w)*, the (%) yield of biodiesel was recognized to be 83.48% at optimum oil to methanol molar ratio. Whereas, in the case of 6% catalyst dosage *(w/w)*, the (%) yield of biodiesel was perceived to be 80.11% at optimum oil to methanol molar ratio. Hence, the catalyst concentration beyond 5% (*w/w*) does not show any remarkable enhancement in the (%) yield of biodiesel. Therefore, it has been realized from the experimental results, as catalyst dosage (% *w/w*) increases, the (%) yield of methyl laureate increases. The influence of MTSA-Si loading (% *w/w*) on (%) yield of the biodiesel has been demonstrated in Fig. 6.

Effect of reaction temperature (°C)

With an intention to study the influence of reaction temperature (°C) on the (%) yield of transesterification reaction, all experiments have been carried out at varying reaction temperatures (100, 110, 120 and 130 °C). From Table 2, it has been realized that as reaction temperature (°C) increases the (%) yield of biodiesel increases. In the case of 100 °C reaction temperature, the (%) yield of biodiesel was found to be 83.48% at optimum oil to methanol molar ratio. Whereas, in the case of 110 °C reaction temperature, the (%) yield of biodiesel was realized to be 83.50% at optimum oil to methanol molar ratio. In the case of 120 °C reaction temperature, the (%) yield of biodiesel was realized to be 85.98% at optimum oil to methanol molar ratio. However, in the case of 130 °C reaction temperature, 5% *(w/w)* MTSA-Si and 10 h reaction time, the (%) yield of biodiesel was realized to be 98.22% at optimum oil to methanol molar ratio. Hence, the reaction temperature beyond 130 °C does not show any remarkable enhancement in the (%) yield of biodiesel. The effect of reaction temperature (°C) on the (%) yield of biodiesel has been given in Fig. 7.

Overall, from experimental results, the optimum reaction conditions within the selected frameworks for the preparation of biodiesel from WFO were found to be, (i) 1:10 oil to methanol molar ratio, (ii) 130 °C reaction temperature, (iii) 10 h reaction time and (iv) 5% *(w/w)* of MTSA-Si catalyst for 98.22% biodiesel yield.

Esterification of raw glycerol to TGLA

Raw glycerol is the large-scale side stream of the biodiesel manufacturing unit. In routine, for every 100 pounds of biodiesel production, proximately 10 pounds of raw glycerol is being produced. The raw glycerol is an uneconomical to refine for its application in food, pharmaceutical and cosmetics industries, biodiesel producers must seek alternative methods for its disposal. [40]. Glycerol is being produced as a side stream as a result of the transesterification of oil along with biodiesel. Hence, the biodiesel manufacturers are staying with a serious problems regarding to dispose of crude glycerol produced from biodiesel production as a side product. On other side, the biodiesel manufacturers are facing a serious trouble regarding the availability of a cheaper feedstock for biodiesel production. Besides, the refining of raw glycerol in the biodiesel production unit is a major and uncleared issue. Hence, it is a new engineering challenge for the developing biodiesel production unit to dispose of the crude glycerol. Therefore, in present work, we made a small attempt to convert the biodiesel derived crude glycerol to triglycerides of lauric acid (TGLA) using MTSA-Si catalyst. It has been found from the results of esterification of raw glycerin, the optimal reaction conditions for the maximum (%) yield of TGLA are, (i) 1:3 glycerol to lauric acid molar ratio, (ii) 2% MTSA-Si catalyst *(w/w)*, (iii) 100 °C reaction temperature and (iv) 7 h reaction time.

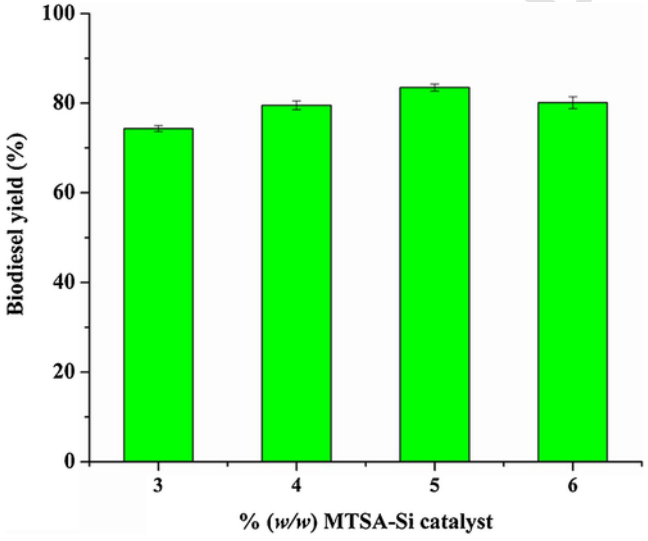

Fig. 6. Influence of % MTSA-Si (*w/w*) on the (%) yield of biodiesel.

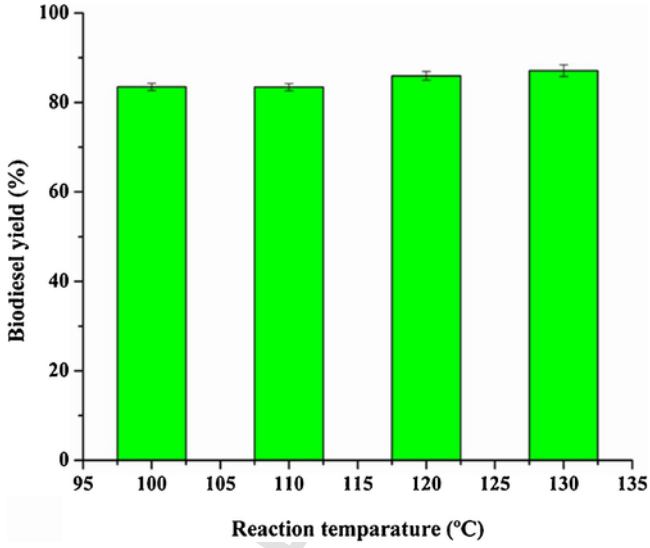

Fig. 7. Influence of reaction temperature (°C) on the (%) yield of biodiesel.

The distillation technique has been employed to isolate the methanol from crude glycerol. The MTSA-Si amount was selected based on the maximum (%) yield of the TGLA and minimum compositions of unspent lauric acid and glycerin in the TGLA. On completion of reaction, the reaction mixture was cooled down to room temperature and MTSA-Si catalyst was filtered off from reaction mixture by vacuum filtration. The filtrate was carefully transferred in to separating funnel containing distilled water. By virtue of the density difference of the TGLA and water, the TGLA comes out at top layer and water settled down at bottom layer. Besides, the unspent lauric acid also comes out at top layer. Hence, it was isolated from the TGLA and 92.28% yield has been reported.

Crude glycerol is readily attainable in the trading market with very lower expenses or almost no expenses. Besides, the separation and refining of crude glycerol is very tedious process and involves several steps for its isolation and purification, hence, it requires higher expenses and multitudinous manpower as well. On other side, the commercial grade lauric acid accessible in the trading market with some higher expenses. But the expense of the lauric acid is earlier protected by glycerol, if glycerol is crude. Because, the refining expenses of crude glycerol is much greater than the expenses of industrial grade lauric acid. The superior advantage affiliated with this

protocol is the production of water as a side stream rather than some toxic products. Hence, this process could offers climatic feasibility as well. Therefore, this process may prove beneficial to the commercial manufacturers of TGLA and biodiesel as well, as TGLA could be an abundant feedstock for the biodiesel manufacturers.

Reaction mechanism for transesterification of WFO

The transesterification reaction is preferably catalyzed by bronsted acid catalysts, like, sulfonic and sulfuric acids based materials and their reaction mechanism is well explained by many researchers [41]. The mechanism of WFO transesterification could be accomplished via below mentioned steps. This step consists of (i) Protonation to one of the terminal carbonyl group by the MTSA-Si catalyst (ii) Nucleophilic attack of the alcohol towards terminal carbonyl group leads to generate a tetrahedral intermediate (iii) Proton migration and breakdown of the intermediate lead to generate one molecule of biodiesel and one molecule of diglycerides. The migrated proton again absorbed by the MTSA-Si catalyst in order to regenerate and reactivate it for the next use. This entire arrangement will replay twice to form three molecules of biodiesel and one molecule of glycerol. The mechanism scheme for the transesterification of waste frying oil is given in Fig. 8.

Reaction mechanism for esterification of raw glycerol

The fischer-speier esterification is a simple esterification reaction carried out by using carboxylic acid with alcohol in the presence of an adequate acid catalyst. The esterification of lauric acid and glycerol completely follows fischer-speier esterification [42]. The mechanism of glycerol and lauric acid esterification could be completed via four steps, in the first step, acid catalyst will protonate the lauric acid molecule via elimination of the proton form MTSA-Si catalyst, in the second step, the nucleophilic attack of oxygen (from glycerol) will take place to form tetrahedral intermediate. In the third step, tautomerization of the tetrahedral intermediate takes place. Finally, in the fourth step, the removal of one molecule of water and deprotonation of tetrahedral intermediate leads to produce the monoglycerides of lauric acid. The eliminated proton again absorbed by the MTSA-Si catalyst in order to regenerate and reactivate it for the next use. This entire arrangement will replay for twice to form TGLA and three moles of water. The mechanism scheme for the esterification of crude glycerol is demonstrated in Fig. 9.

FT-IR analysis of MTSA-Si

The FT-IR spectra of fresh and regenerated MTSA-Si have been demonstrated in Fig. 10.

The FT-IR spectra of fresh and regenerated MTSA-Si catalyst were confirmed with the presence of characteristics bands at 3342.75 cm^{-1} (OH stretching of Si–OH, intermolecular H-bond), 3146.00 cm^{-1} (N–H stretching), 2712.01 cm^{-1} (C–H stretching), 1728.28 cm^{-1} (C═N stretching), 1687.77 cm^{-1} and 1525.74 cm^{-1} (N–H bending), 1400.37 cm^{-1} (S═O stretching), 1361.79 cm^{-1} (S–O stretching), 1170.83 cm^{-1} (SO_2 asymmetric stretching of SO_3H group), 1087.89 cm^{-1} (O–Si–O stretching) and 976.01 cm^{-1} (SO_2 symmetrical stretching) respectively [43]. No remarkable variations were realized in FT-IR spectra of fresh and regenerated catalysts, they affirmed the confinement of skeleton structure on all accounts of the esterification and transesterification.

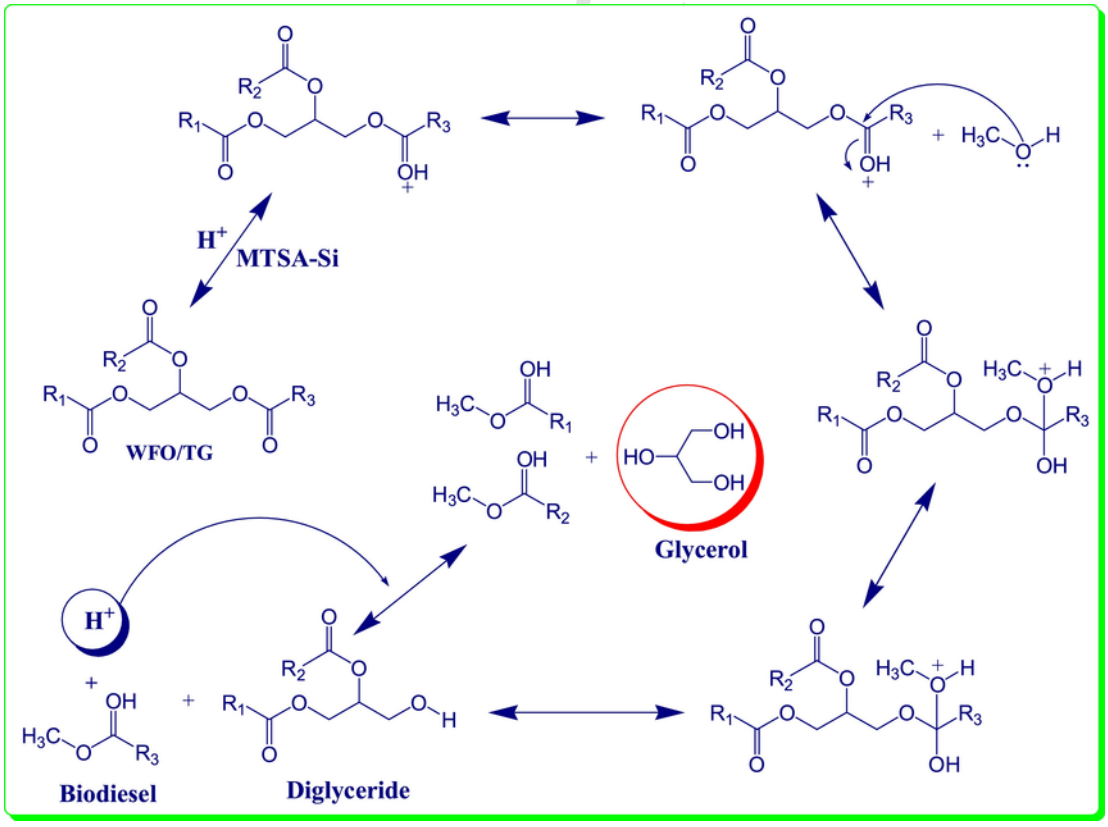

Fig. 8. Mechanism for MTSA-Si catalyzed transesterification of WFO. Where R_1, R_2 and R_3 are carbon chains of different fatty acids.

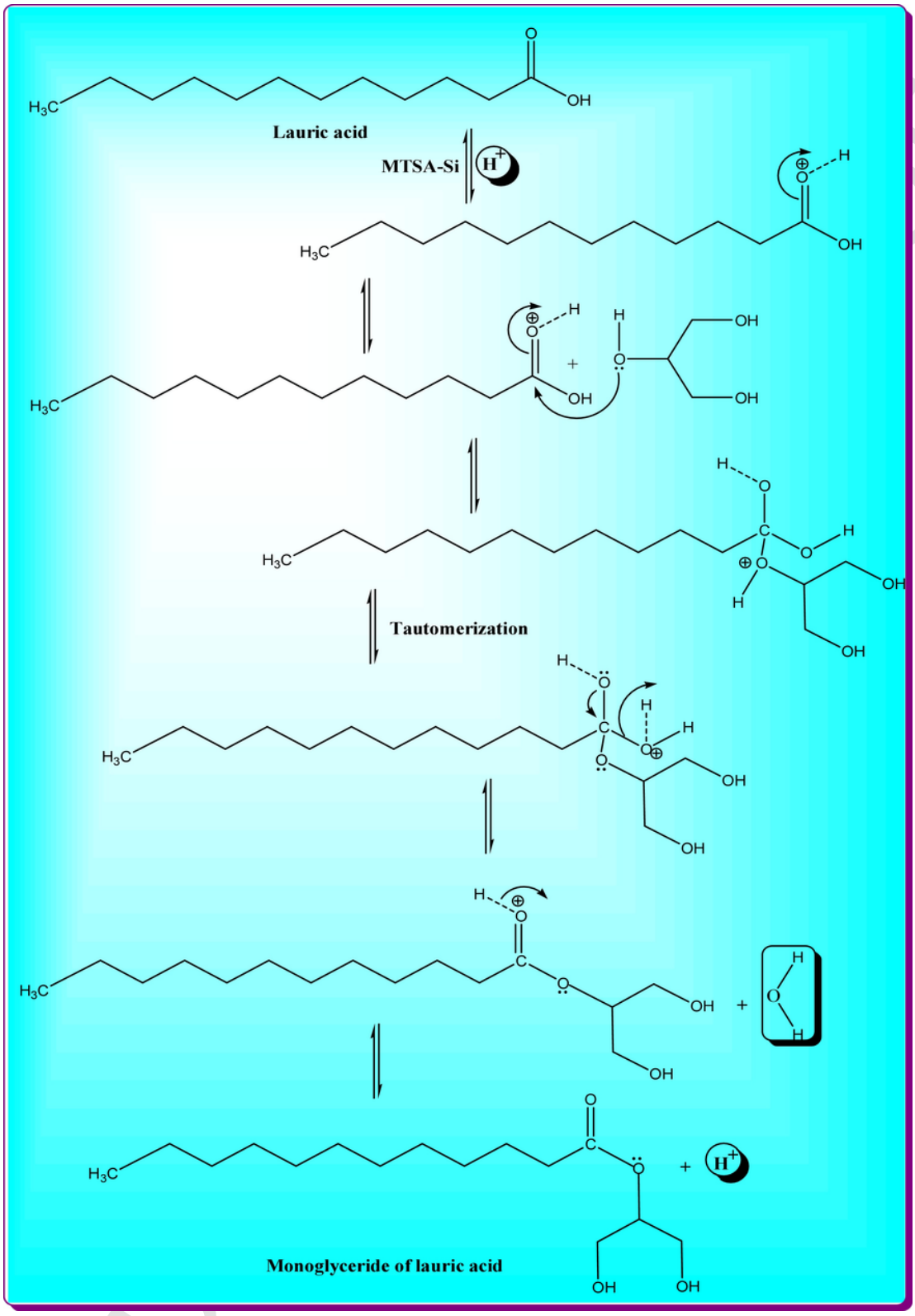

Fig. 9. Mechanism scheme for MTSA-Si catalyzed esterification of crude glycerol to TGLA.

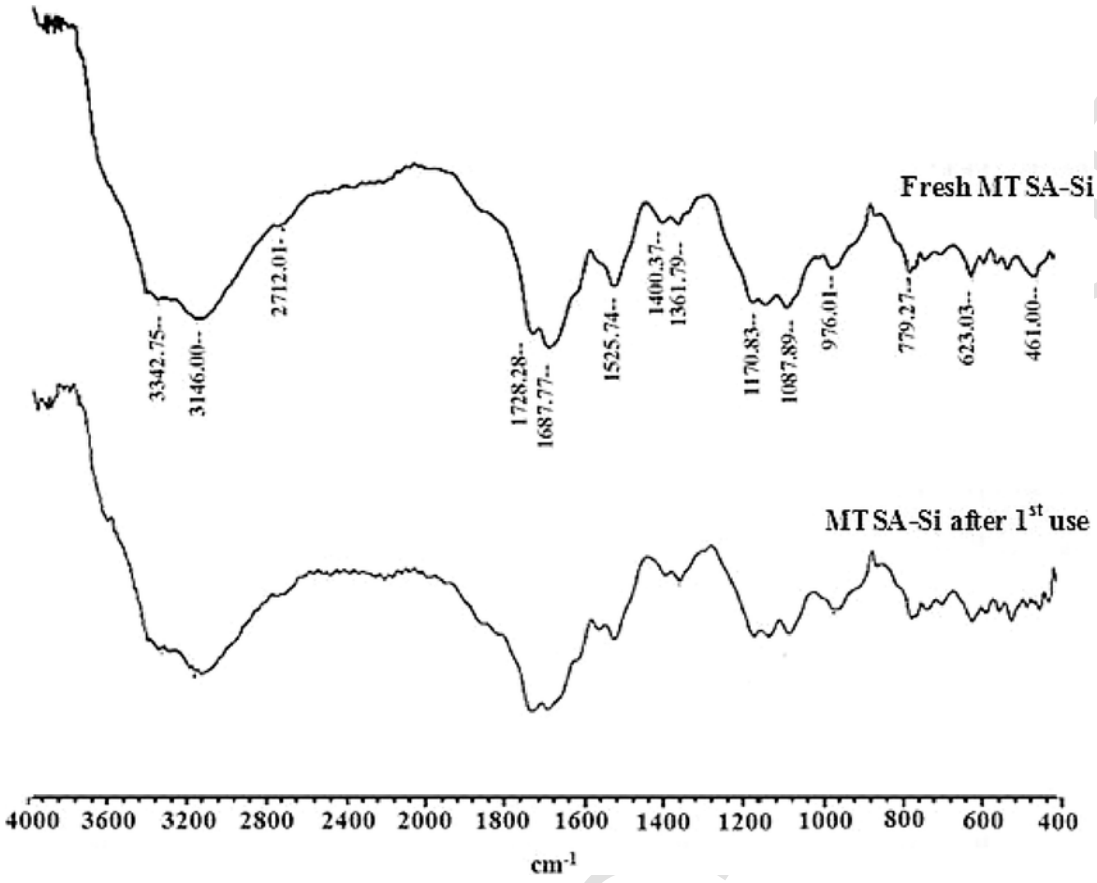

Fig. 10. FT-IR spectra of fresh and regenerated MTSA-Si.

Morphological study of MTSA-Si

The surface morphology of fresh and regenerated MTSA-Si catalysts was recognized using the scanning electron microscope. From SEM micrographs, it has been found that a silica gel molecule offers an irregular pentamerous framework. However, the melamine trisulfonic acid molecules offers irregular flakes like framework structure. It has also been found that the particles size of melamine trisulfonic acid turns to smaller and particles gravitated to assemble after chloro-sulfonation. Additionally, the melamine trisulfonic acid molecules are well arranged in circumforaneous of irregular pentamerous shape silica gel molecules. No indicative changes were ascertained in SEM micrographs of fresh and regenerated MTSA-Si, they affirmed the confinement of skeleton structure throughout the esterification and transesterification. SEM micrographs of fresh and regenerated MTSA-Si catalysts are demonstrated in Fig. 11.

Powder X-ray diffraction study of MTSA-Si

The texture properties of fresh and regenerated MTSA-Si were evaluated by XRD analysis. The spectra displayed natural diffraction peaks suggesting crystallinity of MTSA-Si. The X-Ray diffractograms displays characteristics diffraction pattern showing crystalline planes of MTSA-Si. The characteristics peaks found at 18.94 2θ (deg.), 20.84 2θ (deg.), 22.76 2θ (deg.), 25.14 2θ (deg.), 26.50 2θ (deg.), 28.04 2θ (deg.) and 29.60 2θ (deg.) are attributed to the presence of crystalline silica gel (JCPDS-29-1129). Whereas, sharp peaks recognized at 30.38 2θ (deg.), 32.10 2θ (deg.), 36.64 (deg.), 38.12 2θ (deg.) and 39.74 2θ (deg.) are characteristics of melamine (JCPDS-00-005-0127). In the case of X-Ray diffractrogram of regenerated MTSA-Si catalyst, the intensity of peak at 25.14 2θ (deg.) and 26.50 2θ (deg.) are slight decreased. This may attributed to the leaching of active centers (H^+) from the MTSA-Si surface or slight modification in the structure of MTSA-Si. Otherwise, no indicative major changes were ascertained in the XRD patterns of fresh and regenerated MTSA-Si, they affirmed the confinement of skeleton structure throughout the esterification and transesterification. The wide angle X-Ray diffractograms of fresh and regenerated MTSA-Si have been demonstrated in Fig. 12.

Surface area determination of MTSA-Si

The results of specific surface area, pore size and pore volume have been tabularized in Table 3.

It has been clearly observed from Table 3, the BET surface area (S_{BET}) of MTSA-Si was found to be 108.94 m^2/g. The BET isotherm of MTSA-Si found naturally of Type-IV at lower *p/po* values directing the presence of mesopores in MTSA-Si catalyst. The pore volume and pore size of MTSA-Si was found to be 0.1071 cm^3/g and 15.88 Å respectively. The pore size and surface area reveals the existence of sulfonic acid groups ($–SO_3H$) on the pore surface of melamine species. This fact is in identical with the reported literature [44]. The BET adsorption–desorption isotherm of MTSA-Si has been demonstrated in Fig. 13.

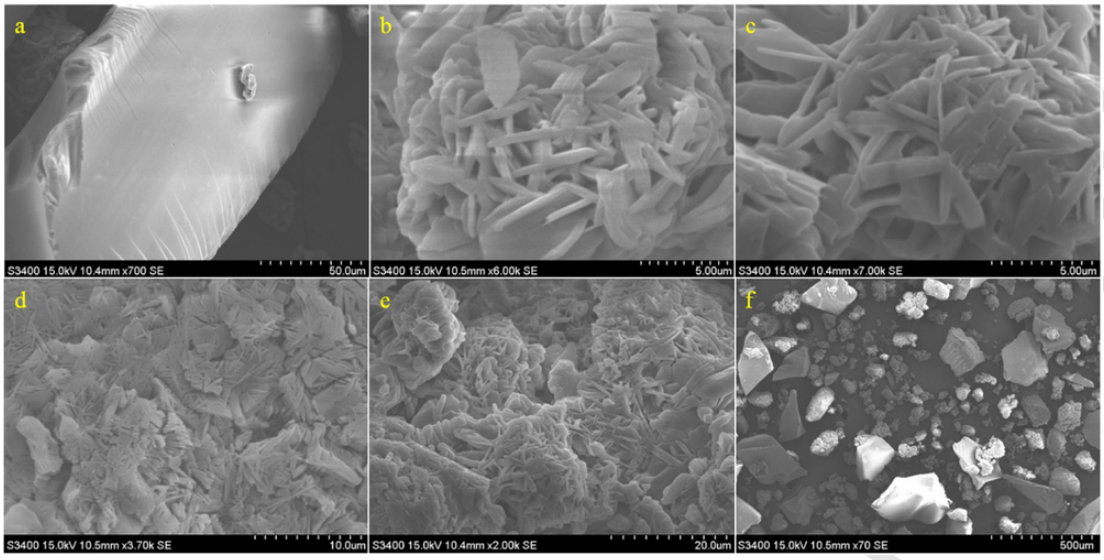

Fig. 11. SEM micrographs of (a) silica gel, (b) fresh MTSA-Si and (c–f) regenerated MTSA-Si.

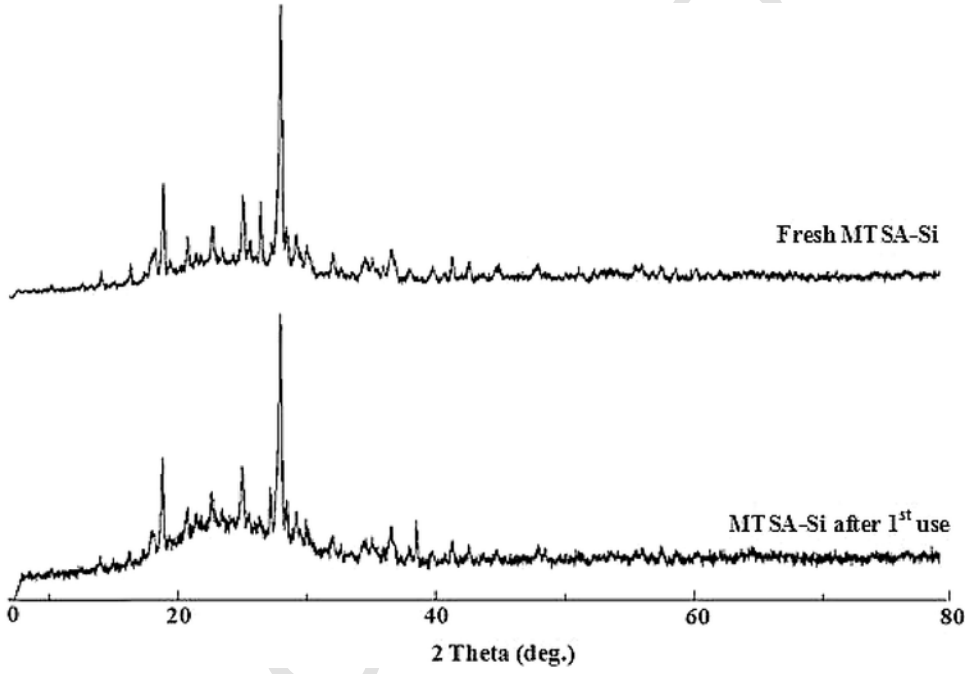

Fig. 12. Large angel X-ray diffractograms of fresh and regenerated MTSA-Si catalysts.

Table 3
Surface area and pore volume of MTSA-Si.

Sr. no	Catalyst	BET surface area (m^2/g) S_{BET}	Total PV (cm^3/g) V_{total}	DFT pore size (Å)
1.	MTSA-Si	232	0.1071	15.88

Acidity measurement study

The acidity of solid acid catalyst is a very significance property for the heterogeneous catalysis. Solid acid catalysts may contain both lewis and bronsted acidic sites. Both nature and strength of acid sites play an important role in expressing catalytic activity of many solid acid catalysts. Hence, the measurement of surface acidity of solid catalysts is of immense importance from technological point of view because it not only helps to characterize a catalyst sample but also provides a method of screening of a catalyst sample for optimal yield in a process. Accordingly, a large number of methods are accessible for the estimation of acidity of solid acid catalysts. The total acidity of the MTSA-Si catalyst was found to be 1.1 mmol g^{-1}, which was estimated through the neutralization titration. In a 500 mL glass beaker, 0.6 g MTSA-Si catalyst was added along with 4 mL 2 N aqueous NaCl and stirred those at ambient conditions for 24 h in order to allow the ion exchange in the solution. Then after, the solids were filtered off from the aqueous solution and washed thrice with distilled

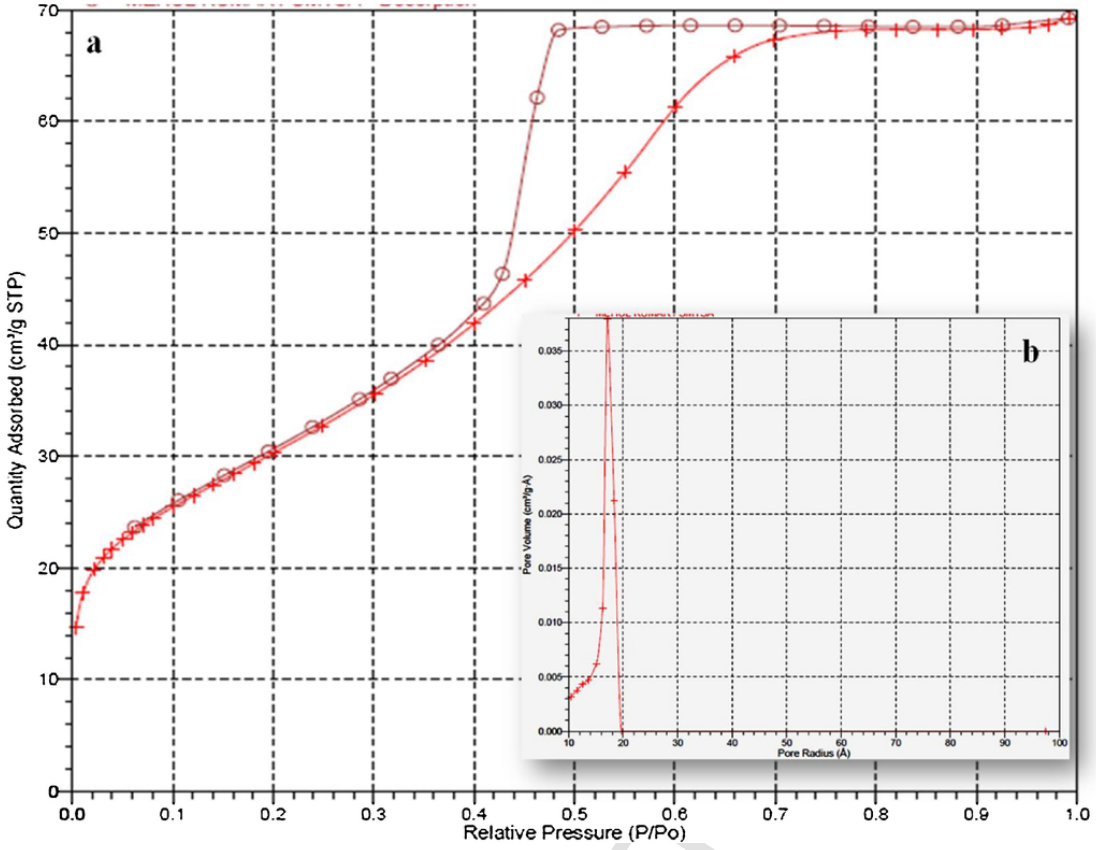

Fig. 13. (a) BET isotherm of MTSA-Si and (b) pore size distribution of MTSA-Si.

water (15 mL). The collective filtrate was titrated with 0.01 N NaOH using phenol red as an indicator [42].

Thermal stability study of MTSA-Si

The thermogravimetric analyzer (TGA) is an essential laboratory tool used for determination of thermal stability of materials and compositions of volatile compounds by keeping track record of the weight loss that occurs when material is heated. The thermal stability of MTSA-Si was estimated by thermogravimetric analysis. From the TGA thermogram of MTSA-Si, it has been found that the 10.72% weight loss occurs in a temperature range of 30–210 °C is pertaining to the molecular moisture decomposition, 26.46% weight loss occurs in a temperature range of 210–550 °C is pertaining to the melamine decomposition and 12.75% weight loss occurs in a temperature range of 570–920 °C is pertaining to the decomposition of sulfonic acid group (–SO_3H) attached to the melamine. In the present study, the maximum reaction temperature employed for the transesterification and esterification reactions are 130 °C and 100 °C respectively. Whereas, the weight loss (7.306%) has been observed in the range of temperature 30–210 °C and it's due to the decomposition of molecular moisture. From the TGA thermogram, it could be recognized that the thermal stability of MTSA-Si is not much influenced at 130 °C reaction temperature. Therefore, the MTSA-Si offers a remarkable thermal stability also. The TGA thermogram of MTSA-Si has been expressed in Fig. 14.

FT-IR analysis of biodiesel

The FTIR spectrum of waste frying biodiesel is confirmed with the presence of characteristics bands at 2924.09 cm^{-1} (CH_3 stretching), 2854.65 cm^{-1} (CH_2 stretching), 2360.87 cm^{-1} (C═C stretching), 1743.65 cm^{-1} (C═O), 1458.18 cm^{-1} (CH bending), 1195.87 cm^{-1} and 1172.72 (C–O) and 725.23 cm^{-1} (CH rocking) respectively [43]. The FT-IR spectrum of synthesized biodiesel is given in Fig. S3.

^{1}H NMR analysis of biodiesel

The purity of waste frying biodiesel is further confirmed by the presence of characteristics peaks at 5.22–5.28 (unsaturated olefinic –CH═CH– protons) ppm, 3.57 (CH_3O-methoxy protons) ppm, 3.36 (OCH_2 protons) ppm, 2.69 (CH protons) ppm, 2.19–2.23 (OCH protons) ppm, 1.91–1.98 (β-CH_2 protons) ppm, 1.52–1.56 (α-CH_2 protons) ppm and 1.18–1.23 (CH_3 protons) ppm respectively [45]. The ^{1}H NMR spectrum of biodiesel has been given in Fig. S4.

^{13}C NMR analysis of biodiesel

The purity of waste frying biodiesel is confirmed by the presence of characteristics peaks, including, 173.88–173.91 ppm (C═O carbons), 127.79–129.92 ppm (olefinic carbons), 76.80–77.43 ppm ($CDCl_3$-solvent), 51.11 ppm (O–CH_3 carbon) and 27.05–33.90 ppm (aliphatic carbons) respectively [46]. The ^{13}C NMR spectrum of biodiesel is given in Fig. S5.

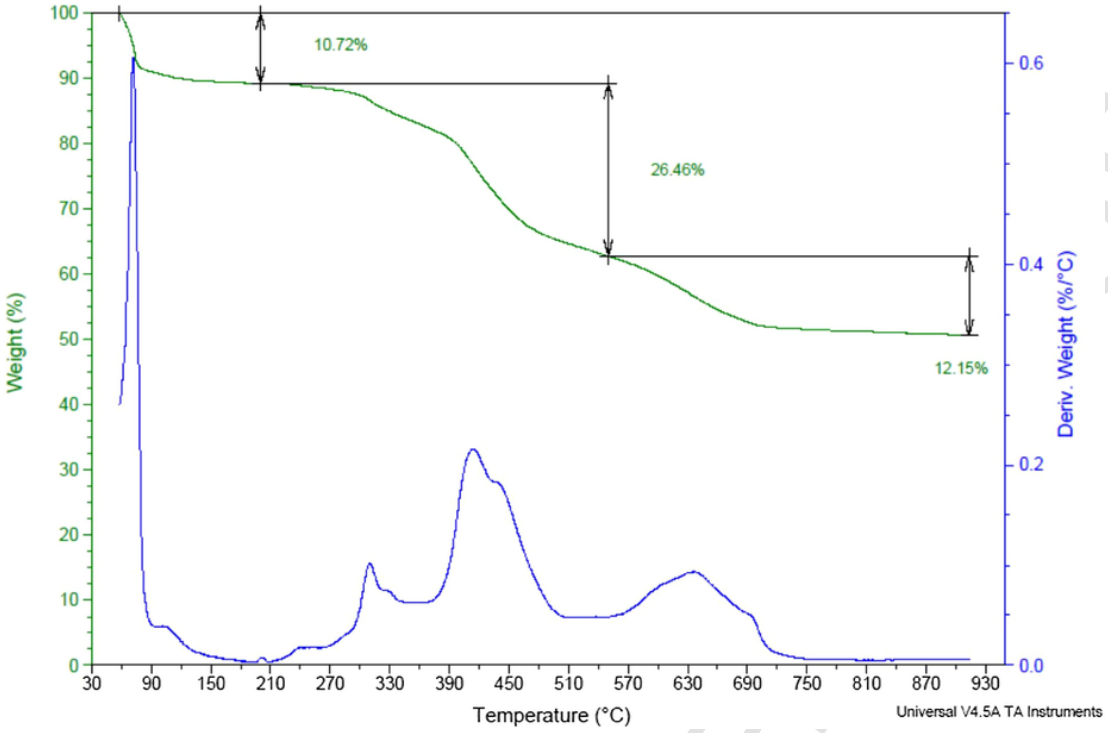

Fig. 14. TGA profile of MTSA-Si.

FT IR analysis of TGLA

FTIR spectrum of TGLA is confirmed with the presence of characteristics bands at 2924.09 cm^{-1} (CH_3 stretching), 2854.65 cm^{-1} (CH_2 stretching), 2360.87 cm^{-1} (C═C stretching), 1712.79 cm^{-1} (C═O), 1458.18 cm^{-1} (CH bending), 1188.15 cm^{-1} (C-O) and 725.23 cm^{-1} (CH rocking) respectively [43]. The FT-IR spectrum of TGLA has been demonstrated in Fig. S6.

^{1}H NMR analysis of TGLA

The purity of TGLA is confirmed by the presence of characteristics peaks corresponding to 3.54 (O–CH_2) ppm, 2.51 (α-CH_2 protons) ppm, 2.12–2.22 (β-CH_2 protons) ppm, 1.96 (CH_3 protons) ppm, and 1.22–1.47 (CH protons) ppm respectively [45]. The ^{1}H NMR spectrum of TGLA is given in Fig. S7.

^{13}C NMR analysis of TGLA

The purity of TGLA is further confirmed by the presence of characteristics peaks, including, 172.80–174.41 ppm (C═O carbons), 127.51–129.26 ppm (olefinic carbons), 50.79 ppm (CH_3 carbon), 69.26 ppm (O–CH_2 carbon) and 28.56–39.91 ppm (aliphatic carbons) respectively [46]. The ^{13}C NMR spectrum of TGLA has been depicted in Fig. S8.

Reusability of MTSA-Si

The widespread and easy commercialization of any fuel is strictly depends on their manufacturing cost. With a view to shorter down the expense of biodiesel and TGLA synthesis, the MTSA-Si was examined for their potential reusability for the esterification and transesterification reactions. Hence, in this approach, after each run, the MTSA-Si catalyst was isolated from the reaction mass through vacuum filtration and treated thrice with dichloro methane in order to eliminate some impurity like, the surface restrained moisture, unspent triacylglyceride, diacylglycerides, monoacylglyceride, glycerol and unspent methyl alcohol. Before reuse, dichloro methane treated MTSA-Si was kept in a tray dryer at 110 °C for 20 h in order to acquiesce elimination of organic solvent traces and reactivation of active centers (H^+) on the melamine surface. It has been recognized from the results of esterification and transesterification reactions, the MTSA-Si catalyst could have a potential to reuse five times without indicative disappearance of catalytic activity. However, the slight subtraction in the (%) yields of biodiesel and TGLA have been recognized on the repetitive runs of MTSA-Si. The percolation of active centers (H^+) or modification of MTSA-Si structure at given reaction temperature could play significant role in the deactivation of MTSA-Si catalyst. It has been found from the repetitive runs and spectral analysis of the MTSA-Si catalyst (Figs. 10–12), the melamine preserves its structure throught the esterification and transesterification reactions without any serious distortion. In the case of biodiesel synthesis, a fresh MTSA-Si catalyst could shows highest conversion up to 98.22%. While, it's first, second, third, fourth and fifth repetitive run could shows highest conversions up to 94.25%, 89.33%, 86.52%, 83.69% and 78.45% respectively. The influence of MTSA-Si run on the (%) yield of biodiesel has been illustrated in Fig. 15.

Whereas, in the case of TGLA synthesis, a fresh MTSA-Si catalyst could shows highest conversion up to 92.28%. While, it's first, second, third, fourth and fifth repetitive run could shows highest conversions up to 89.11%, 86.33%, 81.28%, 77.45% and 70.18% respectively. The influence of MTSA-Si run on the (%) yield of TGLA has been illustrated in Fig. 16.

Comparison of catalytic activity of MTSA-Si

Table 4 shows the comparison of catalytic performance of MTSA-Si with reported results of the various solid acid catalysts employed for the transesterification of oil to biodiesel.

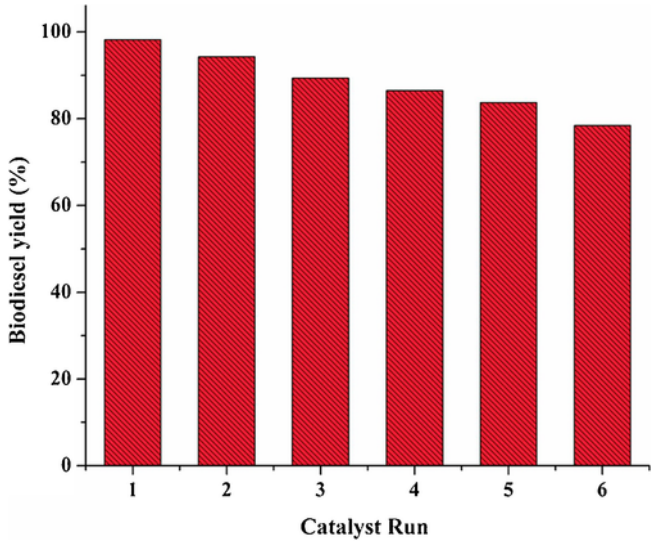

Fig. 15. The effect of catalyst run times on (%) yield of biodiesel.

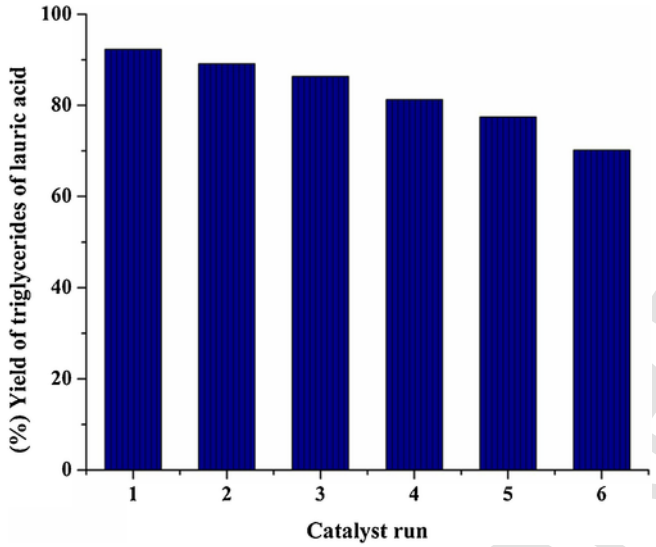

Fig. 16. The effect of catalyst run times on (%) yield of TGLA.

From Table 4, it could be observed that MTSA-Si catalyst shows remarkable catalytic performance for the transesterification of waste frying oil for synthesis of biodiesel. In present study, the best results achieved at optimum reaction conditions like, (i) 130 °C reaction temperature, (ii) 1:10 oil to methanol molar ratio, (iii) 5% (*w/w*) catalyst and (iv) 10 h reaction time, for the 98.22% biodiesel yield. It has also been found from Table 4, the results of the present study are comparable to the results of reported literature of the solid acid catalysts, where comparatively precise reaction parameters (too high reaction temperatures and oil to methanol molar ratio) were reported [47–49,51–54].

Moisture absorption test for MTSA-Si

The MTSA-Si was also studied for its moisture absorption susceptibility. In this process, the required amount of MTSA-Si catalyst was put up in a glass vessel under saturated humidity at atmospheric temperature for several days in order to acquiesce the absorption of moisture on the MTSA-Si surface. The MTSA-Si samples were weighted at regular interval of times. The absorbing moisture rate (*W*%) of the samples were determined by Eq. (3).

$$\mathrm{W\%} = \left[\frac{56\,\Delta \mathrm{m}}{18\mathrm{mo}}\right] \times [100] \tag{3}$$

where, Δm refers to the increased weight and m_0 refers to the initial weight of the MTSA-Si sample. The influence of exposure time (h) on the moisture absorption of MTSA-Si is illustrated in Fig. S9.

From Fig. S9, it has been observed that moisture absorption rate (*W*%) is increased gradually with increased in moisture exposure time (h). The melamine trisulfonic acid (MTSA) catalyst offers three hydroxyl (–OH) groups in association to the three sulfonic acid groups. Hence, as a result of polar texture of catalyst, the MTSA-Si catalyst could easily absorb the moisture from constant humidity surroundings.

Estimation of fuel properties of biodiesel

The most important fuel properties which influence the engine performance of the diesel engine are like, the process taking place in the engine, (i) ignition quality, (ii) serenity of starting, (iii) production and flaming of the fuel-O_2 mixture, (iv) formation of burn out gas and its quality and (v) the calorific index. The cool climate properties like, (i) cloud point, (ii) pour point and (iii) cold filter plugging point. The storage and transportation properties like, (i) oxidative and thermal stability, (ii) flash point, (iii) an ordination period, (iv) micro-

Table 4
Comparison of catalytic activity of MTSA-Si with reported literature.

Sr. no	Catalyst	Reaction conditions				Biodiesel yield (%)	Ref.
		Reaction temp. (°C)	Catalyst % (w/w)	O/M molar ratio	Reaction time (h)		
1.	MTSA-Si	130	5.0	1:10	10	98.22	Present work
2.	$H_3PW_{12}O_{40}$·Nb_2O_5	200	3.0	1:18	20	94.00	[47]
3.	Zr–PMOs	209	12.8	1:48.5	6.0	85.00	[48]
4.	$[(CH_2)_4SO_3HPy\text{-}HSO_4]$	170	2.0	1:12	5.0	92.00	[49]
5.	$H_3PW_{12}O_{40}$/SBA-15	65	0.3	1:2	12	75.0	[50]
6.	Propyl-SO_3H SBA-15	190	5.0	1:6	15 min	38.0	[51]
7.	Arene-SO_3H SBA-15	190	5.0	1:6	15 min	56.0	[51]
8.	Me/Arene-SO_3H SBA-15	190	5.0	1:6	15 min	58.0	[51]
9.	EBD-100	65	1.0	1:12.2	24	100	[52]
10.	EBD-200	65	1.0	1:12.2	24	100	[52]
11.	EBD-300	65	1.0	1:12.2	24	81.0	[52]
12.	Ti/SiO_2 nanoflowers	65	5.0	1:30	4.0	98.0	[53]
13.	Lithium-doped ceria supported SBA-15	65	10.	1:40	4.0	>98.0	[54]

bial degradation and (v) percolation limit temperature. The wear properties like, (i) lubricity, (ii) cleaning effect, (iii) viscosity, (iv) density and (v) consonance with materials employed to prepare a fuel. The physicochemical properties of biodiesel can be estimated by the fatty acid profiles of corresponding oils. The fuel properties of biodiesel can alter substantially from one oil to oil in virtue of its slight higher molar mass than conventional diesel [55]. Some fuel properties of WFO based biodiesel and its comparison with ASTM fuel standards has been tabularized in Table 5.

The flash point and fire point (ASTM D6751) were measured with help of cleveland open cup tester (Pensky-martens). The cetane number (ASTM D 976) was estimated by cetane number analyzer (AFIDA 2805). The iodine value (AOCS CD1-25 1993) and acid value (ASTM D664) were estimated through titration methods. The calorific value (IS:1448:(P:33):1991) was determined by an oxygen bomb calorimeter (model 6772, Parr instrument Ltd, USA). Kinematic viscosity was estimated using viscometer bath (ASTM D6751, Aditya 01). The density (D4052-91) of biodiesel was predicted by hydrometer method (D1298). The cloud point is an exclusive cold flow property that is recognized in ASTM D6751 standards [56]. From Table 5, it has been found that all fuel properties are in consonance with the test limits, which were defined by ASTM and AOCS fuel standards.

Conclusion

Herein, a promising MTSA-Si catalyst was prepared via chlorosulfonation of melamine and evaluated for the transesterification of WFO for biodiesel synthesis. It has been realized from experimental results, the optimum reaction conditions for the biodiesel preparation are (i) 1:10 oil to methanol molar ratio, (ii) 5% MTSA-Si *(w/w)*, (iii) 130 °C reaction temperature and (iv) 10 h reaction time for the 98.22% yield of biodiesel. As MTSA-Si could simultaneously catalyze esterification and transesterification, hence, it does not demands refined feedstocks. Currently, the biodiesel manufacturers are facing a serious problem to dump the crude glycerol produced as a side product during biodiesel production and availability of a cheaper feedstock for biodiesel production. Therefore, we made a small attempt to convert the biodiesel based crude glycerol to triglycerides of lauric acid using MTSA-Si catalyst. It has been illustrated from the experimental results, the optimal reaction conditions for the maximum (%) yield of TGLA (92.28%) are, (i) 1:3 glycerol to lauric acid molar ratio, (ii) 2% MTSA-Si *(w/w)*, (iii) 100 °C reaction temperature and (iv) 7 h reaction time. Hence, this protocol offers duple advantages; i.e (i) crude glycerol is effectively transformed into corresponding triglycerides and (ii) synthesized triglycerides could be used as cheaper feedstock for biodiesel production. Besides, the MTSA-Si could successfully be used for five repetitive runs without any serious distortion of their performance for esterification and transesterification.

Table 5
Fuel properties of WFO based biodiesel based on ASTM and AOCS fuel standards.

Sr. no	Properties	Unit	Method	Value	ASTM limits
1.	Flash point	(°C)	ASTM D6751	133	>130
2.	Fire point	(°C)	ASTM D6751	141	>140
3.	Pour point	(°C)	ASTM D 97	−16	−15
4.	Cetane index	–	ASTM D 976	49	52.0
5.	Iodine value	g I_2/100 g	AOCS CD1-25 1993	91	120
6.	Calorific value	MJ/kg	IS:1448:(P:33):1991	39.85	–
7.	Total acid number	mg KOH/g	ASTM D 664	0.78	0.8
8.	Kinematic viscosity @ 40 °C	mm^2/s	ASTM D6751	4.21	1.9–6.0
9.	Density @ 25 °C	Kg/m^3	ASTM D4052-91	867	860–900
10.	Cloud point	(°C)	ASTM D6751	9.8	–

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jiec.2018.03.036.

References

[1] K. Dincer, Energy Source Part A 30 (2008) 963.
[2] S.N. Naik, V.V. Goud, P.K. Rout, A.K. Dalai, Renew. Sustain. Energy Rev. 14 (2010) 578.
Y.P. Peng, K.T.T. Amesho, C.E. Chen, S.R. Jhang, F.C. Chou, Y.C. Lin, Catalysts 8, 2018, 1.
M.N. Hossain, M.S. Ullah Siddik Bhuyan, A.H.M.A. Alam, Y.C. Seo, Energies 11, 2018, 1.
F. Ma, M.A. Hanna, Bioresour. Technol. 70, 1999, 1.
M.G. Kulkarni, A.K. Dalai, Ind. Eng. Chem. Res. 45, 2006, 2901.
[7] S. Pradhana, J. Shen, S. Emami, P. Mohanty, S.N. Naik, A.K. Dalai, M.J.T. Reaney, J. Ind. Eng. Chem. 46 (2017) 266.
P.M. Veiga, C.O. Veloso, C.A. Henriques, Renew. Energy 99, 2016, 543.
[9] J.F. Puna, J.F. Gomes, J.C. Bordado, M. Joana Neiva Correia, A. Paula Soares Dias, Appl. Catal. A 470 (2014) 451.
M. Catarino, M. Ramos, A.P. Soares Dias, M.T. Santos, J.F. Puna, J.F. Gomes, Waste Biomass Valoriz. 8, 2017, 1699.
[11] I.B. Bankovic-Ilic, M.R. Miladinovic, O.S. Stamenkovic, V.B. Veljkovic, Renew. Sustain. Energy Rev. 72 (2017) 746.
P. Felizardo, M.J.N. Correia, I. Raposo, J.F. Mendes, R. Berkmeier, J.M. Bordado, Waste Manage. 26, 2005, 487.
F. Zaher, Energy Source 25, 2003, 819.
[14] N.P. Anh, M.P. Tan, Fuel 87 (2008) 3490.
[15] M. Niu, X. Kong, RSC Adv. 5 (2015) 27273.
M. Rakib Uddin, K. Ferdous, M. Rahim Uddin, M.R. Khan, M.A. Islam, Chem. Eng. Sci. 1, 2013, 22.
K. Khalisanni, K. Khalizani, M.S. Rohani, P.O. Khalid, Global J. Environ. Res. 2, 2008, 81.
[18] N. Idun-Acquah, G.Y. Obeng, E. Mensah, SciTech 6 (2016) 8.
[19] V.B. Borugadda, V.V. Goud, Waste Biomass Valoriz. 7 (2016) 23.
[20] E. Lotero, Y.J. Liu, D.E. Lopez, K. Suwannakarn, D.A. Bruce, J.G. Goodwin, Ind. Eng. Chem. Res. 44 (2005) 5353.
[21] T. Okuhara, Chem. Rev. 102 (2002) 3641.
W.M. Van Rhijn, D.E. De Vos, B.F. Sels, W.D. Bossaert, P.A. Jacobs, Chem. Commun. 3, 1998, 317.
Y. Zhou, I. Noshadi, H. Ding, J. Liu, R.S. Parnas, A. Clearfield, M. Xiao, Y. Meng, L. Sun, Catalysts 8, 2018, 17.
[24] M.A. Harmer, W.E. Farneth, Q. Sun, Adv. Mater. 10 (1998) 1255.
G.D. Yadav, J.J. Nair, Microporous Mesoporous Mater. 33, 1999, 1.
[26] M.A. Harmer, Q. Sun, A.J. Vega, W.E. Farneth, A. Heidekum, W.F. Hoelderich, Green Chem. 2 (2000) 7.
R.A. Soldi, A.R.S. Oliveira, L.P. Ramos, M.A.F, Appl. Catal. A Gen. 361, 2009, 42.
C.S. Caetano, L. Guerreiro, I.M. Fonseca, A.M. Ramos, J. Vital, J.E. Castanheiro, Appl. Catal. A Gen. 359, 2009, 41.
M.L. Savaliya, M.S. Bhakhar, B.Z. Dholakiya, Catal. Lett. 146, 2016, 2313.
[30] G.P. Hammond, S. Kallu, M.C. Mc Manus, Appl. Energy 85 (2008) 506.
[31] M. Canakc, Bioresour. Technol. 98 (2007) 183.
J.J. Zhang, L.F. Jiang, Bioresour. Technol. 99, 2008, 8995.
C. Oner, C. Altun, Appl. Energy 86, 2009, 2114.
[34] B. Choubisa, M.R. Patel, B.Z. Dholakiya, Res. Chem. Intermed. 39 (2013) 3063.
M. Vafaeejadeh, A. Fattahi, Phosphorous Sulfur Silicon 189, 2014, 849.
[36] H. Ma, S. Li, B. Wang, R. Wang, S. Tian, J. Am. Oil Chem. Soc. 85 (2008) 263.

P. Garcia Moreno, M. Khanum, A. Guadix, E.M. Guadix, Renew. Energy 68, 2014, 618.
[38] A.M. Ruhul, M.A. Kalam, H.H. Masjuki, I.M. Rizwanul Fattah, S.S. Reham, M.M. Rashed, RSC Adv. 5 (2015) 101023.
P. Maneechakr, J. Samerjit, S. Karnjanakom, RSC Adv. 5, 2015, 55252.
D.J. Pyle, Master of Science Thesis, 2008, Virginia Polytechnic Institute and State University Blacksburg, p. 1.
[41] B.Z. Dholakiya, Arch. Appl. Sci. Res. 4 (2012) 551.
[42] M.L. Savaliya, B.Z. Dholakiya, RSC Adv. 5 (2015) 74416.
G. Gauglitz, T. Vo-Dinh, Handbook of Spectroscopy, 2003, Wiley-VCH Verlag Gmbh & Co Kgaa, Weinheim, ISBN 3-527-29782-0, 1-502.
[44] S. Brunauer, P.H. Emmett, E. Teller, J. Am. Chem. Soc. 60 (1938) 309.
J.K.M. Saunders, B.K. Hunter, Modern NMR Spectroscopy — A Guide for Chemists, 2nd Edn, 1993, Oxford University Press, Oxford, p. 1.
[46] I. Wawera, S. Witkowski, Curr. Org. Chem. 5 (2001) 987.
[47] V. Brahmkhatri, A. Patel, Fuel 102 (2012) 72.
[48] R. Sánchez-Vázquez, C. Pirez, J. Iglesias, K. Wilson, A.F. Lee, J.A. Melero, ChemCatChem 5 (2013) 994.
[49] W. Schmidt Dr, ChemCatChem 1 (2009) 53.
[50] V. Brahmkhatri, A. Patel, Appl. Catal. A 403 (2011) 161.
[51] D. Zuo, J. Lane, D. Culy, M. Schultz, A. Pullar, M. Waxman, Appl. Catal. B 129 (2013) 342.
[52] B.M.E. Russbueldt, W.F. Hoelderich, Appl. Catal. A 362 (2009) 47.
[53] M. Kaur, R. Malhotra, A. Ali, Renew. Energy 116 (2018) 109.
[54] R. Malhotra, A. Ali, Renew. Energy 119 (2018) 32.
[55] P. Purohit, S. Gaikwad, R. Gurav, International conference on recent technology, Institute of knowledge, College of engineering, Shikrapur, pune, India, (2012) 1–6.
[56] A. Evcil, F. Al-Shanableh, M.A. Savas, Fuel215 (2018) 522.

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Eco-friendly process for preparation of biodiesel from WFO over MTSA-Si catalyst: An innovative approach for the utilization of side product

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ABSTRACT

Present work aimed for the synthesis of a promising MTSA-Si catalyst and its application for biodiesel preparation using WFO. It has been illustrated from the experimental results, the most favorable reaction conditions for the biodiesel preparation using WFO are (i) 1:10 oil to methanol molar ratio, (ii) 5% MTSA-Si catalyst *(w/w)*, (iii) 130 °C reaction temperature and (iv) 10 h reaction time, for the 98.22% yield of biodiesel. The side product raw glycerin was further transformed into the triglycerides over MTSA-Si catalyzed lauric acid esterification. The fuel properties of biodiesel were estimated and correlated fuel standards.

Introduction

Currently, alternative energy research community across the world is insisting for an exploration of alternative energy resources in order to minimize consumption of the traditional energy resources by virtue of their everlasting depletion and growing destructive concussion on the climate [1]. The manufacturing of second generation biofuel from non edible oils likes, Jatropha curcas, Sterculia foetida, Ceiba pentandra and Cerbera manghas, as well as waste frying oil has been become the key of energy insufficiency to counter any reduction in the supply of edible oil resources to the food manufactory [2–4]. Biodiesel is being produced from the reaction of vegetable oil or animal fats with a shorter chain alcohol like methanol or ethanol in presence of a relevant catalyst. The global energy insistence is increasing day-to-day, while the repertory of conventional fuels such as coal and petroleum are reducing constantly. Besides, the consumption of conventional fuels motives the global warming by raising the effects of greenhouse gases notably. Biodiesel is a non-toxic, biodegradable and green alternative by virtue of its lower emission figurations. Contradictory to these dominance, the most significant disadvantage of biodiesel is its higher cost than conventional fuels [5,6]. Such alternative fuel has received considerable attention due to its being produced from non-conventional sources and it potentially lower down the climatic impact in association to conventional diesel fuel [7]. Biodiesel synthesis is mainly executed by the transesterification of oils over homogeneous, heterogeneous and enzymatic catalysts [8]. The currently well established manufacturing facilities for biodiesel synthesis are mainly based on homogeneous base catalysis [9]. The noncorrosive, eco-friendly and reusable nature of heterogeneous acid and alkali [10] catalysts makes them more suitable for the biodiesel synthesis with respect to homogeneous acid catalysts. However, they are associated with some limitations for their commercial scale production likes, (i) complex synthesis process and (ii) difficulties in handling in application to commercial scale plants [11]. The booming production of WFO from domiciliary as well as industrial sectors is a maturing scrape globally by virtue of its oxidation and hydrogenation characteristics. Waste frying oil commonly abundant of free fatty acids, polymeric material and disintegration products, besides triglyceride, diglycerides and monoglycerides. This residue is habitually discharged into the water, arising the problems for drainage water treatment units and energy mislay, or is intersperse into the food cycle through animal feeds, hence, becoming a potential cause of human health problems [12].

There are considerable applications of waste frying oil, such as in the production of soap, in production of energy through anaerobic digestion, in thermal cracking [13], recently, in the synthesis of biodiesel fuel [14], and much more. Waste frying oil (WFO) is the provocative alternative resource for the biodiesel synthesis due to its inherent in shortening expenses and environmental percussion of biodiesel when correlated with traditional feedstocks. Therefore, waste frying oil as an adequate raw material for biodiesel preparation has attracted significant attention recently due to its reasonable price and smooth availability [15]. The physicochemical properties of WFO are tabularized in Table 1.

In recent times, the usage of solid acid catalysts were describe in literature as a most favorable key for biodiesel production, because it could potentially eliminate some reaction steps like complex isola-

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Table 1
Physicochemical properties of WFO [16–19].

Properties	Test standards	Value
Physical state	–	Liquid
Color	–	Deep oily
Calorific index (MJ/kg)	IS:1448:(P:33):1991	38.314
Peroxide index (O_2/kg)	AOCSCD8-53	10.00–25.25
Specific gravity (g/cm^3)	ASTM D854-10	0.92
Density @ 20 °C (kg/m^3)	ASTM D1298, ASTM D4052-91, IS:1448:(P:32):1992	897.0
Acid index (mg KOH/g)	ASTM D664	3.0
Iodine index (g I_2/100 g)	AOCS CD1-25 1993	102.3
Kinematic viscosity @ 40 °C (mm^2/s)	ASTM D 445, IS:1448:(P:25):1976	54.53
Saponification index (mg KOH/g)	AOCS CD3 2003	192
Average molecular weight of FFA (g/mol)	–	275.5
Mean molecular weight (g/mol)	–	864.5
Flash point (°C)	ASTM D92-94, IS:1448:(P:21):1992	Not less than 250
Pour point (°C)	ASTM D 97	−9.7
Cloud point (°C)	ASTM D 2500, EN 23015	−8.2
Fatty acid compositions	ASTM D1585-96	19.7%

tion, corrosion issue, toxicity and environmental contemplation [20]. Magnificently, a solid acid catalyst used for biodiesel production should offer a higher acidic density of active sites, admirable thermal stability, larger pore size and pore volume, lower cost and hydrophobic exterior [21]. The heterogeneous acidic catalysts have been reported and examined for biodiesel synthesis are the inorganic material based such as zeolite [22,23], niobic acid [24] and sulfated zirconia [25]. However, these catalysts offer smaller pore size and pore volume, which restrict the penetration of the longer chain fatty acid molecules, and hence they are unsuitable for the synthesis of biodiesel. Whereas, the strong acidic ion-exchange resins, i.e., Amberlyst-15 and Nafion-NR50 [26], offer a large fraction of sulfonic acid groups but their application is very limited by virtue of their higher preparation cost and lower thermal stability. While, solid acid catalysts prepared from polystyrene [27] and polyvinyl alcohol crosslinked with sulfosuccinic acid [28] also offer remarkable activity for the esterification of fatty acids using methanol regarding biodiesel production. But leaching of active site form catalysts into the reaction system is a major and uncleared concern. Hence, it is adorable to prepare solid acid catalysts with a higher thermal stability and higher density of active sites.

Currently, the considerable sense behind uncommercialization of biodiesel is its higher preparation expense than conventional diesel [29,30]. The higher preparation expense of biodiesel is principally in view of its being produced from refined oils with low levels of FFA contents. A potential approach for lessening down the biodiesel expense is to utilize lower expense oils composed of higher concentration of FFA, recycled or waste oil and side products of edible oils refineries [31,32]. The crude glycerol- a side stream of biodiesel synthesis is also spoiled with the unspent methanol, unspent glycerides, moisture and catalyst, that compulsorily be separated out to acquire its commercial assessment. As per the environmental protection Act, the raw glycerol must be dumping out in a shorter period of time or to be sold at minimum price, in addition the cost of dumping is also to much expensive [33]. Very insufficient experiments have been carried out to transform the raw glycerin to effective products [34].

In the view of reported studies, we have observed that melamine is a cheaper and commercially feasible chemical, its offers three primary amino ($–NH_2$) groups; hence, it could easily react with sulfurochloridic acid to yield melamine trisulfonic acid (MTSA) at ambient conditions. Besides, synthesized MTSA was sensibly added with silica gel to reinforce the MTSA-Si via formation of inter molecular hydrogen bonding with silica gel. Therefore, an attempt has been made to examine transestrification of waste frying oil to biodiesel over MTSA-Si catalyst. Besides, biodiesel based crude glycerol was also transformed into the TGLA via esterification of lauric acid using MTSA-Si catalyst. Usually, the activity of solid acid catalyst does not influence by the presence of higher levels of FFA contents. Hence, this advance may be helpful to synthesize biodiesel from waste oil based stocks with lower cost as well as feedstocks with higher levels of FFA contents. Generally, solid acid catalyst could show remarkable catalytic activity in esterification and transesterification of oils concurrently. Over and above, heterogeneous nature of MTSA-Si catalyst, it could be simply isolated from the reaction mass and reused for five successful cycles after smooth filtration and reactivation. It has been found from the experimental results, the optimum reaction conditions for the biodiesel preparation via transesterification of WFO are (i) 1:10 oil to methanol molar ratio, (ii) 5% MTSA-Si catalyst *(w/w)*, (iii) 130 °C reaction temperature and (iv) 10 h reaction time for the 98.22% yield of biodiesel.

Materials and method

Materials

Waste frying oil (single time used sunflower oil) was obtained as an open-handed gift from Jay Sardar Restaurant, Rajkot, Gujarat, India. Lauric acid (99% purity) and anhydrous dichloro methane (99.8% purity) were supplied by Sterling Lab care Pvt. Ltd, Surat, Gujarat, India. Methanol (AR grade) was purchased from Advent Chembio Pvt. Ltd. Sulfurochloridic acid, melamine and silica gel (99% purity) were supplied by Aashka Scientific Co., Surat, Gujarat, India. Methanol less crude glycerol was produced using current biodiesel synthesis procedure.

Analytical instrumental methods

The FT-IR analyses of fresh and regenerated MTSA-Si have been carried out on a (Model, Shimadzu FIIR-8400S) FT-IR spectrophotometer. However, the FT-IR analysis of biodiesel and TGLA were carried out on a (Model- RZX Perkin-Elmer) FT-IR spectrophotometer. ^{1}H NMR and ^{13}C NMR analysis were carried out on a (Model, Bruker Biospin, Switzerland 400 MHz liquid state NMR spectrometer) FT-NMR spectrometer. Large angle X-ray diffraction (XRD, Rigaku, Miniflex) study was carried out by using X-ray diffractometer. The surface area of the MTSA-Si was measured on a (Micromeritics ASAP 2020) porosimeter. The thermal stability of MTSA-Si was recognized by Thermogravimetric analysis (Model: Perkin Elmer TGA-7, IIT madras). Surface and structural morphologies of the fresh and regenerated MTSA-Si catalysts were predicted by scanning electron microscope (SEM, Model, Hitachi S3400N). The total acidity of the MTSA-Si was measured by neutralization titration. The biodiesel (%) yield was estimated by gas chromatography analysis. The SUPELCO C_8-C_{24} component FAME mixture was employed as a standard for recognition and determination of the peaks retrieved in the WFO based biodiesel in gas chromatography analysis (YL 6500GC).

Experimental

Preparation of MTSA-Si

A 250 mL three neck suction flask (FBF) was charged with sulfurochloridic acid (5 mL, 75.2 mmol). The melamine powder (3.16 g, 25.07 mmol) was charged in little fractions over a time slot of 45 min at ambient conditions under nitrogen atmosphere (g) and constant

stirring. As a result, the hydrochloric acid (g) was elaborated from the reaction flask immediately. On the completion of addition of melamine, the reaction mixture was rattled for 45 min and the remaining side product hydrochloric acid (g) was removed by vacuum. The mixture was triturated with dichloro methane (20 mL) and then filtered. The powdery residue was again treated with dichloro methane (20 mL) and dried under vacuum oven. The melamine trisulfonic acid (MTSA, 8.2 g, 90%) was obtained as an off-white powder. Then after, 15.2 g silica gel (200–400 mesh) was mixed with off-white MTSA and stirred for 30 min for the formation of an intermolecular hydrogen bond to support the MTSA-Si [35]. At last, a dried and grayish powdery material composed of MTSA-Si was obtained (23.1 g). The scheme for synthesis of MTSA-Si is given in Fig. 1.

Preparation of biodiesel

All the transesterification reactions were executed in a laboratory autoclave (Amar, close SS reactor), assembled with pressure indicator, temperature controller, internal cooling system, online sampling valve, automatic and manually chilling systems. The 289 g of WFO was transferred into the reactor of autoclave and preheated at 55 °C in order to reduce the viscosity of WFO, hence it could be homogeneously stirred in an autoclave. The MTSA-Si-methanol mixture was carefully transferred in an autoclave and stirred at 700 rpm with the interest to restraint the mass transfer constraint. The biodiesel synthesis experiments have been conducted at different oil: methanol molar ratio (1:6, 1:7, 1:8, 1:9, 1:10 and 1:11), reaction temperature (100, 110, 120 and 130 °C), catalyst (MTSA-Si) loading (3, 4, 5 and 6% *w/w*) and reaction time (4, 5, 6, 7, 8, 9, 10 and 11 h). All transesterification reactions were performed at endogenous pressure till the achievement of the optimum conversions. The reaction scheme for biodiesel synthesis is illustrated in Fig. 2.

On the completion of the transesterification reaction, the MTSA-Si was isolated from the reaction slurry by simple filtration. The unspent methanol was also completely removed by distillation and the mixture was thoroughly transferred to a separating funnel for a gravitational settling of biodiesel as well as glycerol, as demonstrated in Fig. S1.

From Fig. S1, it has been clearly observed that due to difference in the densities of biodiesel and glycerol, the biodiesel comes out at top layer and glycerin as well as traces of MTSA-Si catalyst settled

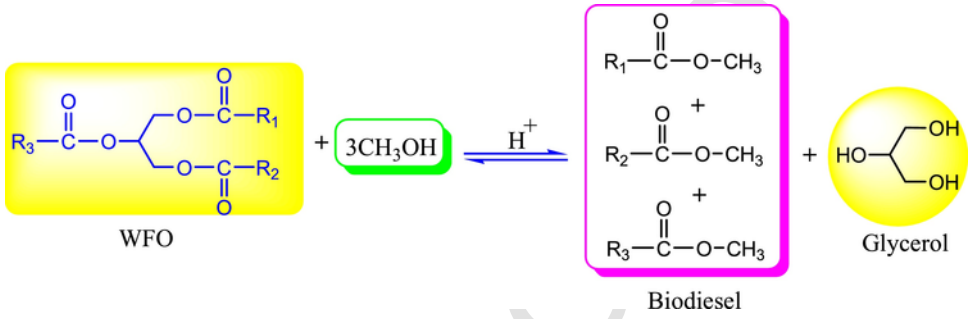

Fig. 1. Transesterification of WFO to biodiesel.

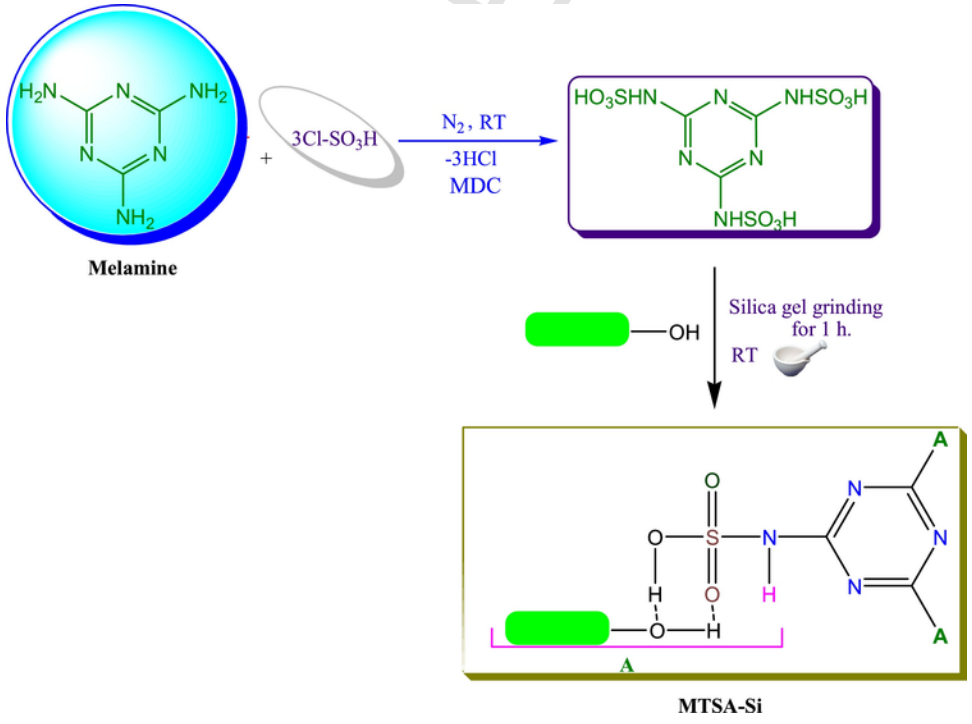

Fig. 2. Reaction scheme for the synthesis of MTSA-Si.

down at the bottom layer. The biodiesel layer was refined by using demineralised water and then treated with anhydrous Na_2SO_4 in order to make it free from moisture. Therefore, 100 mL of biodiesel was mixed with 1.0 g of anhydrous Na_2SO_4 and stirred for 30 min. Then after, the mixture was allowed for gravitational settling (24 h). The decanted moisture free biodiesel was isolated with the service of a vacuum pump for the expulsion of solid impurities traces. The resultant biodiesel has been stored in a glass bottles for further analysis and applications.

Esterification of raw glycerol to TGLA

Esterification is an equilibrium restrained reaction. In pursuance to reduce the equilibrium restrain, commonly an esterification of lauric acid is executed by taking alcohol in excess to enhance the forward reaction [36]. Besides, the expulsion of water during esterification is significantly required, as it is being produced as a side stream and will act as a poison for the catalyst as well as can also promote the reverse reaction. Hence, it could unnecessarily increase the reaction time for the optimal yield of desired esters. The esterification is an equilibrium constrained reaction. The required conversion of desired esters could be attained with the isolation of either water or esters. In order to rectify this problem of present study, an anhydrous sodium sulphate (0.1 mol) was charged in a reactor along with glycerol and lauric acid with a view to encounter water makeup during esterification.

Therefore, in the present work, a 100 mL three neck flat bottom flask was charged with a mixture of lauric acid (3 mol), crude glycerol (1 mol), anhydrous sodium sulphate (0.1 mol) and MTSA-Si (0.8 g) catalyst. The mixture was stirred at 100 °C for the 7 h. Finally, the reaction mixture was cooled down to an ambient temperature and MTSA-Si catalyst was filtered off from the reaction media. The filtrate was poured into a cold water to isolate the resultant triglycerides. Due to the density difference, triglyceride of lauric acid comes out at upper layer in water. In addition, the unspent lauric acid is further coming out at upper layer. Therefore, it was separated from the TGLA and 92.28% yield was reported. The reaction scheme for the preparation of TGLA is demonstrated in Fig. 3.

Biodiesel (%) yield estimation

The waste frying oil based biodiesel samples were preserved under N_2 (g) atmosphere at 4 °C in a glass sample vials for GC analysis. The heptadecanoate was selected as an internal standard for quantifiable determination. On the determination of FAMEs of the biodiesel samples, the peak areas were used to estimate the FAME content of each and every sample by Eqs. (1) and (2) [37].

$$\text{Conversion (C)} = \left[\frac{\sum A - A_{IS}}{A_{IS}}\right] \times \left[\frac{C_{IS} \times V_{IS}}{m}\right] \times [100] \quad (1)$$

where, $\sum A$ is the total peaks area, A_{IS} is the internal standard (methyl heptadecanoate) peak area, C_{IS} is the concentration of the compositional standard solution (mg/mL), V_{IS} is the volume of the internal standard solution used (mL) and m is the mass of the biodiesel sample (mg).

$$\text{Yield (\%)} = \left[\frac{M_{Biodiesel} \times C}{M_{Oil}}\right] \times [100] \quad (2)$$

where $M_{Biodiesel}$ is the mass of pure methyl esters obtained, M_{Oil} is the mass of waste frying oil used and C is the fatty acid methyl ester concentration determined as described in above Eq. (1). The gas chromatogram of WFO based biodiesel is given in Fig. S2. It has been recognized from the gas chromatograph of waste frying oil based biodiesel, the biodiesel mixture is composed of methyl esters of corresponding fatty acid likes, methyl oleate, methyl linoleate, methyl lenolenate and methyl behenate.

Results and discussion

Transesterification of WFO to biodiesel

The synthesis of biodiesel from the transesterication reaction using a suitable catalyst is a highly convenient process. The transesterication reaction for biodiesel synthesis can be carried using different methods and is widely described as the incorporation of shorter chain alcohol to lipids in the presence of acid or base catalyst [38]. Maneechakr et al. have synthesized biodiesel from waste cooking oil over a novel sulfonic modified carbon spheres catalyst under ultrasonic transesterification. From the experimental results, they found 90.8% biodiesel yield with 11.5 wt% catalyst loading, 8.8 min reaction time and 117 °C reaction temperature under ultrasonic conditions [39]. Therefore, in this study, the biodiesel preparation reactions were performed at diversified oil: methanol molar ratio (1:6, 1:7, 1:8, 1:9, 1:10 and 1:11), reaction temperature (100, 110, 120 and 130 °C), MTSA-Si loading (3, 4, 5 and 6% *w/w*) and reaction time (4, 5, 6, 7, 8, 9, 10 and 11 h). The results of (%) yield of biodiesel with varying reaction parameters are summarized in Table 2.

Effect of oil to methanol molar ratio

With a view to study the influence of oil to methanol molar ratio, all transesterification experiments have been carried out at different

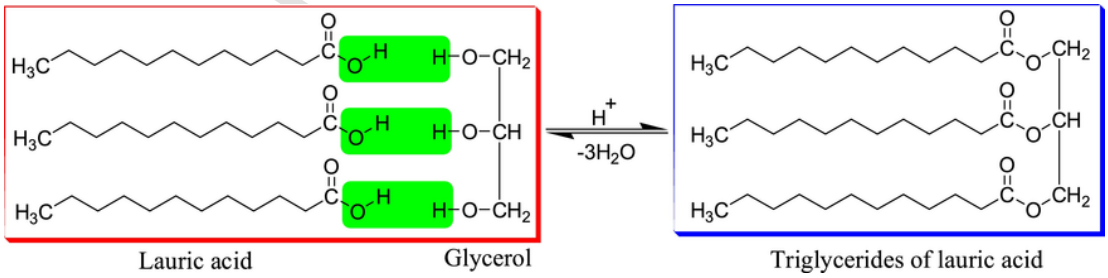

Fig. 3. Reaction scheme for the esterification of crude glycerol to TGLA.

Table 2
Result of (%) yield of biodiesel with varying reaction parameters.

Entry	O:M molar ratio	MTSA-Si loading (% *w/w*)	Reaction temp. (°C)	Reaction time (h)	Biodiesel yield[a] (%)
1	1:6	3	100	4	22.28 ± 0.99
2	1:7	3	100	4	31.24 ± 0.91
3	1:8	3	100	4	45.29 ± 1.19
4	1:9	3	100	4	61.21 ± 1.25
5	1:10	3	100	4	74.33 ± 0.66
6	1:11	3	100	4	69.44 ± 0.91
7	1:10	4	100	4	79.53 ± 0.98
8	1:10	5	100	4	83.48 ± 0.78
9	1:10	6	100	4	80.11 ± 1.33
10	1:10	5	110	4	83.50 ± 0.79
11	1:10	5	120	4	85.98 ± 0.99
12	1:10	5	130	4	87.11 ± 1.29
13	1:10	5	130	5	89.10 ± 1.11
14	1:10	5	130	6	91.58 ± 0.90
15	1:10	5	130	7	93.25 ± 0.97
16	1:10	5	130	8	95.59 ± 1.33
17	1:10	5	130	9	96.68 ± 1.39
18	1:10	5	130	10	98.22 ± 0.88
19	1:10	5	130	11	98.22 ± 0.69

[a] (n = 3) All experiments have been carried out in triplicates.

oil to methanol molar ratio (1:6, 1:7, 1:8, 1:9, 1:10 and 1:11). From Table 2, it has been realized that as methanol to oil molar ratio increases, it directly influence the biodiesel yield (%). The (%) yield of biodiesel is increased with the increasing in the methanol to oil molar ratio. The maximum (%) yield of biodiesel was noticed with 1:10 oil to methanol molar ratio. The oil to methanol molar ratio down to 1:10 directly enhances the reversible reaction. Therefore, the main sense behind decrement in the (%) yield of biodiesel down to 1:10 oil to methanol molar ratio is the reversible nature of the transesterification reaction. It has also been noticed that the decrement in the % yield of biodiesel beyond the 1:10 oil to methanol molar ratio. This may be associated with the polar feature of catalyst and methyl alcohol. Therefore, as the methanol to oil molar ratio increases, the polarity of the reaction is increases gradually. The reaction mechanism of transesterification clearly recommends that the protonation of oil takes place first. However, the polarity of the reaction is increases as the concentration of methyl alcohol increases. Therefore, instead of oil phase, the MTSA-Si directly moves to the methyl alcohol phase. Hence, interactions of methanol towards catalyst phase become quite stronger than interactions of methanol towards oil phase. Therefore, the diminishment in the (%) yield of biodiesel was observed beyond the 1:10 oil to methanol molar ratio. The graphical representation of the influence of oil to methanol molar ratio on the (%) yield of biodiesel has been illustrated in Fig. 4.

Effect of reaction time (h)

In order to study the influence of reaction time (h) on the (%) yield of biodiesel, all the transesterification reactions of oil were also studied using different length reaction time comprising 4, 5, 6, 7, 8, 9, 10 and 11 h. From, the experimental results, it has been perceived that 1:10 oil to methanol molar ratio shows maximum yield of biodiesel (74.33%). Therefore, 1:10 oil to methanol molar ratio was selected as an optimum ratio to study biodiesel synthesis using different reaction times. From the experimental result, it can be concluded that, in the case of 4 h reaction time, the highest (%) yield of biodiesel perceived was 87.11%. Whereas, in the case of 5 h reaction time, the maximum (%) yield of biodiesel sensed was 89.10%. In the case of 6 h reaction time, the maximum (%) yield of biodiesel recognized was 91.58%. In the case of 7 h reaction time, the highest (%) yield of biodiesel observed was 93.25%. In the case of 8 h reaction time, the highest (%) yield of biodiesel sensed was 95.59%. Whereas,

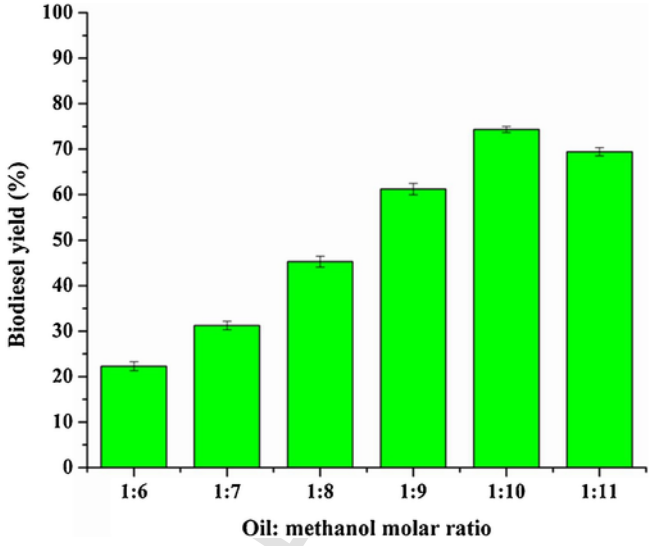

Fig. 4. Influence of oil to methanol molar ratio on the (%) yield of biodiesel.

in the case of 9 h reaction time, the maximum (%) yield of biodiesel recognized was 96.68%. In the case of 10 h reaction time, the highest (%) yield of biodiesel remarked was 98.22%. However, in the case of 11 h reaction time, the highest (%) yield of biodiesel observed was 98.22%. Therefore, the reaction time beyond 10 h does not show any remarkable enhancement in the (%) yield of biodiesel. The similar (%) yields of biodiesel were obtained using 10 h and 11 h reaction times at identical operation conditions. The graphical representation of the influence of reaction time (h) on the (%) yield of biodiesel has been illustrated in Fig. 5.

Effect of MTSA-Si loading (% w/w)

In order to study the influence of catalyst dosage (% *w/w*) on the transesterification, all experiments have been performed at varying catalyst dosages (3, 4, 5 and 6% *w/w*). From Table 2, it has been realized that as catalyst concentration (% *w/w*) increases, the (%) yield of biodiesel increases. In the case of 3% catalyst dosage *(w/w)*, the (%) yield of biodiesel was observed to be 74.33% at optimum oil to methanol molar ratio. Whereas, in the case of 4% catalyst dosage *(w/*

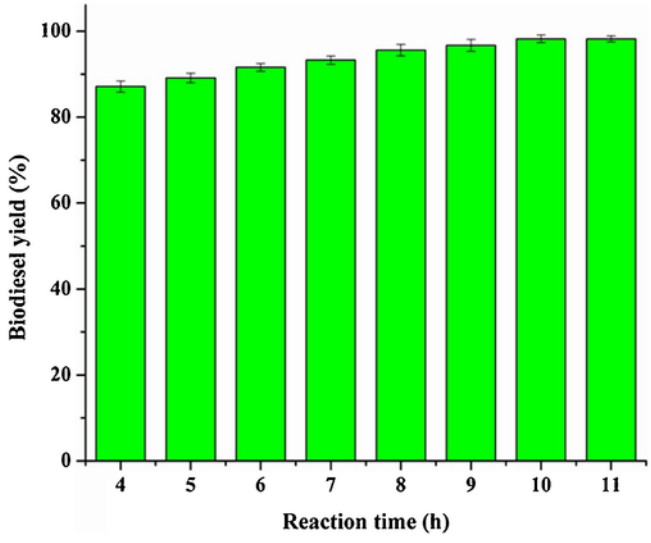

Fig. 5. Influence of reaction time (h) on the (%) yield of biodiesel.

w), the (%) yield of biodiesel was remarked to be 79.53% at optimum oil to methanol molar ratio. In the case of 5% catalyst dosage *(w/w)*, the (%) yield of biodiesel was recognized to be 83.48% at optimum oil to methanol molar ratio. Whereas, in the case of 6% catalyst dosage *(w/w)*, the (%) yield of biodiesel was perceived to be 80.11% at optimum oil to methanol molar ratio. Hence, the catalyst concentration beyond 5% (*w/w*) does not show any remarkable enhancement in the (%) yield of biodiesel. Therefore, it has been realized from the experimental results, as catalyst dosage (% *w/w*) increases, the (%) yield of methyl laureate increases. The influence of MTSA-Si loading (% *w/w*) on (%) yield of the biodiesel has been demonstrated in Fig. 6.

Effect of reaction temperature (°C)

With an intention to study the influence of reaction temperature (°C) on the (%) yield of transesterification reaction, all experiments have been carried out at varying reaction temperatures (100, 110, 120 and 130 °C). From Table 2, it has been realized that as reaction temperature (°C) increases the (%) yield of biodiesel increases. In the case of 100 °C reaction temperature, the (%) yield of biodiesel was found to be 83.48% at optimum oil to methanol molar ratio. Whereas, in the case of 110 °C reaction temperature, the (%) yield of biodiesel was realized to be 83.50% at optimum oil to methanol molar ratio. In the case of 120 °C reaction temperature, the (%) yield of biodiesel was realized to be 85.98% at optimum oil to methanol molar ratio. However, in the case of 130 °C reaction temperature, 5% *(w/w)* MTSA-Si and 10 h reaction time, the (%) yield of biodiesel was realized to be 98.22% at optimum oil to methanol molar ratio. Hence, the reaction temperature beyond 130 °C does not show any remarkable enhancement in the (%) yield of biodiesel. The effect of reaction temperature (°C) on the (%) yield of biodiesel has been given in Fig. 7.

Overall, from experimental results, the optimum reaction conditions within the selected frameworks for the preparation of biodiesel from WFO were found to be, (i) 1:10 oil to methanol molar ratio, (ii) 130 °C reaction temperature, (iii) 10 h reaction time and (iv) 5% *(w/w)* of MTSA-Si catalyst for 98.22% biodiesel yield.

Esterification of raw glycerol to TGLA

Raw glycerol is the large-scale side stream of the biodiesel manufacturing unit. In routine, for every 100 pounds of biodiesel production, proximately 10 pounds of raw glycerol is being produced. The raw glycerol is an uneconomical to refine for its application in food, pharmaceutical and cosmetics industries, biodiesel producers must seek alternative methods for its disposal. [40]. Glycerol is being produced as a side stream as a result of the transesterification of oil along with biodiesel. Hence, the biodiesel manufacturers are staying with a serious problems regarding to dispose of crude glycerol produced from biodiesel production as a side product. On other side, the biodiesel manufacturers are facing a serious trouble regarding the availability of a cheaper feedstock for biodiesel production. Besides, the refining of raw glycerol in the biodiesel production unit is a major and uncleared issue. Hence, it is a new engineering challenge for the developing biodiesel production unit to dispose of the crude glycerol. Therefore, in present work, we made a small attempt to convert the biodiesel derived crude glycerol to triglycerides of lauric acid (TGLA) using MTSA-Si catalyst. It has been found from the results of esterification of raw glycerin, the optimal reaction conditions for the maximum (%) yield of TGLA are, (i) 1:3 glycerol to lauric acid molar ratio, (ii) 2% MTSA-Si catalyst *(w/w)*, (iii) 100 °C reaction temperature and (iv) 7 h reaction time.

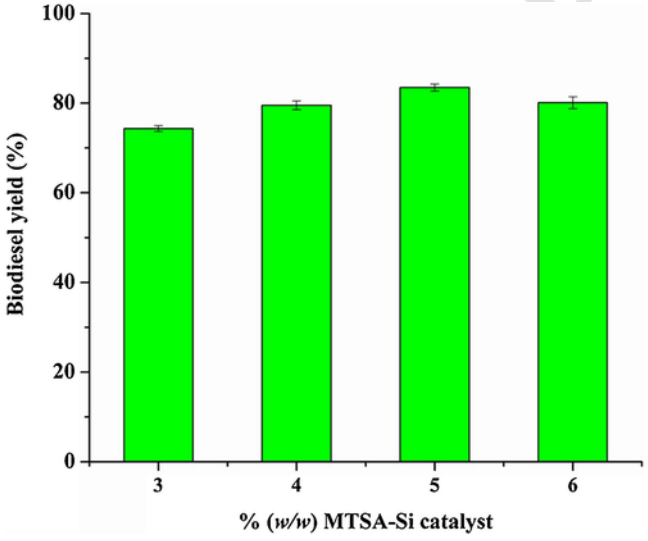

Fig. 6. Influence of % MTSA-Si (*w/w*) on the (%) yield of biodiesel.

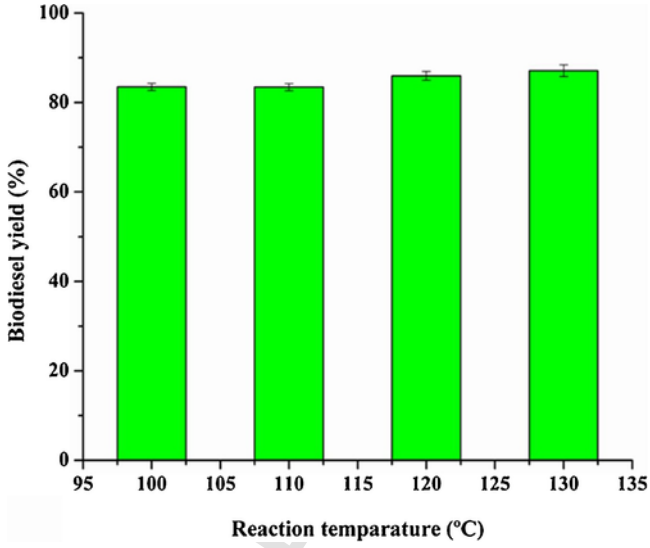

Fig. 7. Influence of reaction temperature (°C) on the (%) yield of biodiesel.

The distillation technique has been employed to isolate the methanol from crude glycerol. The MTSA-Si amount was selected based on the maximum (%) yield of the TGLA and minimum compositions of unspent lauric acid and glycerin in the TGLA. On completion of reaction, the reaction mixture was cooled down to room temperature and MTSA-Si catalyst was filtered off from reaction mixture by vacuum filtration. The filtrate was carefully transferred in to separating funnel containing distilled water. By virtue of the density difference of the TGLA and water, the TGLA comes out at top layer and water settled down at bottom layer. Besides, the unspent lauric acid also comes out at top layer. Hence, it was isolated from the TGLA and 92.28% yield has been reported.

Crude glycerol is readily attainable in the trading market with very lower expenses or almost no expenses. Besides, the separation and refining of crude glycerol is very tedious process and involves several steps for its isolation and purification, hence, it requires higher expenses and multitudinous manpower as well. On other side, the commercial grade lauric acid accessible in the trading market with some higher expenses. But the expense of the lauric acid is earlier protected by glycerol, if glycerol is crude. Because, the refining expenses of crude glycerol is much greater than the expenses of industrial grade lauric acid. The superior advantage affiliated with this

protocol is the production of water as a side stream rather than some toxic products. Hence, this process could offers climatic feasibility as well. Therefore, this process may prove beneficial to the commercial manufacturers of TGLA and biodiesel as well, as TGLA could be an abundant feedstock for the biodiesel manufacturers.

Reaction mechanism for transesterification of WFO

The transesterification reaction is preferably catalyzed by bronsted acid catalysts, like, sulfonic and sulfuric acids based materials and their reaction mechanism is well explained by many researchers [41]. The mechanism of WFO transesterification could be accomplished via below mentioned steps. This step consists of (i) Protonation to one of the terminal carbonyl group by the MTSA-Si catalyst (ii) Nucleophilic attack of the alcohol towards terminal carbonyl group leads to generate a tetrahedral intermediate (iii) Proton migration and breakdown of the intermediate lead to generate one molecule of biodiesel and one molecule of diglycerides. The migrated proton again absorbed by the MTSA-Si catalyst in order to regenerate and reactivate it for the next use. This entire arrangement will replay twice to form three molecules of biodiesel and one molecule of glycerol. The mechanism scheme for the transesterification of waste frying oil is given in Fig. 8.

Reaction mechanism for esterification of raw glycerol

The fischer-speier esterification is a simple esterification reaction carried out by using carboxylic acid with alcohol in the presence of an adequate acid catalyst. The esterification of lauric acid and glycerol completely follows fischer-speier esterification [42]. The mechanism of glycerol and lauric acid esterification could be completed via four steps, in the first step, acid catalyst will protonate the lauric acid molecule via elimination of the proton form MTSA-Si catalyst, in the second step, the nucleophilic attack of oxygen (from glycerol) will take place to form tetrahedral intermediate. In the third step, tautomerization of the tetrahedral intermediate takes place. Finally, in the fourth step, the removal of one molecule of water and deprotonation of tetrahedral intermediate leads to produce the monoglycerides of lauric acid. The eliminated proton again absorbed by the MTSA-Si catalyst in order to regenerate and reactivate it for the next use. This entire arrangement will replay for twice to form TGLA and three moles of water. The mechanism scheme for the esterification of crude glycerol is demonstrated in Fig. 9.

FT-IR analysis of MTSA-Si

The FT-IR spectra of fresh and regenerated MTSA-Si have been demonstrated in Fig. 10.

The FT-IR spectra of fresh and regenerated MTSA-Si catalyst were confirmed with the presence of characteristics bands at 3342.75 cm^{-1} (OH stretching of Si–OH, intermolecular H-bond), 3146.00 cm^{-1} (N–H stretching), 2712.01 cm^{-1} (C–H stretching), 1728.28 cm^{-1} (C═N stretching), 1687.77 cm^{-1} and 1525.74 cm^{-1} (N–H bending), 1400.37 cm^{-1} (S═O stretching), 1361.79 cm^{-1} (S–O stretching), 1170.83 cm^{-1} (SO_2 asymmetric stretching of SO_3H group), 1087.89 cm^{-1} (O–Si–O stretching) and 976.01 cm^{-1} (SO_2 symmetrical stretching) respectively [43]. No remarkable variations were realized in FT-IR spectra of fresh and regenerated catalysts, they affirmed the confinement of skeleton structure on all accounts of the esterification and transesterification.

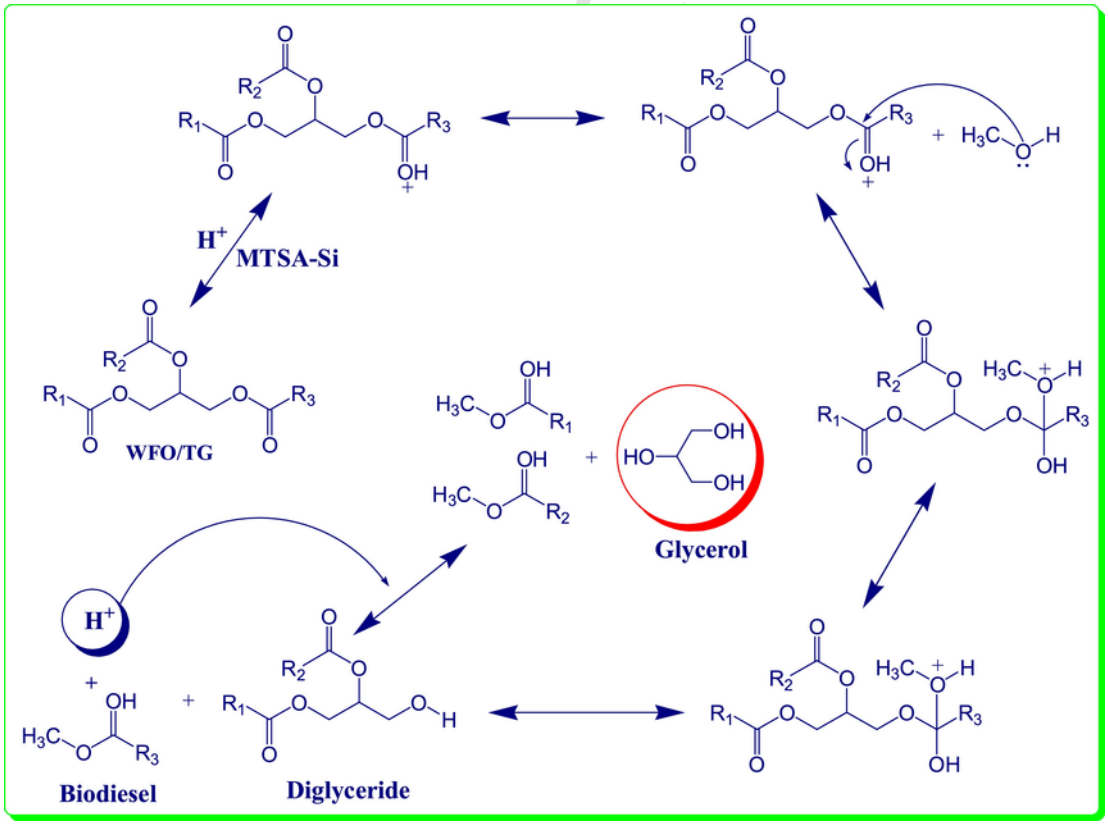

Fig. 8. Mechanism for MTSA-Si catalyzed transesterification of WFO. Where R_1, R_2 and R_3 are carbon chains of different fatty acids.

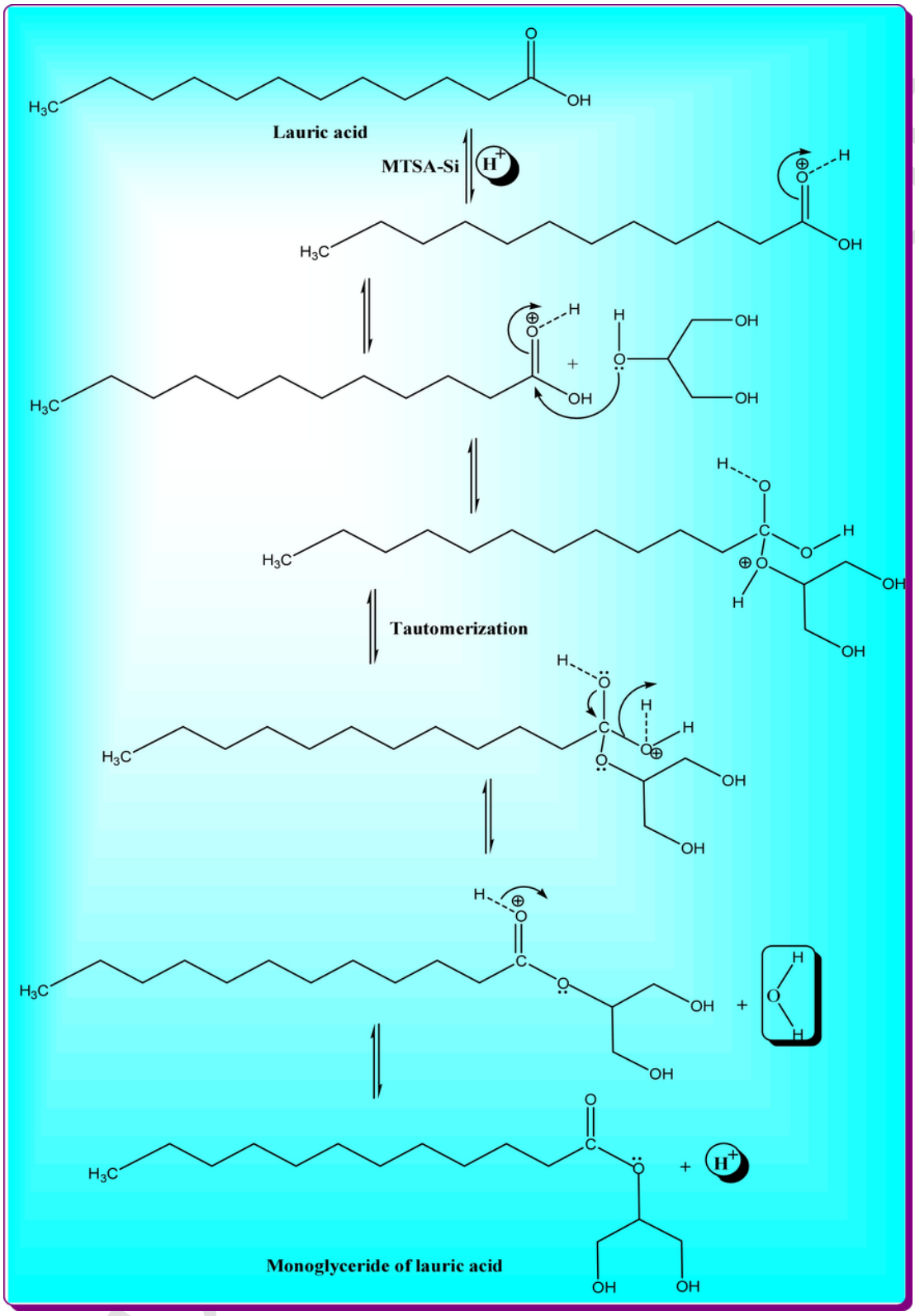

Fig. 9. Mechanism scheme for MTSA-Si catalyzed esterification of crude glycerol to TGLA.

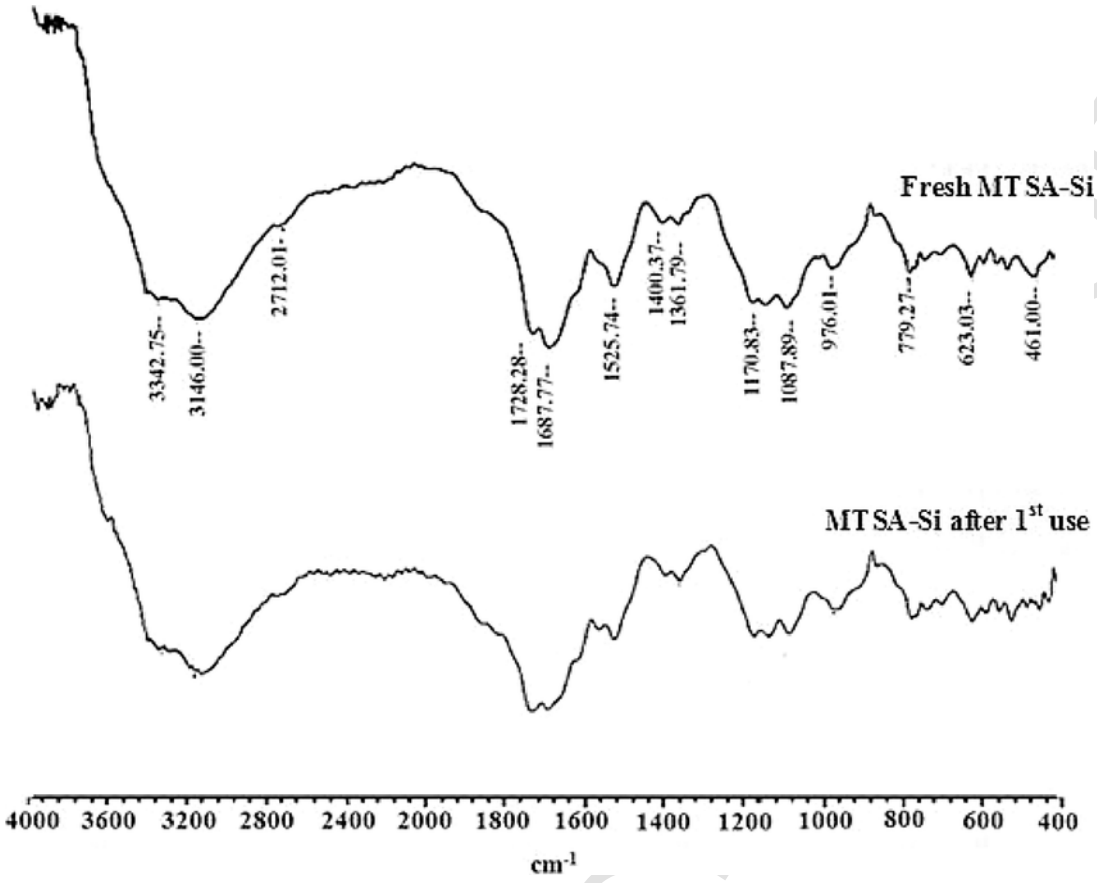

Fig. 10. FT-IR spectra of fresh and regenerated MTSA-Si.

Morphological study of MTSA-Si

The surface morphology of fresh and regenerated MTSA-Si catalysts was recognized using the scanning electron microscope. From SEM micrographs, it has been found that a silica gel molecule offers an irregular pentamerous framework. However, the melamine trisulfonic acid molecules offers irregular flakes like framework structure. It has also been found that the particles size of melamine trisulfonic acid turns to smaller and particles gravitated to assemble after chloro-sulfonation. Additionally, the melamine trisulfonic acid molecules are well arranged in circumforaneous of irregular pentamerous shape silica gel molecules. No indicative changes were ascertained in SEM micrographs of fresh and regenerated MTSA-Si, they affirmed the confinement of skeleton structure throughout the esterification and transesterification. SEM micrographs of fresh and regenerated MTSA-Si catalysts are demonstrated in Fig. 11.

Powder X-ray diffraction study of MTSA-Si

The texture properties of fresh and regenerated MTSA-Si were evaluated by XRD analysis. The spectra displayed natural diffraction peaks suggesting crystallinity of MTSA-Si. The X-Ray diffractograms displays characteristics diffraction pattern showing crystalline planes of MTSA-Si. The characteristics peaks found at 18.94 2θ (deg.), 20.84 2θ (deg.), 22.76 2θ (deg.), 25.14 2θ (deg.), 26.50 2θ (deg.), 28.04 2θ (deg.) and 29.60 2θ (deg.) are attributed to the presence of crystalline silica gel (JCPDS-29-1129). Whereas, sharp peaks recognized at 30.38 2θ (deg.), 32.10 2θ (deg.), 36.64 (deg.), 38.12 2θ (deg.) and 39.74 2θ (deg.) are characteristics of melamine (JCPDS-00-005-0127). In the case of X-Ray diffractrogram of regenerated MTSA-Si catalyst, the intensity of peak at 25.14 2θ (deg.) and 26.50 2θ (deg.) are slight decreased. This may attributed to the leaching of active centers (H^+) from the MTSA-Si surface or slight modification in the structure of MTSA-Si. Otherwise, no indicative major changes were ascertained in the XRD patterns of fresh and regenerated MTSA-Si, they affirmed the confinement of skeleton structure throughout the esterification and transesterification. The wide angle X-Ray diffractograms of fresh and regenerated MTSA-Si have been demonstrated in Fig. 12.

Surface area determination of MTSA-Si

The results of specific surface area, pore size and pore volume have been tabularized in Table 3.

It has been clearly observed from Table 3, the BET surface area (S_{BET}) of MTSA-Si was found to be 108.94 m^2/g. The BET isotherm of MTSA-Si found naturally of Type-IV at lower *p/po* values directing the presence of mesopores in MTSA-Si catalyst. The pore volume and pore size of MTSA-Si was found to be 0.1071 cm^3/g and 15.88 Å respectively. The pore size and surface area reveals the existence of sulfonic acid groups ($–SO_3H$) on the pore surface of melamine species. This fact is in identical with the reported literature [44]. The BET adsorption–desorption isotherm of MTSA-Si has been demonstrated in Fig. 13.

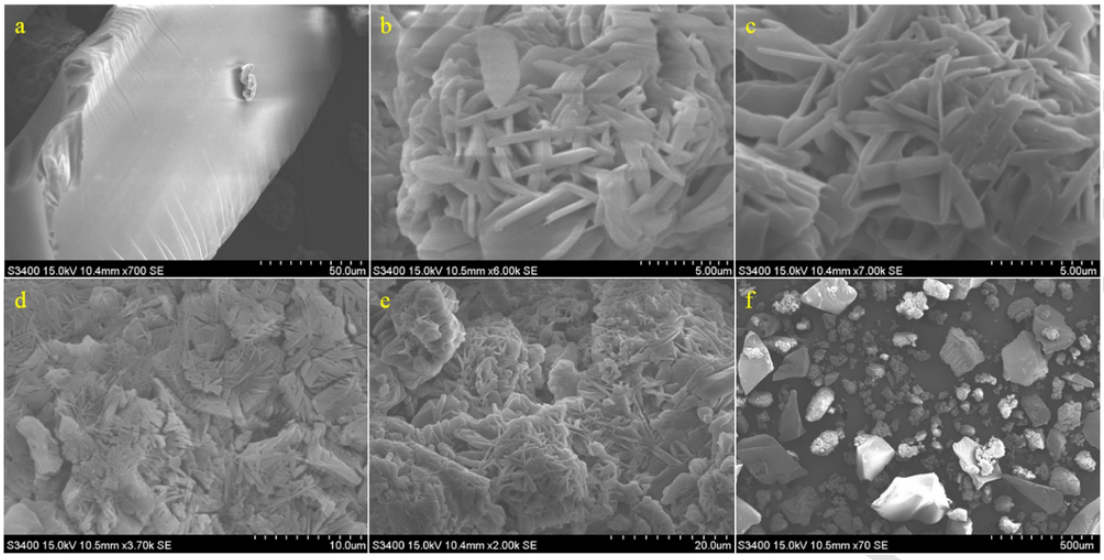

Fig. 11. SEM micrographs of (a) silica gel, (b) fresh MTSA-Si and (c–f) regenerated MTSA-Si.

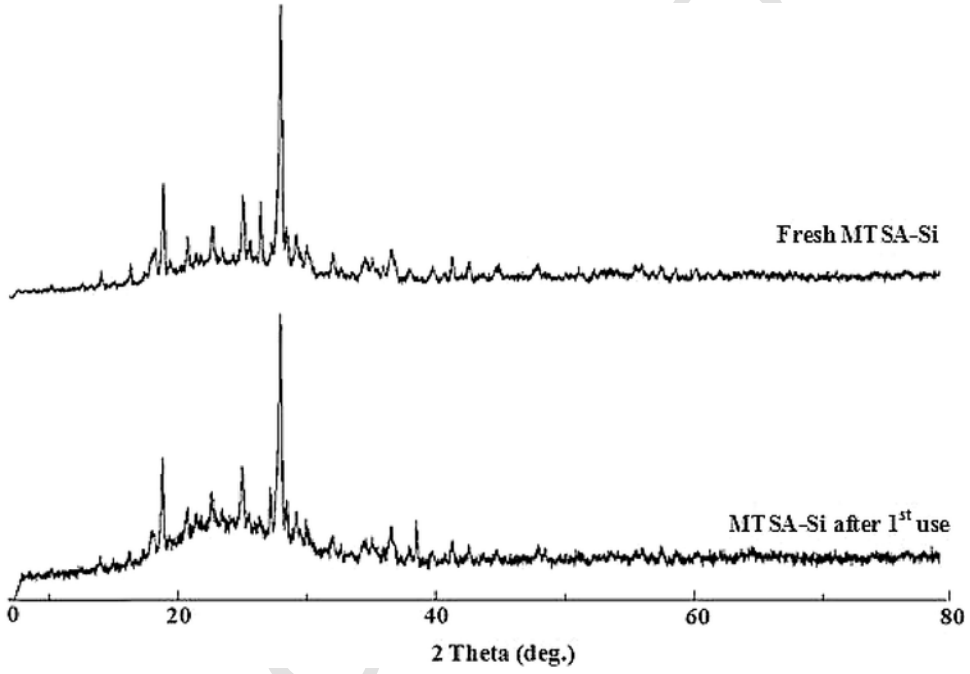

Fig. 12. Large angel X-ray diffractograms of fresh and regenerated MTSA-Si catalysts.

Table 3
Surface area and pore volume of MTSA-Si.

Sr. no	Catalyst	BET surface area (m^2/g) S_{BET}	Total PV (cm^3/g) V_{total}	DFT pore size (Å)
1.	MTSA-Si	232	0.1071	15.88

Acidity measurement study

The acidity of solid acid catalyst is a very significance property for the heterogeneous catalysis. Solid acid catalysts may contain both lewis and bronsted acidic sites. Both nature and strength of acid sites play an important role in expressing catalytic activity of many solid acid catalysts. Hence, the measurement of surface acidity of solid catalysts is of immense importance from technological point of view because it not only helps to characterize a catalyst sample but also provides a method of screening of a catalyst sample for optimal yield in a process. Accordingly, a large number of methods are accessible for the estimation of acidity of solid acid catalysts. The total acidity of the MTSA-Si catalyst was found to be 1.1 mmol g^{-1}, which was estimated through the neutralization titration. In a 500 mL glass beaker, 0.6 g MTSA-Si catalyst was added along with 4 mL 2 N aqueous NaCl and stirred those at ambient conditions for 24 h in order to allow the ion exchange in the solution. Then after, the solids were filtered off from the aqueous solution and washed thrice with distilled

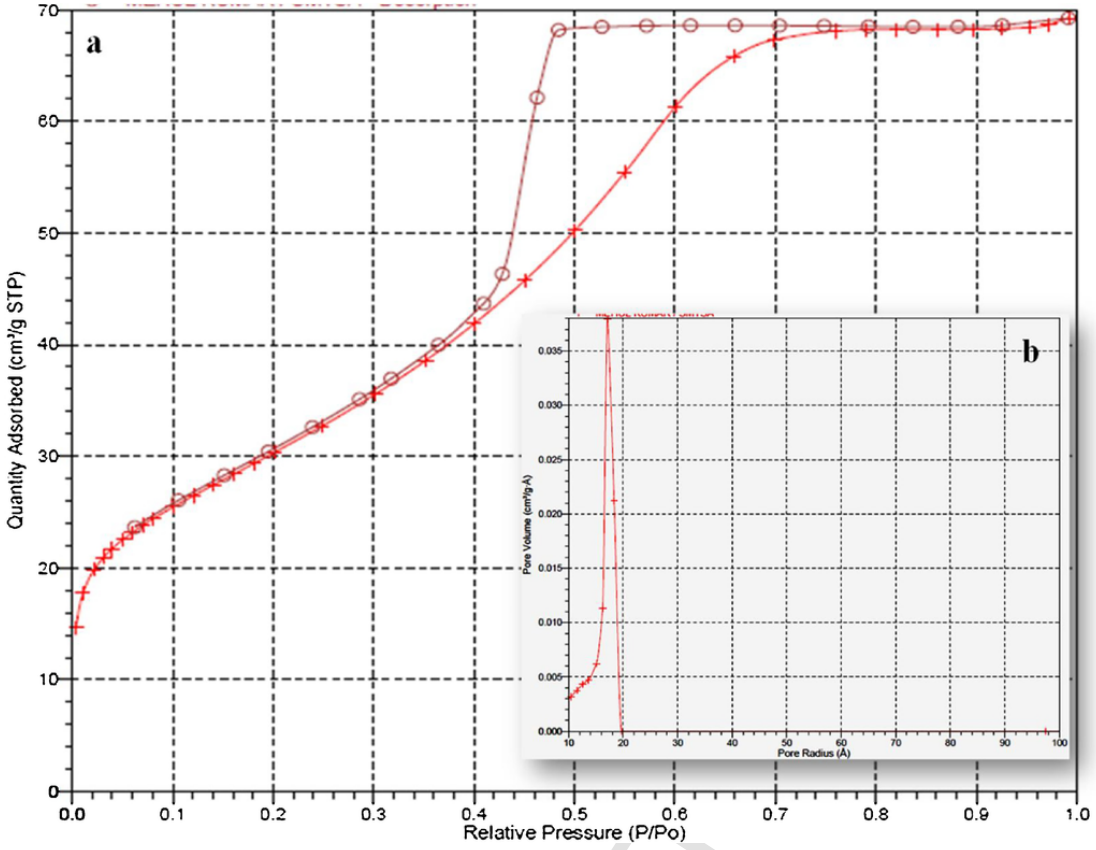

Fig. 13. (a) BET isotherm of MTSA-Si and (b) pore size distribution of MTSA-Si.

water (15 mL). The collective filtrate was titrated with 0.01 N NaOH using phenol red as an indicator [42].

Thermal stability study of MTSA-Si

The thermogravimetric analyzer (TGA) is an essential laboratory tool used for determination of thermal stability of materials and compositions of volatile compounds by keeping track record of the weight loss that occurs when material is heated. The thermal stability of MTSA-Si was estimated by thermogravimetric analysis. From the TGA thermogram of MTSA-Si, it has been found that the 10.72% weight loss occurs in a temperature range of 30–210 °C is pertaining to the molecular moisture decomposition, 26.46% weight loss occurs in a temperature range of 210–550 °C is pertaining to the melamine decomposition and 12.75% weight loss occurs in a temperature range of 570–920 °C is pertaining to the decomposition of sulfonic acid group (–SO_3H) attached to the melamine. In the present study, the maximum reaction temperature employed for the transesterification and esterification reactions are 130 °C and 100 °C respectively. Whereas, the weight loss (7.306%) has been observed in the range of temperature 30–210 °C and it's due to the decomposition of molecular moisture. From the TGA thermogram, it could be recognized that the thermal stability of MTSA-Si is not much influenced at 130 °C reaction temperature. Therefore, the MTSA-Si offers a remarkable thermal stability also. The TGA thermogram of MTSA-Si has been expressed in Fig. 14.

FT-IR analysis of biodiesel

The FTIR spectrum of waste frying biodiesel is confirmed with the presence of characteristics bands at 2924.09 cm^{-1} (CH_3 stretching), 2854.65 cm^{-1} (CH_2 stretching), 2360.87 cm^{-1} (C═C stretching), 1743.65 cm^{-1} (C═O), 1458.18 cm^{-1} (CH bending), 1195.87 cm^{-1} and 1172.72 (C–O) and 725.23 cm^{-1} (CH rocking) respectively [43]. The FT-IR spectrum of synthesized biodiesel is given in Fig. S3.

^{1}H NMR analysis of biodiesel

The purity of waste frying biodiesel is further confirmed by the presence of characteristics peaks at 5.22–5.28 (unsaturated olefinic –CH═CH– protons) ppm, 3.57 (CH_3O-methoxy protons) ppm, 3.36 (OCH_2 protons) ppm, 2.69 (CH protons) ppm, 2.19–2.23 (OCH protons) ppm, 1.91–1.98 (β-CH_2 protons) ppm, 1.52–1.56 (α-CH_2 protons) ppm and 1.18–1.23 (CH_3 protons) ppm respectively [45]. The ^{1}H NMR spectrum of biodiesel has been given in Fig. S4.

^{13}C NMR analysis of biodiesel

The purity of waste frying biodiesel is confirmed by the presence of characteristics peaks, including, 173.88–173.91 ppm (C═O carbons), 127.79–129.92 ppm (olefinic carbons), 76.80–77.43 ppm ($CDCl_3$-solvent), 51.11 ppm (O–CH_3 carbon) and 27.05–33.90 ppm (aliphatic carbons) respectively [46]. The ^{13}C NMR spectrum of biodiesel is given in Fig. S5.

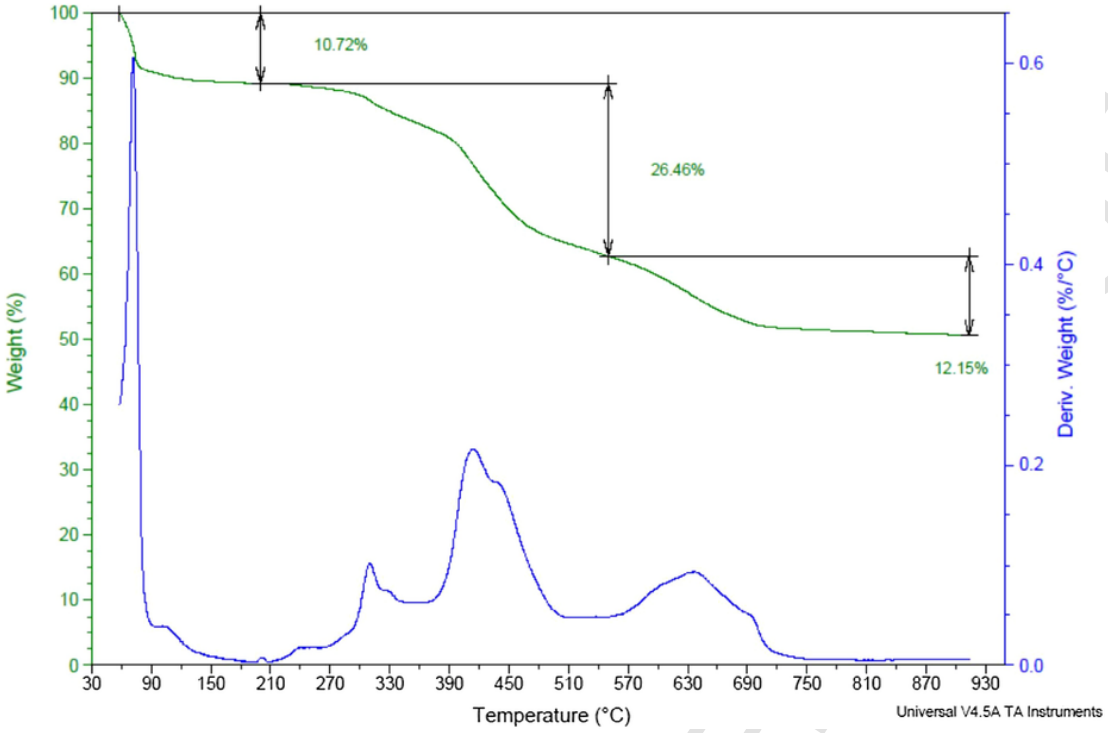

Fig. 14. TGA profile of MTSA-Si.

FT IR analysis of TGLA

FTIR spectrum of TGLA is confirmed with the presence of characteristics bands at 2924.09 cm^{-1} (CH_3 stretching), 2854.65 cm^{-1} (CH_2 stretching), 2360.87 cm^{-1} (C═C stretching), 1712.79 cm^{-1} (C═O), 1458.18 cm^{-1} (CH bending), 1188.15 cm^{-1} (C-O) and 725.23 cm^{-1} (CH rocking) respectively [43]. The FT-IR spectrum of TGLA has been demonstrated in Fig. S6.

^{1}H NMR analysis of TGLA

The purity of TGLA is confirmed by the presence of characteristics peaks corresponding to 3.54 (O–CH_2) ppm, 2.51 (α-CH_2 protons) ppm, 2.12–2.22 (β-CH_2 protons) ppm, 1.96 (CH_3 protons) ppm, and 1.22–1.47 (CH protons) ppm respectively [45]. The ^{1}H NMR spectrum of TGLA is given in Fig. S7.

^{13}C NMR analysis of TGLA

The purity of TGLA is further confirmed by the presence of characteristics peaks, including, 172.80–174.41 ppm (C═O carbons), 127.51–129.26 ppm (olefinic carbons), 50.79 ppm (CH_3 carbon), 69.26 ppm (O–CH_2 carbon) and 28.56–39.91 ppm (aliphatic carbons) respectively [46]. The ^{13}C NMR spectrum of TGLA has been depicted in Fig. S8.

Reusability of MTSA-Si

The widespread and easy commercialization of any fuel is strictly depends on their manufacturing cost. With a view to shorter down the expense of biodiesel and TGLA synthesis, the MTSA-Si was examined for their potential reusability for the esterification and transesterification reactions. Hence, in this approach, after each run, the MTSA-Si catalyst was isolated from the reaction mass through vacuum filtration and treated thrice with dichloro methane in order to eliminate some impurity like, the surface restrained moisture, unspent triacylglyceride, diacylglycerides, monoacylglyceride, glycerol and unspent methyl alcohol. Before reuse, dichloro methane treated MTSA-Si was kept in a tray dryer at 110 °C for 20 h in order to acquiesce elimination of organic solvent traces and reactivation of active centers (H^+) on the melamine surface. It has been recognized from the results of esterification and transesterification reactions, the MTSA-Si catalyst could have a potential to reuse five times without indicative disappearance of catalytic activity. However, the slight subtraction in the (%) yields of biodiesel and TGLA have been recognized on the repetitive runs of MTSA-Si. The percolation of active centers (H^+) or modification of MTSA-Si structure at given reaction temperature could play significant role in the deactivation of MTSA-Si catalyst. It has been found from the repetitive runs and spectral analysis of the MTSA-Si catalyst (Figs. 10–12), the melamine preserves its structure throught the esterification and transesterification reactions without any serious distortion. In the case of biodiesel synthesis, a fresh MTSA-Si catalyst could shows highest conversion up to 98.22%. While, it's first, second, third, fourth and fifth repetitive run could shows highest conversions up to 94.25%, 89.33%, 86.52%, 83.69% and 78.45% respectively. The influence of MTSA-Si run on the (%) yield of biodiesel has been illustrated in Fig. 15.

Whereas, in the case of TGLA synthesis, a fresh MTSA-Si catalyst could shows highest conversion up to 92.28%. While, it's first, second, third, fourth and fifth repetitive run could shows highest conversions up to 89.11%, 86.33%, 81.28%, 77.45% and 70.18% respectively. The influence of MTSA-Si run on the (%) yield of TGLA has been illustrated in Fig. 16.

Comparison of catalytic activity of MTSA-Si

Table 4 shows the comparison of catalytic performance of MTSA-Si with reported results of the various solid acid catalysts employed for the transesterification of oil to biodiesel.

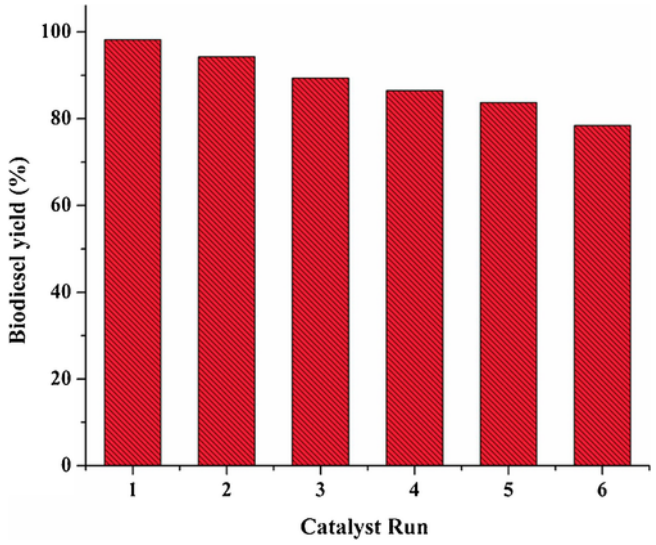

Fig. 15. The effect of catalyst run times on (%) yield of biodiesel.

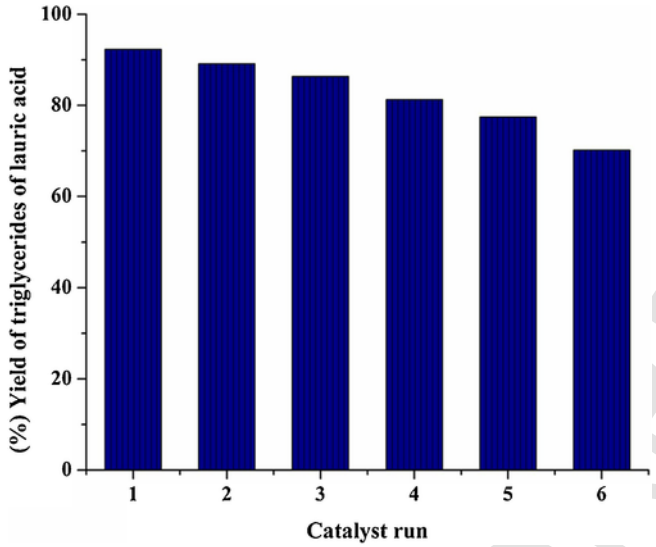

Fig. 16. The effect of catalyst run times on (%) yield of TGLA.

From Table 4, it could be observed that MTSA-Si catalyst shows remarkable catalytic performance for the transesterification of waste frying oil for synthesis of biodiesel. In present study, the best results achieved at optimum reaction conditions like, (i) 130 °C reaction temperature, (ii) 1:10 oil to methanol molar ratio, (iii) 5% (*w/w*) catalyst and (iv) 10 h reaction time, for the 98.22% biodiesel yield. It has also been found from Table 4, the results of the present study are comparable to the results of reported literature of the solid acid catalysts, where comparatively precise reaction parameters (too high reaction temperatures and oil to methanol molar ratio) were reported [47–49,51–54].

Moisture absorption test for MTSA-Si

The MTSA-Si was also studied for its moisture absorption susceptibility. In this process, the required amount of MTSA-Si catalyst was put up in a glass vessel under saturated humidity at atmospheric temperature for several days in order to acquiesce the absorption of moisture on the MTSA-Si surface. The MTSA-Si samples were weighted at regular interval of times. The absorbing moisture rate (*W*%) of the samples were determined by Eq. (3).

$$\mathrm{W\%} = \left[\frac{56\,\Delta \mathrm{m}}{18\mathrm{mo}}\right] \times [100] \tag{3}$$

where, Δm refers to the increased weight and m_0 refers to the initial weight of the MTSA-Si sample. The influence of exposure time (h) on the moisture absorption of MTSA-Si is illustrated in Fig. S9.

From Fig. S9, it has been observed that moisture absorption rate (*W*%) is increased gradually with increased in moisture exposure time (h). The melamine trisulfonic acid (MTSA) catalyst offers three hydroxyl (–OH) groups in association to the three sulfonic acid groups. Hence, as a result of polar texture of catalyst, the MTSA-Si catalyst could easily absorb the moisture from constant humidity surroundings.

Estimation of fuel properties of biodiesel

The most important fuel properties which influence the engine performance of the diesel engine are like, the process taking place in the engine, (i) ignition quality, (ii) serenity of starting, (iii) production and flaming of the fuel-O_2 mixture, (iv) formation of burn out gas and its quality and (v) the calorific index. The cool climate properties like, (i) cloud point, (ii) pour point and (iii) cold filter plugging point. The storage and transportation properties like, (i) oxidative and thermal stability, (ii) flash point, (iii) an ordination period, (iv) micro-

Table 4
Comparison of catalytic activity of MTSA-Si with reported literature.

Sr. no	Catalyst	Reaction conditions				Biodiesel yield (%)	Ref.
		Reaction temp. (°C)	Catalyst % (w/w)	O/M molar ratio	Reaction time (h)		
1.	MTSA-Si	130	5.0	1:10	10	98.22	Present work
2.	$H_3PW_{12}O_{40}$·Nb_2O_5	200	3.0	1:18	20	94.00	[47]
3.	Zr–PMOs	209	12.8	1:48.5	6.0	85.00	[48]
4.	$[(CH_2)_4SO_3HPy\text{-}HSO_4]$	170	2.0	1:12	5.0	92.00	[49]
5.	$H_3PW_{12}O_{40}$/SBA-15	65	0.3	1:2	12	75.0	[50]
6.	Propyl-SO_3H SBA-15	190	5.0	1:6	15 min	38.0	[51]
7.	Arene-SO_3H SBA-15	190	5.0	1:6	15 min	56.0	[51]
8.	Me/Arene-SO_3H SBA-15	190	5.0	1:6	15 min	58.0	[51]
9.	EBD-100	65	1.0	1:12.2	24	100	[52]
10.	EBD-200	65	1.0	1:12.2	24	100	[52]
11.	EBD-300	65	1.0	1:12.2	24	81.0	[52]
12.	Ti/SiO_2 nanoflowers	65	5.0	1:30	4.0	98.0	[53]
13.	Lithium-doped ceria supported SBA-15	65	10.	1:40	4.0	>98.0	[54]

bial degradation and (v) percolation limit temperature. The wear properties like, (i) lubricity, (ii) cleaning effect, (iii) viscosity, (iv) density and (v) consonance with materials employed to prepare a fuel. The physicochemical properties of biodiesel can be estimated by the fatty acid profiles of corresponding oils. The fuel properties of biodiesel can alter substantially from one oil to oil in virtue of its slight higher molar mass than conventional diesel [55]. Some fuel properties of WFO based biodiesel and its comparison with ASTM fuel standards has been tabularized in Table 5.

The flash point and fire point (ASTM D6751) were measured with help of cleveland open cup tester (Pensky-martens). The cetane number (ASTM D 976) was estimated by cetane number analyzer (AFIDA 2805). The iodine value (AOCS CD1-25 1993) and acid value (ASTM D664) were estimated through titration methods. The calorific value (IS:1448:(P:33):1991) was determined by an oxygen bomb calorimeter (model 6772, Parr instrument Ltd, USA). Kinematic viscosity was estimated using viscometer bath (ASTM D6751, Aditya 01). The density (D4052-91) of biodiesel was predicted by hydrometer method (D1298). The cloud point is an exclusive cold flow property that is recognized in ASTM D6751 standards [56]. From Table 5, it has been found that all fuel properties are in consonance with the test limits, which were defined by ASTM and AOCS fuel standards.

Conclusion

Herein, a promising MTSA-Si catalyst was prepared via chlorosulfonation of melamine and evaluated for the transesterification of WFO for biodiesel synthesis. It has been realized from experimental results, the optimum reaction conditions for the biodiesel preparation are (i) 1:10 oil to methanol molar ratio, (ii) 5% MTSA-Si *(w/w)*, (iii) 130 °C reaction temperature and (iv) 10 h reaction time for the 98.22% yield of biodiesel. As MTSA-Si could simultaneously catalyze esterification and transesterification, hence, it does not demands refined feedstocks. Currently, the biodiesel manufacturers are facing a serious problem to dump the crude glycerol produced as a side product during biodiesel production and availability of a cheaper feedstock for biodiesel production. Therefore, we made a small attempt to convert the biodiesel based crude glycerol to triglycerides of lauric acid using MTSA-Si catalyst. It has been illustrated from the experimental results, the optimal reaction conditions for the maximum (%) yield of TGLA (92.28%) are, (i) 1:3 glycerol to lauric acid molar ratio, (ii) 2% MTSA-Si *(w/w)*, (iii) 100 °C reaction temperature and (iv) 7 h reaction time. Hence, this protocol offers duple advantages; i.e (i) crude glycerol is effectively transformed into corresponding triglycerides and (ii) synthesized triglycerides could be used as cheaper feedstock for biodiesel production. Besides, the MTSA-Si could successfully be used for five repetitive runs without any serious distortion of their performance for esterification and transesterification.

Table 5
Fuel properties of WFO based biodiesel based on ASTM and AOCS fuel standards.

Sr. no	Properties	Unit	Method	Value	ASTM limits
1.	Flash point	(°C)	ASTM D6751	133	>130
2.	Fire point	(°C)	ASTM D6751	141	>140
3.	Pour point	(°C)	ASTM D 97	−16	−15
4.	Cetane index	–	ASTM D 976	49	52.0
5.	Iodine value	g I_2/100 g	AOCS CD1-25 1993	91	120
6.	Calorific value	MJ/kg	IS:1448:(P:33):1991	39.85	–
7.	Total acid number	mg KOH/g	ASTM D 664	0.78	0.8
8.	Kinematic viscosity @ 40 °C	mm^2/s	ASTM D6751	4.21	1.9–6.0
9.	Density @ 25 °C	Kg/m^3	ASTM D4052-91	867	860–900
10.	Cloud point	(°C)	ASTM D6751	9.8	–

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jiec.2018.03.036.

References

[1] K. Dincer, Energy Source Part A 30 (2008) 963.
[2] S.N. Naik, V.V. Goud, P.K. Rout, A.K. Dalai, Renew. Sustain. Energy Rev. 14 (2010) 578.
Y.P. Peng, K.T.T. Amesho, C.E. Chen, S.R. Jhang, F.C. Chou, Y.C. Lin, Catalysts 8, 2018, 1.
M.N. Hossain, M.S. Ullah Siddik Bhuyan, A.H.M.A. Alam, Y.C. Seo, Energies 11, 2018, 1.
F. Ma, M.A. Hanna, Bioresour. Technol. 70, 1999, 1.
M.G. Kulkarni, A.K. Dalai, Ind. Eng. Chem. Res. 45, 2006, 2901.
[7] S. Pradhana, J. Shen, S. Emami, P. Mohanty, S.N. Naik, A.K. Dalai, M.J.T. Reaney, J. Ind. Eng. Chem. 46 (2017) 266.
P.M. Veiga, C.O. Veloso, C.A. Henriques, Renew. Energy 99, 2016, 543.
[9] J.F. Puna, J.F. Gomes, J.C. Bordado, M. Joana Neiva Correia, A. Paula Soares Dias, Appl. Catal. A 470 (2014) 451.
M. Catarino, M. Ramos, A.P. Soares Dias, M.T. Santos, J.F. Puna, J.F. Gomes, Waste Biomass Valoriz. 8, 2017, 1699.
[11] I.B. Bankovic-Ilic, M.R. Miladinovic, O.S. Stamenkovic, V.B. Veljkovic, Renew. Sustain. Energy Rev. 72 (2017) 746.
P. Felizardo, M.J.N. Correia, I. Raposo, J.F. Mendes, R. Berkmeier, J.M. Bordado, Waste Manage. 26, 2005, 487.
F. Zaher, Energy Source 25, 2003, 819.
[14] N.P. Anh, M.P. Tan, Fuel 87 (2008) 3490.
[15] M. Niu, X. Kong, RSC Adv. 5 (2015) 27273.
M. Rakib Uddin, K. Ferdous, M. Rahim Uddin, M.R. Khan, M.A. Islam, Chem. Eng. Sci. 1, 2013, 22.
K. Khalisanni, K. Khalizani, M.S. Rohani, P.O. Khalid, Global J. Environ. Res. 2, 2008, 81.
[18] N. Idun-Acquah, G.Y. Obeng, E. Mensah, SciTech 6 (2016) 8.
[19] V.B. Borugadda, V.V. Goud, Waste Biomass Valoriz. 7 (2016) 23.
[20] E. Lotero, Y.J. Liu, D.E. Lopez, K. Suwannakarn, D.A. Bruce, J.G. Goodwin, Ind. Eng. Chem. Res. 44 (2005) 5353.
[21] T. Okuhara, Chem. Rev. 102 (2002) 3641.
W.M. Van Rhijn, D.E. De Vos, B.F. Sels, W.D. Bossaert, P.A. Jacobs, Chem. Commun. 3, 1998, 317.
Y. Zhou, I. Noshadi, H. Ding, J. Liu, R.S. Parnas, A. Clearfield, M. Xiao, Y. Meng, L. Sun, Catalysts 8, 2018, 17.
[24] M.A. Harmer, W.E. Farneth, Q. Sun, Adv. Mater. 10 (1998) 1255.
G.D. Yadav, J.J. Nair, Microporous Mesoporous Mater. 33, 1999, 1.
[26] M.A. Harmer, Q. Sun, A.J. Vega, W.E. Farneth, A. Heidekum, W.F. Hoelderich, Green Chem. 2 (2000) 7.
R.A. Soldi, A.R.S. Oliveira, L.P. Ramos, M.A.F, Appl. Catal. A Gen. 361, 2009, 42.
C.S. Caetano, L. Guerreiro, I.M. Fonseca, A.M. Ramos, J. Vital, J.E. Castanheiro, Appl. Catal. A Gen. 359, 2009, 41.
M.L. Savaliya, M.S. Bhakhar, B.Z. Dholakiya, Catal. Lett. 146, 2016, 2313.
[30] G.P. Hammond, S. Kallu, M.C. Mc Manus, Appl. Energy 85 (2008) 506.
[31] M. Canakc, Bioresour. Technol. 98 (2007) 183.
J.J. Zhang, L.F. Jiang, Bioresour. Technol. 99, 2008, 8995.
C. Oner, C. Altun, Appl. Energy 86, 2009, 2114.
[34] B. Choubisa, M.R. Patel, B.Z. Dholakiya, Res. Chem. Intermed. 39 (2013) 3063.
M. Vafaeejadeh, A. Fattahi, Phosphorous Sulfur Silicon 189, 2014, 849.
[36] H. Ma, S. Li, B. Wang, R. Wang, S. Tian, J. Am. Oil Chem. Soc. 85 (2008) 263.

P. Garcia Moreno, M. Khanum, A. Guadix, E.M. Guadix, Renew. Energy 68, 2014, 618.
[38] A.M. Ruhul, M.A. Kalam, H.H. Masjuki, I.M. Rizwanul Fattah, S.S. Reham, M.M. Rashed, RSC Adv. 5 (2015) 101023.
P. Maneechakr, J. Samerjit, S. Karnjanakom, RSC Adv. 5, 2015, 55252.
D.J. Pyle, Master of Science Thesis, 2008, Virginia Polytechnic Institute and State University Blacksburg, p. 1.
[41] B.Z. Dholakiya, Arch. Appl. Sci. Res. 4 (2012) 551.
[42] M.L. Savaliya, B.Z. Dholakiya, RSC Adv. 5 (2015) 74416.
G. Gauglitz, T. Vo-Dinh, Handbook of Spectroscopy, 2003, Wiley-VCH Verlag Gmbh & Co Kgaa, Weinheim, ISBN 3-527-29782-0, 1-502.
[44] S. Brunauer, P.H. Emmett, E. Teller, J. Am. Chem. Soc. 60 (1938) 309.
J.K.M. Saunders, B.K. Hunter, Modern NMR Spectroscopy — A Guide for Chemists, 2nd Edn, 1993, Oxford University Press, Oxford, p. 1.
[46] I. Wawera, S. Witkowski, Curr. Org. Chem. 5 (2001) 987.
[47] V. Brahmkhatri, A. Patel, Fuel 102 (2012) 72.
[48] R. Sánchez-Vázquez, C. Pirez, J. Iglesias, K. Wilson, A.F. Lee, J.A. Melero, ChemCatChem 5 (2013) 994.
[49] W. Schmidt Dr, ChemCatChem 1 (2009) 53.
[50] V. Brahmkhatri, A. Patel, Appl. Catal. A 403 (2011) 161.
[51] D. Zuo, J. Lane, D. Culy, M. Schultz, A. Pullar, M. Waxman, Appl. Catal. B 129 (2013) 342.
[52] B.M.E. Russbueldt, W.F. Hoelderich, Appl. Catal. A 362 (2009) 47.
[53] M. Kaur, R. Malhotra, A. Ali, Renew. Energy 116 (2018) 109.
[54] R. Malhotra, A. Ali, Renew. Energy 119 (2018) 32.
[55] P. Purohit, S. Gaikwad, R. Gurav, International conference on recent technology, Institute of knowledge, College of engineering, Shikrapur, pune, India, (2012) 1–6.
[56] A. Evcil, F. Al-Shanableh, M.A. Savas, Fuel215 (2018) 522.

Method Development and Validation for the estimation of Bupivacaine HCl API by HPLC and Stability Indicating Method.

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By

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Date:

CERTIFICATE

This is certify that the dissertation project entitled **"Method Development and Validation for the estimation of Bupivacaine HCl API by HPLC and Stability Indicating Method"** was successfully carried out by **Dhwani Chandarana** and submitted to Department of Biotechnology, Shree Manibhai Virani and Smt. Navalben Virani Science College (Autonomous) affiliated to Saurashtra University, Rajkot**,** in partial fulfillment of requirements for the degree of Master of Science in Biotechnology. It is an authentic record of **her** own work carried out by **her** during the academic year of 2018-19.

(Signature)

Bhavesh Patel
(Guide)
Designation
Zydus Cadila
.

(Signature with seal)
Zydus Cadila/
Designation,
Name of company

DECLARATION

I hereby declare that the dissertation project entitled **"Method Development and Validation for the estimation of Bupivacaine Hcl API by HPLC and Stability Indicating Method."** which is being submitted as a partial fulfillment of the degree of Master of Science in Biotechnology, is carried out by me during academic year 2018-19. The information and articles referred from authors, journals and library are duly acknowledged. I further declare that this dissertation thesis written by me has not been previously submitted to this or any other College/Institute/University for any Certificate/ Diploma/ Degree

Student's signature

Dhwani Chandarana

Date:

Place: Rajkot

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Abbreviations

Min	Minutes
Gms	Grams
mL	Milli litre
µg	Micro gram
˚C	Degree Centigrade
%RSD	Relative Standard Deviation
ICH	International council for Harmonization
NaOH	Sodium Hydroxide
H2O2	Hydrogen Peroxide
HCl	Hydrochloric Acid

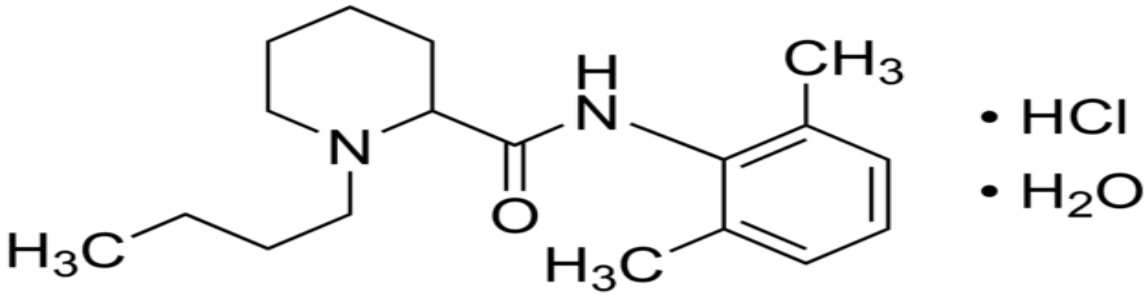
1. ABSTRACT

A simple and precise HPLC method was developed and validated for the determination of bupivacaine hydrochloride API. Chromatography was carried out using Zorbax Eclipse, C8 150*4.6 mm*5µm and pH 7.7 of mobile phase buffer: acetonitrile (35:65) and the flow rate was 1.0 mL/min and the column oven temperature was maintained at 25˚C. The analyte was monitored using PDA detector at 220 nm. The retention time of the drug was 4.59 min for bupivacaine hydrochloride. The proposed method was found to have linearity in the concentration range of 50.5 µg/mL – 151.5 µg/mL with correlation coefficient of $r^2 = 0.9999$. The developed method has been statistically validated and found simple and accurate. The mean recoveries obtained for bupivacaine hydrochloride were in the range of 98% to 102%. The % RSD of Bupivacaine HCl during the assay method precision study was found to be 0.9%.Due to its simplicity, rapidness, robustness, specificity, high precision and accuracy of the proposed method, it may be used for determining bupivacaine hydrochloride API.

2. INTRODUCTION

2.1 Introduction to Bupivacaine:

Bupivacaine hydrochloride (BPCH) is 2-piperidinecarboxamide1, 1-butyl-N-(2,6dimethylphenyl)-, monohydrochloride, monohydrate, a white crystalline powder that is freely soluble in 95 percent ethanol, soluble in water, and slightly soluble in chloroform or acetone.



Bupivacaine block the generation and the conduction of nerve impulses, presumably by increasing the threshold for electrical excitation in the nerve, by slowing the propagation of the nerve impulse, and by reducing the rate of rise of the action potential. Bupivacaine binds to the intracellular portion of sodium channels and blocks sodium influx into nerve cells, which prevents depolarization.

Literature survey reveals that there are no stability indicating method by HPLC for Bupivacaine HCl injection. So an attempt has been made to develop and accurate, specific and reproducible method for determination of Bupivacaine using HPLC along with method validation as per ICH norms. The stability tests were performed on Drug Substance according to the ICH norms.

2.2 Importance of development of stability-indicating analytical methods in pharmaceutical research and development.

Stability requirements during development of a drug:

The stability testing provides evidence on how the quality of an active pharmaceutical ingredient or drug product varies with time under the effect of several environmental factors such as various temperature conditions, light & humidity conditions. This facilitates suitable or recommended storage conditions, retesting periods and shelf lives to be established for the API or drug substances.

The stability information of the active pharmaceutical ingredient or drug substance is an integral part and provides a systematic approach to stability assessment. The goal of stability establishment is an integral part of product development and begins with the stage of development of the drug product. At early development stage of drug product, it is necessary to understand the essential stability of the drug substance and its interaction with the proposed excipients. At this stage the effect of pH and different environmental conditions like moisture, air/oxygen and light on the stability of the drug substance is mandate for consideration in to the study. The subjected accelerated testing on drug substance and drug product provides the information to the intrinsic stability of the molecule/formulation and may establish the likely degradation pathways.

3. REVIEW OF LITERATURE

1) A method was developed for the determination of fernatyl citrate and Bupivacaine HCl mixtures in infusion solutions where stationary phase was LiChrospher 100 CN, 250*4 mm*10 µm and the mobile phase was mixture of ACN: phosphate buffer at pH 2.8 and addition of potassium chloride was found where the method was not validated as per ICH norms.

2) A method was developed for the determination of Meloxicam and Bupivacaine HCl mixtures in Human Plasma where stationary phase was HSS T3 column of Dimensions: 50 mm x 2.1 mm i.d., 1.8 µm and the mobile phase A and B were used. Mobile A consists of mixture of Ammonium formate at pH 2.8 and Mobile phase B consisted of ACN:WATER :FORMIC ACID was found where the method was validated as per ICH norms.

4. MATERIALS AND METHOD

4.1 Instrumentation:

To develop quantitative analysis on High Performance Liquid Chromatography method for determination of Bupivacaine HCl was carried out using Agilent HPLC 1100 Series consisting of Variable Wavelength Detectors (UV/Visible) and for Stability indicating method photo diode array detector was used. The output signal was monitored and processed using Chromeleon Software.

4.2 Chemicals and reagents:

Bupivacaine Hydrochloride was obtained as a sample from the Cambrex Corporation. The HPLC grade Acetonitrile (ACN) of Qualigens and Merk was used. The HPLC grade Methanol (MeOH) of Rankem was used. High purity water i.e. Milli Q water was used for Buffer Preparation and Diluent Preparation. Buffer was prepared by using Potassium dihydrogen phosphate and Dipotassium hydrogen phosphate of Sigma-Aldrich and for the adjusting the pH Ortho-Phosphoric Acid was used.

4.3 Method Development:

4.3.1 Selection of Wavelength:

Different trials were taken for selection of wavelength using water: methanol, and only methanol as a diluent for Bupivacaine HCl API.

4.3.2Optimization of Mobile Phase:

Different systematic trials were made using different mobile phase given as under,

(1) Buffer Preparation:

Buffer was prepared by weighing accurately 1.94gms of potassium dihydrogen phosphate and 2.48gms of dipotassium hydrogen phosphate in was dissolved in 1000 mL in water and adjust pH 6.8 with KOH solution.

- Mobile Phase: Mix Acetonitrile: Buffer in a ratio of (65:35) and adjust the pH 7.7 with Ortho-Phosphoric Acid.

(2) Buffer Preparation:

Buffer was prepared by weighing accurately 1.36gms of potassium dihydrogen phosphate was dissolved in 1000mL of water and adjust the pH to 7.4 with Tri-ethylamine.

- Mobile Phase: Mix Acetonitrile: Buffer in a ratio of (70:30)

(3) Buffer Preparation:

Buffer was prepared by weighing accurately 2.0 gms of Potassium dihydrogen phosphate and 2.5gms of Dipotassium hydrogen phosphate dissolving it in 1000 mL of Milli-Q water. The pH was then adjusted to 6.8 with diluted ortho-phosphoric acid and filtered through 0.45 µm nylon membrane filter.

- Mobile Phase***:*** Mobile phase was prepared in a ratio of Buffer: Acetonitrile of (35:65) and the pH was adjusted to 7.7 with diluted ortho-phosphoric acid.

Diluent Preparation:

- Diluent was prepared using Milli Q water and Methanol in the ratio of (10:90) (v/v).

4.3.3 Optimization of Column:

Different systematic column trials were made using different column of Water Symmetry (C18, 250, 4.6*5µm), Kromasil 100 (C18, 250* 4.5*5µm), Hypersil BDS (250*4.6*5µm).

4.4 Chromatographic Conditions:

Mobile phase consists of buffer: acetonitrile in the ratio of (35:65) where the pH was adjusted to 7.7 with ortho-phosphoric acid. The column used was Zorbax Eclipse, C8 150*4.6 mm*5µm. The mobile phase was pumped from the solvent reservoir to the column at a flow rate 1.0 mL/min. The column temperature was maintained at 25˚C and the volume of each injection was 10 µL.

4.5 Preparation of Standard Solution.

20.0 mg of Bupivacaine HCl API was weighed accurately for working standard and transferred into a 20 mL clean dry volumetric flask. About 10 mL of diluent was added, sonicated for 5 minutes and made up to volume to 20 mL. Further 5 mL of solution was taken in 50 mL clean dry volumetric flask, and made up to volume 50 mL with diluent.

4.6Method Validation:

4.6.1 Linearity:

A series of dilutions were prepared using Bupivacaine working standard (100µg/mL) at concentration levels from 50% to 150% of target concentration (50%, 80%, 100%, 120% and 150%). The peak area response of solutions was measured.

4.6.2 Accuracy:

Drug assay was performed in triplicate as per test method for each spike level to get the concentration of Bupivacaine HCl equivalent to 50%, 100%, and 150%. The average % recovery was calculated.

4.6.3 Precision:

The system precision was performed by analyzing a standard solution of Bupivacaine HCl at working concentration level for 6 times.

4.6.4 Robustness:

Robustness is carried out by system suitability under normal conditions and accelerated conditions as given below:

Changes in the flow rate by ± 10%

Changes in temperature of Column oven by ± 5˚C

Changes in ratio Organic Phase of Buffer by ± 2% of absolute value.

Changes in pH of Mobile Phase by ± 0.2 pH.

4.6.5 Solution Stability:

The solution stability of standard solutions and mobile phase at different time intervals are examined by running them for a long time.

4.6.6 System Suitability Testing:

The system suitability was assessed by five replicate of Bupivacaine at the level of 100%. The acceptance criterion of % RSD was ±2%, for tailing factor it was less than 2 and for theoretical plate it was more than 2000.

4.6.7 Specificity:

For specificity, Forced degradation studies were carried out by giving them accelerated condition such as Hydrolysis, Oxidation, Thermal, and Photolysis.

Forced Degradation Studies:

4.6.7.1 Acid Degradation:

10mg of Bupivacaine HCl was taken into 100mL cylinder and then approximately 10mL of diluent was added to it and then it was sonicated for 5mins. 5N HCl 5mL was added to the solution and kept at 60˚C for 1 hour and it was neutralized by 5N 5mL NaOH and then it was made up to volume 100mL by diluent

4.6.7.2 Alkali Degradation:

10mg of Bupivacaine HCl was taken into 100mL cylinder and then approximately 10mL of diluent was added to it and then it was sonicated for 5mins. 5N NaOH 5mL was added to the solution and kept at 60˚C for 1 hour and it was neutralized by 5N 5mL HCl and then it was made up to volume 100mL by diluent.

4.6.7.3 Oxidative Degradation:

10mg of Bupivacaine HCl was taken into 100mL cylinder and then approximately 10mL of diluent was added to it and then it was sonicated for 5mins. 3%H2O2 2mL was added to the solution and then was kept at 60˚C for 10 mins and then it was made up to volume 100mL by diluent.

5. RESULT AND DISCUSSION

5.1 Method Development:

5.1.1 Selection of Wavelength:

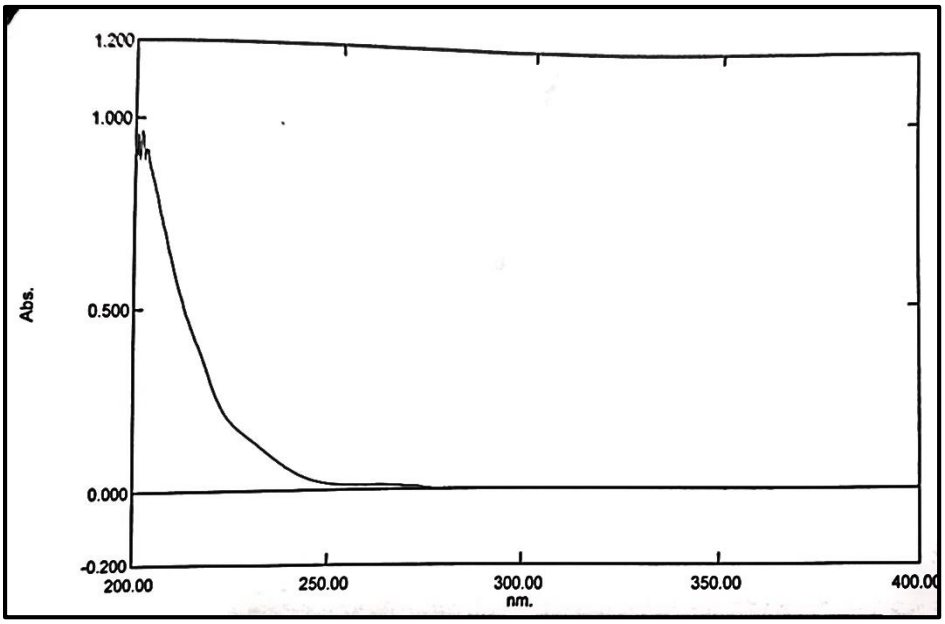


Figure No: 1 U.V. spectra of Bupivacaine

Maximum Absorbance was observed at 220 nm of Bupivacaine HCl API so it was selected as detection wavelength for the method and the best diluent was found to be Methanol.

5.1.2 Optimization of Mobile Phase:

(1) By using the Acetonitrile: Buffer in the ratio of (65:35), the retention time was found to be 11.47 and the response ratio was very low and Fronting was observed in the Chromatogram and the tailing factor was found to be 0.73 and the theoretical plate was found to be 9842 and the area was found to be 804.216.

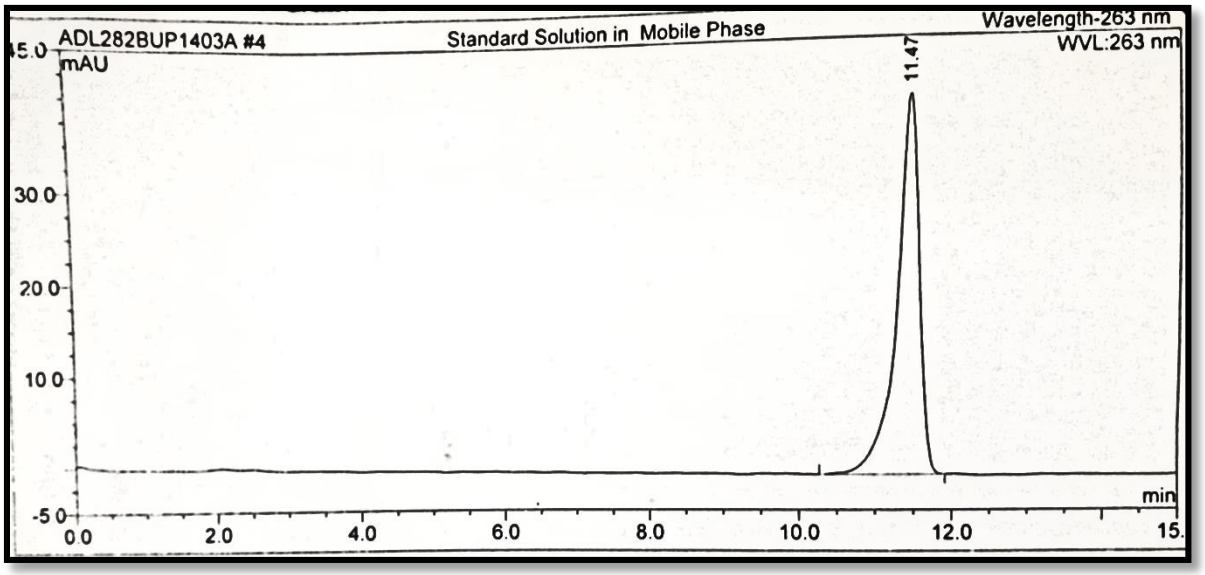


Figure No: 2 Optimization of Mobile Phase (1)

(2) By using the Acetonitrile: Buffer in the ratio of (70:30), the retention time was found to be 6.46 and the response ratio was very low of the Chromatogram and the tailing factor was found to be 1.07 and the theoretical plate was found to be 5060 and the area was found to be 156.446.

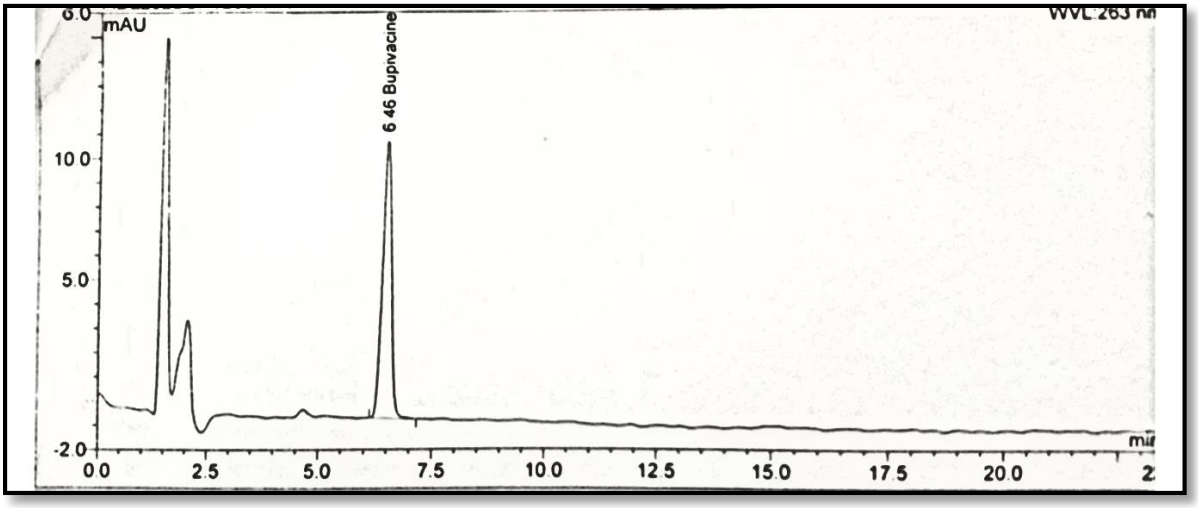


Figure No: 3 Optimization of Mobile Phase (2)

4.1.3 Optimization of Column:

1) By using Water Symmetry (C18, 250, 4.6mm*5µm)

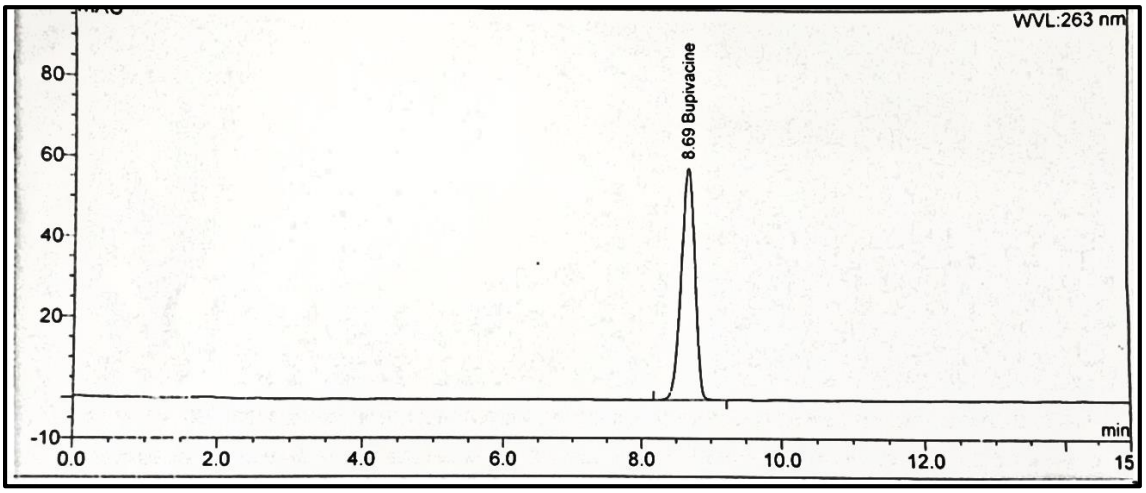


Figure No: 4 Optimization of Column (1)

2) By using *Kromasil 100 (C18, 250* 4.5mm*5µm)*

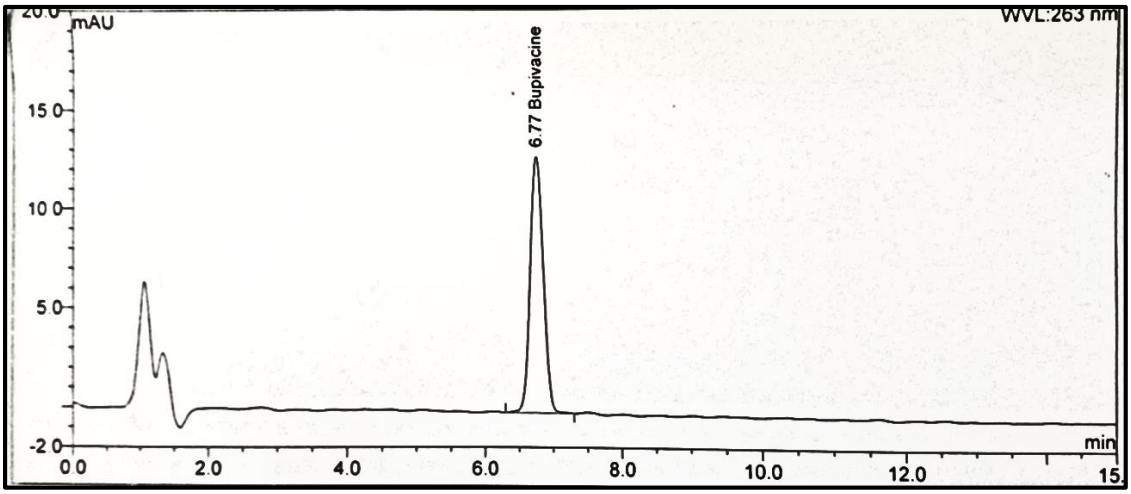


Figure No: 5 Optimization of Column (2)

3) By using Hypersil BDS (250*4.6*mm, 5µm).

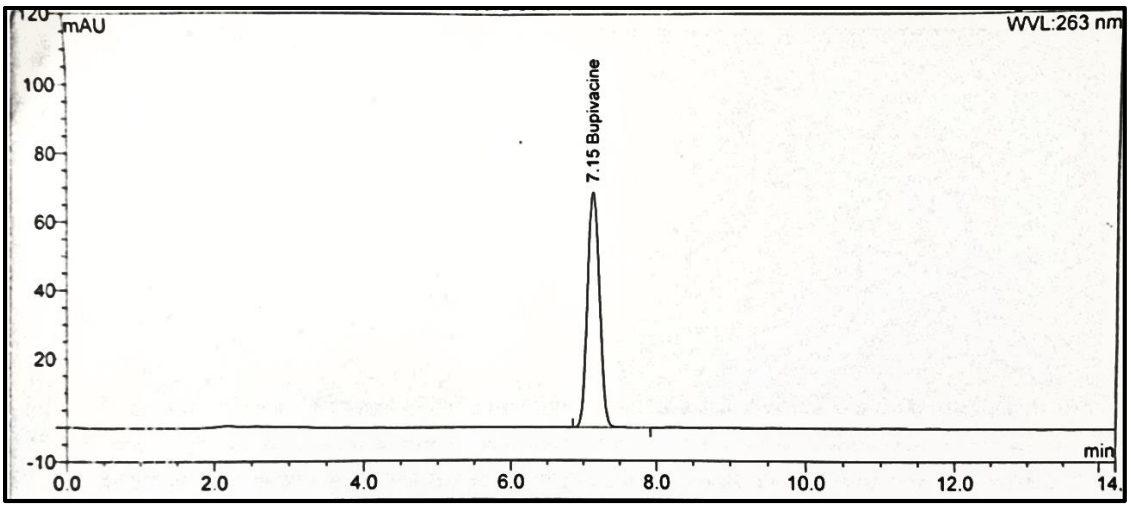


Figure No: 6 Optimization of Column (3)

By using these columns the results obtained showed very low response ratio so the final column used for the method was Zorbax Eclipse C8,150*4.6mm*5µm.

5.2 Chromatogram of Standard:

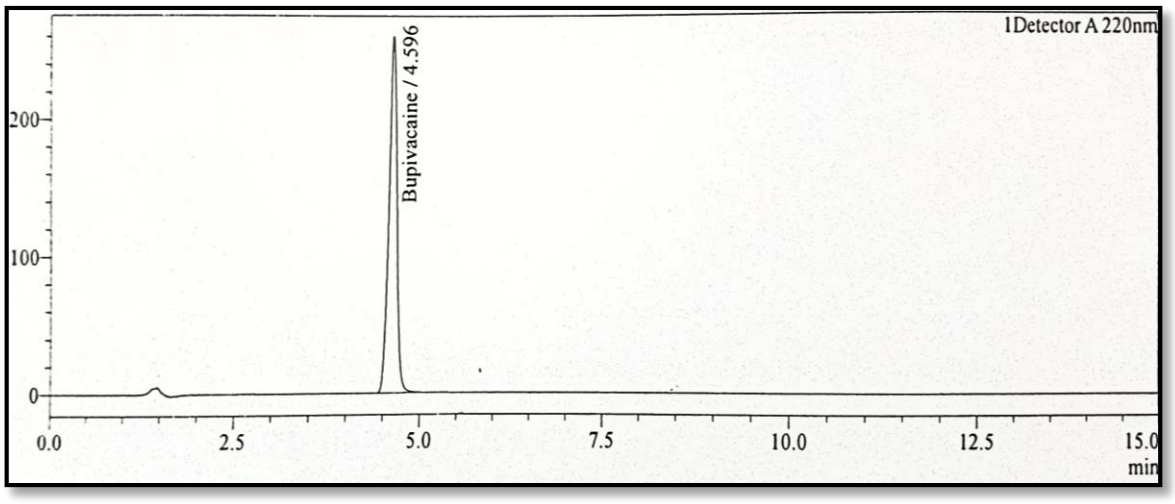


Figure No: 7 Chromatogram of Standard

Name	Retention Time	Tailing Factor	Theoretical Plates	Area mAU*sec
Bupivacaine	4.596	7804	1.66	1978.073

Table No: 1 Peak Analysis

5.3 Method Validation:

5.3.1 Linearity:

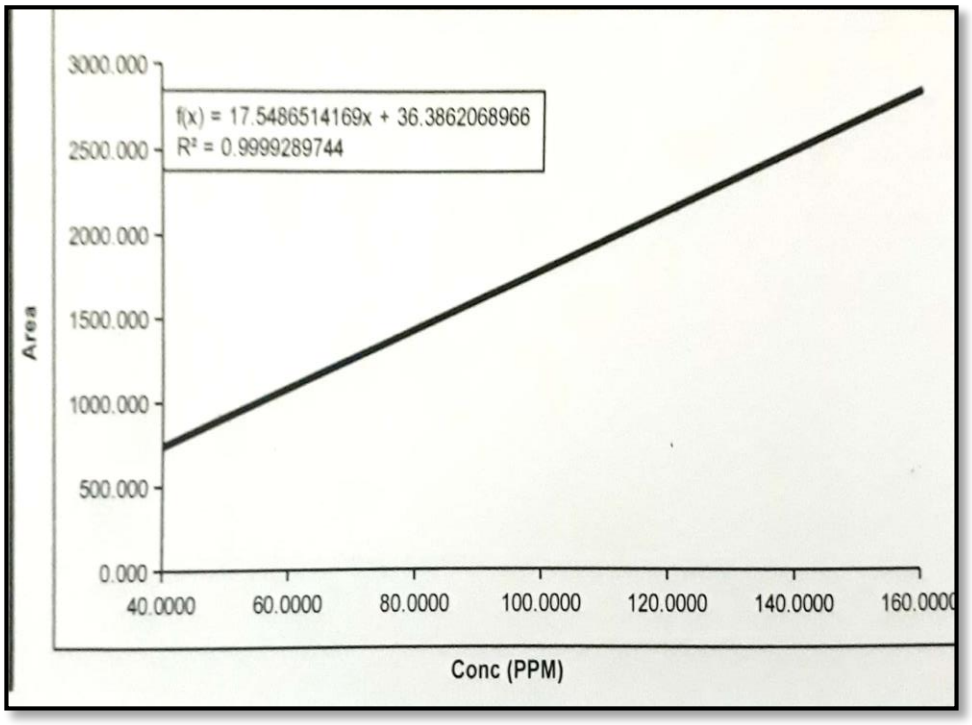


Figure No: 8 Linearity Plot

Linear calibration plot for assay method was obtained over the calibration range tested, 50.5 µg/mL to with 151.5 µg/mL for Bupivacaine and the correlation obtained was 0.999.

5.3.2 Accuracy:

Recoveries of assay of Bupivacaine was found between 98% to 102% and %RSD of all the concentration was less than 2.0 %

Levels	Set	Area	Mean % Recovery	%RSD
50%	1	991.625	99.4	2.0
	2	994.374		
	3	1016.269		
100%	1	1898.447	99.2	0.9
	2	1902.287		
	3	1914.414		
150%	1	2782.643	99.1	0.3
	2	2782.966		
	3	2799.840		

Table No: 2 Recoveries of Assay

5.3.3 Precision:

The % RSD of Bupivacaine HCl during the assay method precision study was found to be 0.9%.

Std. Prepn.						
mg	mL	mL	mL	mL	mL	Conc. (mg/mL)
20.8	20.0	5.0	50.0	1.0	1.0	0.1040
Test Preperation						
mg	mL	mL	mL	mL	mL	Dilution Factor
X mg	100.0	1.0	1.0	1.0	1.0	100
Std. Reading						
Reading 1-6 --->	1976.000					
Mean	1976.000	**SD**	#DIV/0!	**% RSD**	#DIV/0!	
Set No.	Precision	Precision	Precision	Precision	Precision	Precision
	Set-1	Set-2	Set-3	Set-4	Set-5	Set-6
Test Wt. (mg)	10.60	10.62	10.92	10.75	10.53	10.42
Test Reading 1	2014.000	2016.000	2040.000	2039.000	1960.000	1952.000
Test Reading 2						
Mean	2014.000	2016.000	2040.000	2039.000	1960.000	1952.000
mg/Tab or Capsule	1.00	1.00	0.98	1.00	0.98	0.99
Assay % of L.C.	100.0	99.9	98.3	99.8	98.0	98.6
Mean Assay %	**99.1**					
% RSD	**0.9**					

Figure No: 9 Method Precision

5.3.4Robustness:

System Suitability Parameter	As Such (1.0 ml/min)	0.9 (ml/min)	1.1 (ml/min)
USP tailing factor	1.166	1.165	1.163
Theoretical Plates	7804	8413	7344
Average Area of Standard	1974.674	2194.374	1794.876
%RSD of the Standard	0.2	0.1	0.1

Table No: 3 Variation in Flow Rate

System Suitability Parameter	As Such (25˚C Temperature)	20˚C Temperature	30˚C Temperature
USP tailing factor	1.166	1.166	1.162
Theoretical Plates	7804	7597	8058
Average Area of Standard	1974.674	1958.458	1956.400
%RSD of the Standard	0.2	0.2	0.1

Table No: 4 Variation in Column Oven Temperature

System Suitability Parameter	As Such Organic Phase(35:65)	Organic Phase(33:67)	Organic Phase(37:63)
USP tailing factor	1.166	1.120	1.120
Theoretical Plates	7804	8058	9793
Average Area of Standard	1974.674	1742.091	1746.082
%RSD of the Standard	0.2	0.2	0.2

Table No: 5 Variation in Organic Phase

System Suitability Parameter	As Such pH of Mobile Phase (7.7)	pH of Mobile Phase (7.5)	pH of Mobile Phase (7.9)
USP tailing factor	1.166	1.10	1.09
Theoretical Plates	7804	9550	10095
Average Area of Standard	1974.674	1739.212	1753.830
%RSD of the Standard	0.2	0.1	0.0

Table No: 6 Variation in pH of Mobile Phase

5.3.5 Solution Stability:

The solution stability of standard solutions and sample solutions at different time intervals data confirmed that the standard and sample solution used during assay determination were stable up to the study period was 25 hours.

5.3.6 System Suitability Testing:

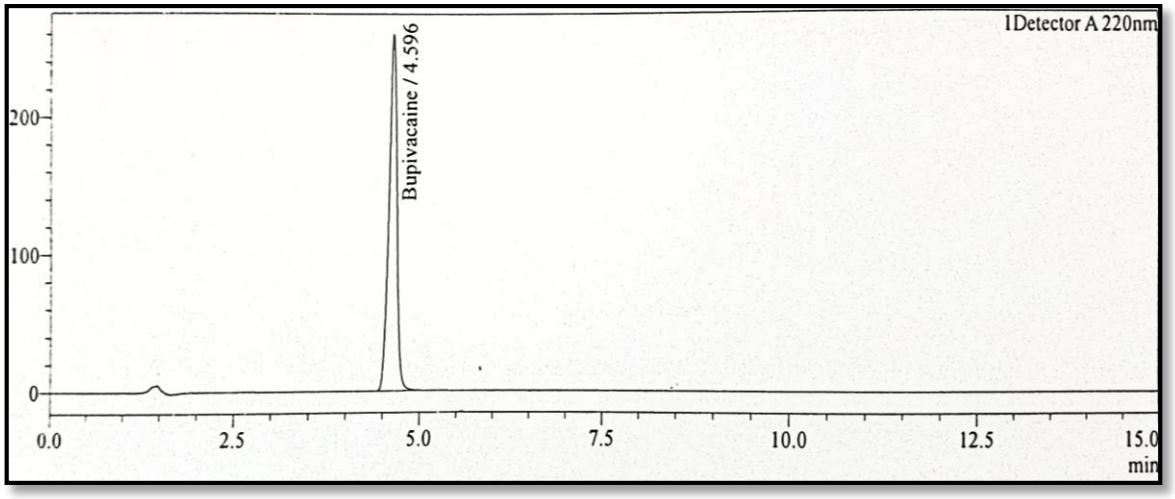


Figure No: 10 Chromatogram for System Suitability.

Injection No	Standard response
1	1978.073
2	1976.728
3	1977.755
4	1972.921
5	1971.291
Average	1974.674
SD	3.0675
%RSD	0.2
Acceptance criteria	< 2

Table No: 7 System Suitability Testing

5.3.7 Specificity:

1) As Such Sample:

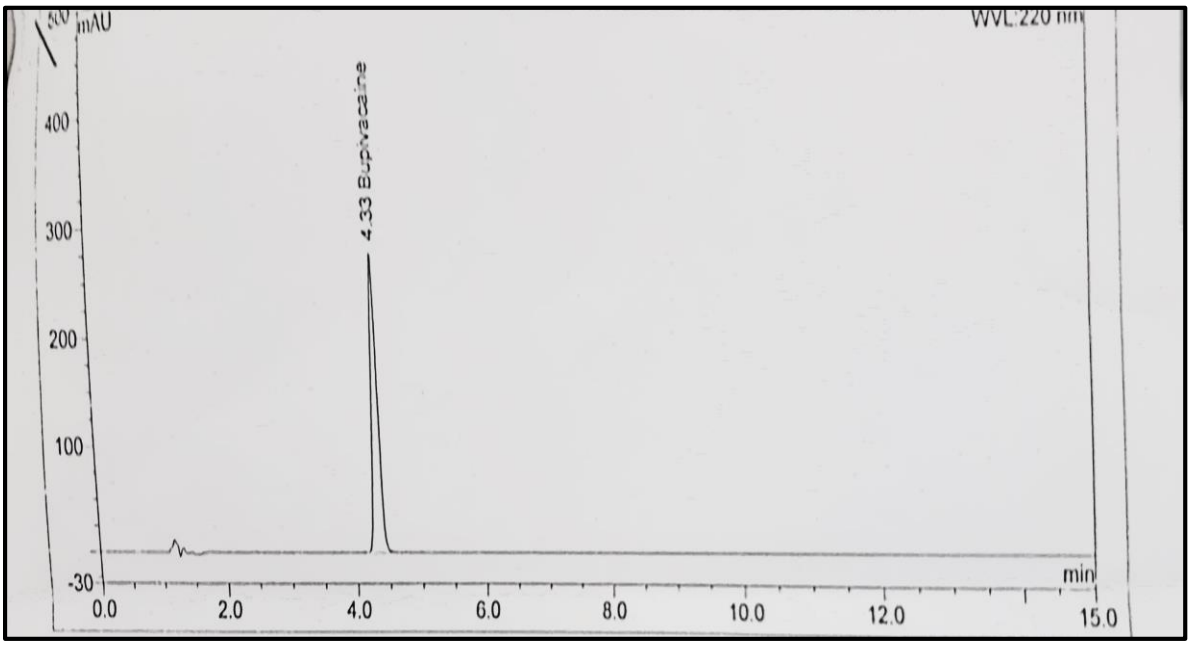


Figure No: 11 Forced Degradation As Such Sample.

Condition	Retention time	Area	% Rel Area
As Such Sample	4.33	1749.708	100%
Alkaline Condition	4.33	1671.540	99.43
Acidic Condition	4.33	1707.361	99.86
Oxidative Condition	4.33	1655.357	99.45

Table No: 8 Changes During Forced Degradation.

Forced Degradation Studies:

5.3.7.1 Hydrolysis: By NaOH

By providing the accelerated condition of 5N 5mL NaOH at 60˚C for 1hour there was no degradation was found and the relative % area was found to be 99.43.

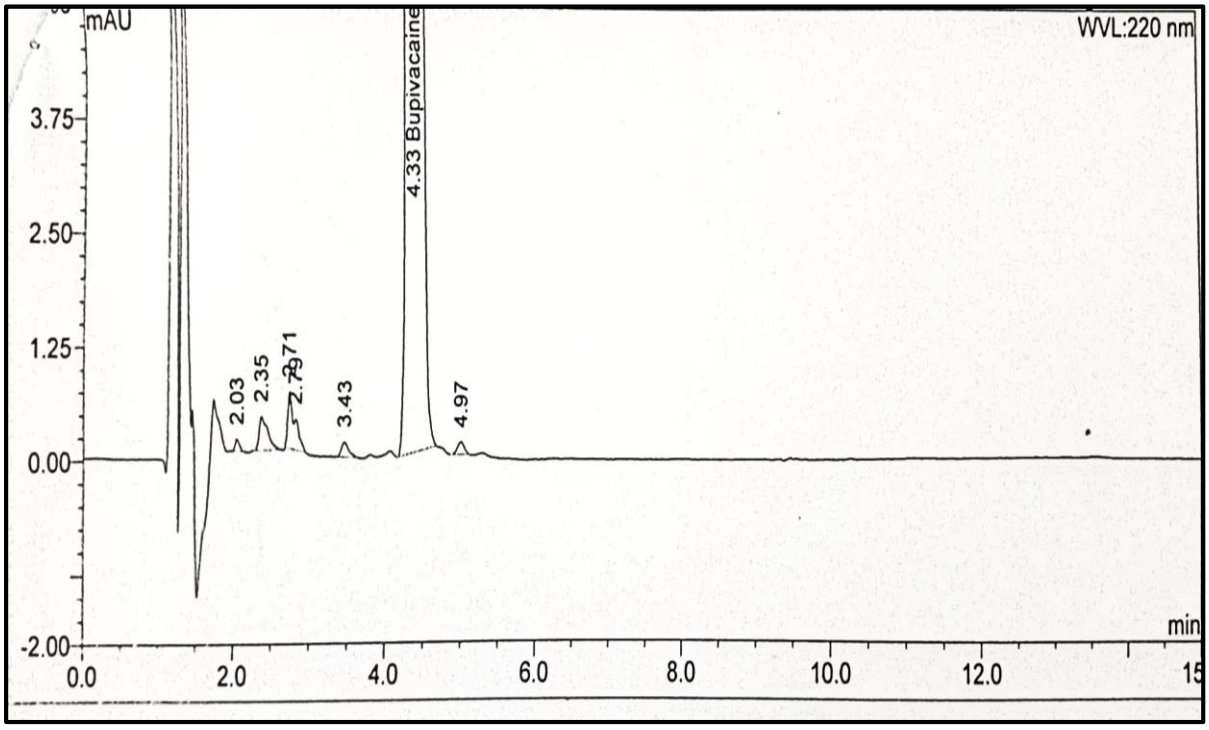


Figure No: 12 Forced Degradation Sample for 5N 5mL NaOH at 60˚C

5.7.3.2 Hydrolysis: By HCl

By providing the condition of 5N 5mL HCl at 60˚C for 1hour there was no degradation was found and the rel.Area % was found to be 99.86%

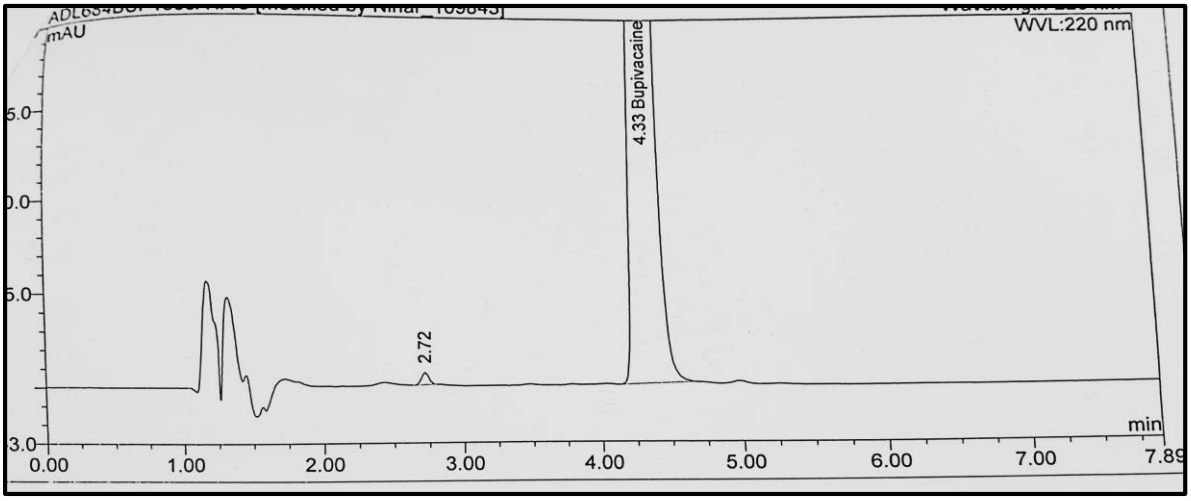


Figure No: 13 Forced Degradation Sample for 5N 5mL HCl at 60˚C for 1 hour.

5.3.7.3 Oxidative Degradation:

By providing the accelerated condition of 3% H2O2 2 mL at 60˚C for 10mins there was about 6% degradation was found and the rel. Area% was found to be 99.45%.

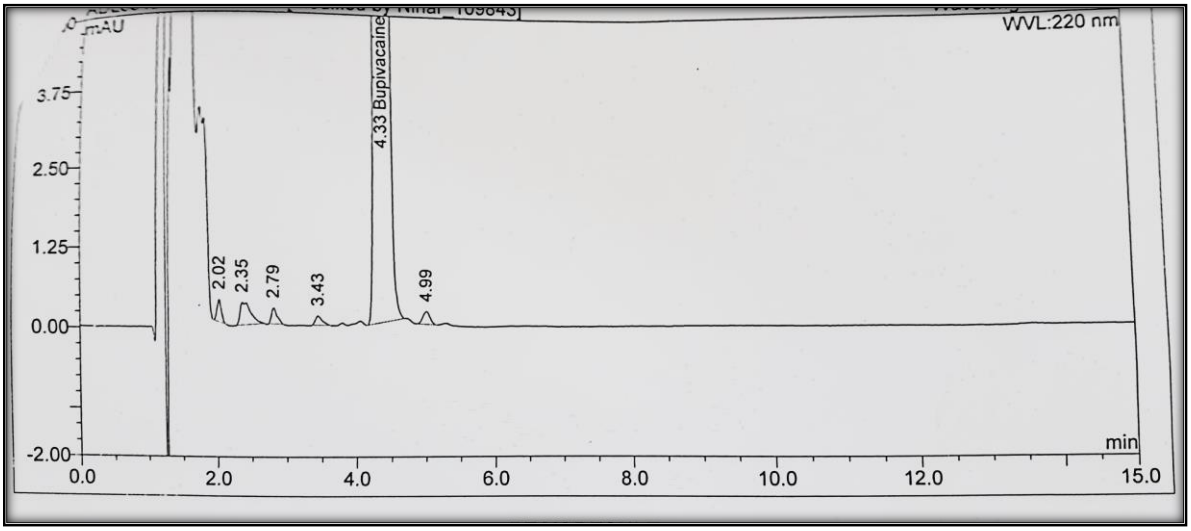


Figure No: 13 Forced Degradation Sample for of 3% H2O2 2 mL at 60˚C for 10 mins

6. CONCLUSION

From these results, it can be concluded that the developed method by HPLC is Linear, Specific, Precise and Accurate and offers determination Of Bupivacaine HCl within 5 mins And also it is a stability indicating method as the solutions of Bupivacaine HCl were given accelerated conditions and then were checked and calculated wherein the solutions in NaOH and HCl did not show any changes in the assay but when it was reacted with H_2O_2 it showed that the assay was degraded by 6%. Hence, it can be concluded that Bupivacaine HCl is very sensitive to Oxidative Degradation.

7. REFERENCES

1) Blessy, M., Patel, R. D., Prajapati, P. N., & Agrawal, Y. K. (2014). Development of forced degradation and stability indicating studies of drugs - A review. *Journal of Pharmaceutical Analysis*, *4*(3), 159–165. http://doi.org/10.1016/j.jpha.2013.09.003

2) Siddareddy, K., Reddy, M. A. U., Suresh, B., & Sreeramulu, J. (2017). Development and Validation of Analytical Method for Simultaneous Estimation of Bupivacaine and Meloxicam in Human Plasma Using UPLC-MS/MS. *Pharmaceutical Methods*, *9*(1), 02–08. http://doi.org/10.5530/phm.2018.1.2

3) RESEARCH ARTICLE A COMPARATIVE STUDY FOR FORCE DEGRADATION OF THREE LOCAL ANESTHETIC DRUGS BUPIVACAINE , ROPIVACAINE , MEPIVACAINE AND QUANTITATIVE ANALYSIS OF THEIR DEGRADED PRODUCTS BY NEWLY DEVELOPED AND VALIDATION HPLC-UV HPLC AND LC-MS METHOD Kamlesh M . Patel and * Dr . Ashaben D . Patel.

4) Essink-Tjebbes, C. M., Burger, D. M., Beelen, M., Wuis, E. W., & Hekster, Y. A. (1999). Long-term stability of morphine and bupivacaine mixture for spinal use. *Pharmacy World and Science*, *21*(3), 144–146. http://doi.org/10.1023/A:1008623317934

5) Salama, N. N., & Wang, S. (2009). Quantitative mass spectrometric analysis of ropivacaine and bupivacaine in authentic, pharmaceutical and spiked human plasma without chromatographic separation. *Analytical Chemistry Insights*, *2009*(4), 11–19.

6) Halaszynski, T. (2010). Bupivacaine. *The Essence of Analgesia and Analgesics*, 274–276. http://doi.org/10.1017/CBO9780511841378.065

7) Clark, B. J., Hamdi, A., Berrisford, R. G., Sabanathan, S., & Mearns, A. J. (1991). Reversed-phase and chiral high-performance liquid chromatographic assay of bupivacaine and its enantiomers in clinical samples after continuous extraplural infusion. *Journal of Chromatography A*, *553*(C), 383–390. http://doi.org/10.1016/S0021-9673 (01)88508-3

8) Shanmugasundaram, P., Naidu, P. Y., & Singamsetty, S. (2012). Research Article pharmaceutical formulation, *4*(11), 4702–4709.

9) Emara, S., & Khedr, A. (1996). Rapid and Specific Precolumn Extraction High-Performance Liquid Chromatographic Assay for Bupivacaine in Human Serum, *10*, 3–6.

10) Gross, A. S., Nicolay, A., & Eschalier, A. (1999). Simultaneous analysis of ketamine and bupivacaine in plasma by high-performance liquid chromatography, *728*, 107–115, Kastrissios, H. (1992). In plasma and urine, *577*, 103–107.

11) Applications, B. (1984). High-performance liquid chromatographic of bupivacaine in human serum, *309*, 369–374.

12) Shanmukha Kumar, J. V., Ramachandran, D., & Vijaya Saradhi, S. (2010). RP-HPLC method for the estimation of montelukast sodium in pharmaceutical dosage forms. *Current Trends in Biotechnology and Pharmacy*, *4*(4), 943–946.

14) Macorigh, C., Guibbert, V., Casanova, M., & Haenni, C. (2018). Stability study of hydromorphone and bupivacaine mixture by HPLC-UV. *European Journal of Hospital Pharmacy*, ejhpharm-2018-001553. http://doi.org/10.1136/ejhpharm-2018-001553

15) Venkateshwaran, T. G., & Stewart, J. T. (1995). Hplc determination of morphine-hydromorphone-bupivacaine and morphine-hydromorphone-tetracaine mixtures in 0.9% sodium chloride injection. *Journal of Liquid Chromatography*, *18*(3), 565–578. http://doi.org/10.1080/10826079508009257

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Vaccine Technology Center,
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Sarkhej-Bavla N.H. 8A, Changodar,
Dist : Ahmedabad - 382 213. India.
Phone : +91-2717- 664 600
CIN : L24230GJ1995PLC025878

Ref No: ZC/HR&CC/OFFER/70/2017
Date: 17.02.2017

Mr. Jay Vachhani,
'Shree Hari Provision Store',
New Sagar Society,
50 feet road,
Maheshwari Main Road,
Rajkot, Gujarat- 360002

Dear Mr. Jay Vachhani,

We refer to your application for the suitable position and the subsequent interview you had with us.

We are pleased to offer you a position in our organization on the mutually agreed terms and conditions. **This offer letter is subject to the condition that you will sign a bond to serve Cadila Healthcare Limited for minimum three years and have to deposit all your original certificates with us. Also you have to undergo and to pass a pre-employment medical check-up from a hospital suggested by the company**. We shall be issuing the regular letter of appointment on your joining the organization.

We shall thank you to kindly confirm this arrangement and communicate to us the date of your joining along with a copy of the acceptance of your resignation letter at the earliest. **Also please note that if you unable to clear your master degree, this offer stands cancelled and your appointment will be terminated**.

At the time of joining, we expect you to bring the following:

1. Resignation letter of the previous company.
2. Relieving letter from your previous employer.
3. Salary certificate from your employer.
4. Experience Certificate.
5. All Original Mark sheets & Certificates
6. Copy of all mark sheets & certificates and birth date proof.
7. Four passport size photographs (if not already submitted).
8. Copy of PAN CARD

We look forward to a long and mutually rewarding relationship.

With best wishes,

Yours in Healthcare,

Sonali Dhiman
Senior Executive - Human Resources

I accept and shall join on or before _____.
Dated: _____

Mr. Jay Vachhani

COMMITMENT SHEET

THIS IS TO BE READ IN CONJUNCTION WITH THE OFFER LETTER. THE CANDIDATE AND CHL BOTH CONFIRM THAT NO OTHER COMMITMENTS HAVE BEEN MUTUALLY MADE THAT CAN BE LATER ON REFERRED TO

- **MONETARY:**

(Pl mention any financial commitments, like a guaranteed increment/raise, any deferred payment etc committed)

- No Commitment

- **PERKS:**

(Pl confirm any non-cash perks like travel category, mobile handset reimbursement etc)

- No Commitment

- **PROMOTIONS:**

(Pl confirm if any deferred promotion is committed)

- No Commitment

- **ANY OTHER COMMITMENTS:**

- You have to sign a three (3) years' service agreement with organization.
- You will be eligible for next increment in April 2019 as per company norms on successful completion of probation period.

Mr. Jay Vachhani
(Offered – VTC, Zydus)

Ms. Sonali Dhiman
Senior Executive – Human Resources

Date: _____

Place: _____

Zydus
dedicated to life

SUB: Pre Employment Medical Test

Dear Mr. Jay Vachhani,

We would advise you to have the Pre-Employment Medical Tests done from Zydus Hospital, Sola.

Please fill up the following details as required:

Name of the Candidate: Jay Vachhani **Date:** 17/02/2017

Designation: Trainee Officer **Age:** 22 years **Sex:** M

Department: MMR **Location:** VTC - Changodar

The address of "Zydus Hospital" is as under:

Zydus Hospitals Road,
Nr. Sola Bridge, S.G. Highway,
Ahmedabad - 380054,
Gujarat, India.
079-66190217/ 218

Timing: 2.00 p.m. to 4.00 p.m.

Please carry this letter at the time of Medical Checkup and submit it to HR Department at the time of your joining.

Cadila Healthcare Ltd
Authorized Signatory
Name: Sonali Dhiman

Zydus Hospitals
Authorized Signatory

Zydus dedicated to life

Zydus Biologics

A division of
Cadila Healthcare Ltd.
Plot Survey No. 40/P,23,25P,42,37,
Opposite Ramdev Masala,
Sarkhej Bavla N.H. 8A,
Changodar Road,
Ahmedabad - 382 213.
CIN:L24230GJ1995PLC025878

Ref No: ZC/HR&CC/OFFER/22/2017
Date: 09.03.2017

Mr. Sagar Chandubhai Kumbhani
At. Lunki
Ta. Babara
Dist. Amreli (365421)

Dear Mr. Sagar,

We refer to your application for the suitable position and the subsequent interview you had with us.

We are pleased to offer you a position in our organization on the mutually agreed terms and conditions. **This offer letter is subject to the condition that you will sign a bond to serve Cadila Healthcare Limited for minimum three years and have to deposit all your original certificates with us. Also you have to undergo and to pass a pre-employment medical check-up from a hospital suggested by the company**. We shall be issuing the regular letter of appointment on your joining the organization.

We shall thank you to kindly confirm this arrangement and communicate to us the date of your joining along with a copy of the acceptance of your resignation letter at the earliest.

At the time of joining, we expect you to bring the following:

1. Resignation letter of the previous company.
2. Relieving letter from your previous employer.
3. Salary certificate from your employer.
4. Experience Certificate.
5. All Original Mark sheets & Certificates
6. Copy of all mark sheets & certificates and birth date proof.
7. Four passport size photographs (if not already submitted).
8. Copy of PAN CARD

We look forward to a long and mutually rewarding relationship.

With best wishes,

Yours in Healthcare,

Rejoice Thomas
Assistant Manager - Human Resources

I accept and shall join on or before _____. **Mr. Sagar Chandubhai Kumbhani**

Dated: _____

COMMITMENT SHEET

THIS IS TO BE READ IN CONJUNCTION WITH THE OFFER LETTER. THE CANDIDATE AND CHL BOTH CONFIRM THAT NO OTHER COMMITMENTS HAVE BEEN MUTUALLY MADE THAT CAN BE LATER ON REFERRED TO

- **MONETARY:**

(Pl mention any financial commitments, like a guaranteed increment/raise, any deferred payment etc committed)

- No Commitment

- **PERKS:**

(Pl confirm any non-cash perks like travel category, mobile handset reimbursement etc)

- No Commitment

- **PROMOTIONS:**

(Pl confirm if any deferred promotion is committed)

- No Commitment

- **ANY OTHER COMMITMENTS:**

- You have to sign a three (3) years' service agreement with organization.
- You will be eligible for next increment in April 2019 as per company norms on successful completion of probation period.

Mr. Sagar Chandubhai Kubhani
(Offered – ZB, Zydus)

Mr. Rejoice Thomas
Assistant Manager – Human Resources

Date: _____

Place: _____

Zydus
dedicated to life

Zydus Biologics

A division of
Cadila Healthcare Ltd.
Plot Survey No. 40/P,23,25P,42,37,
Opposite Ramdev Masala,
Sarkhej Bavla N.H. 8A,
Changodar Road,
Ahmedabad - 382 213.
CIN:L24230GJ1995PLC025878

Ref No: ZC/HR&CC/OFFER/21/2017
Date: 09.03.2017

Mr. Babu Ghanshyambhai Dalvadi
"Chamunda Nivas"
Vasant Park – 1, Halvad,
Dist - Morbi

Dear Mr. Babu,

We refer to your application for the suitable position and the subsequent interview you had with us.

We are pleased to offer you a position in our organization on the mutually agreed terms and conditions. **This offer letter is subject to the condition that you will sign a bond to serve Cadila Healthcare Limited for minimum three years and have to deposit all your original certificates with us. Also you have to undergo and to pass a pre-employment medical check-up from a hospital suggested by the company**. We shall be issuing the regular letter of appointment on your joining the organization.

We shall thank you to kindly confirm this arrangement and communicate to us the date of your joining along with a copy of the acceptance of your resignation letter at the earliest.

At the time of joining, we expect you to bring the following:

1. Resignation letter of the previous company.
2. Relieving letter from your previous employer.
3. Salary certificate from your employer.
4. Experience Certificate.
5. All Original Mark sheets & Certificates
6. Copy of all mark sheets & certificates and birth date proof.
7. Four passport size photographs (if not already submitted).
8. Copy of PAN CARD

We look forward to a long and mutually rewarding relationship.

With best wishes,

Yours in Healthcare,

Rejoice Thomas
Assistant Manager - Human Resources

I accept and shall join on or before _____.

Mr. Babu G Dalwadi

Dated: _____

COMMITMENT SHEET

THIS IS TO BE READ IN CONJUNCTION WITH THE OFFER LETTER. THE CANDIDATE AND CHL BOTH CONFIRM THAT NO OTHER COMMITMENTS HAVE BEEN MUTUALLY MADE THAT CAN BE LATER ON REFERRED TO

- **MONETARY:**

(Pl mention any financial commitments, like a guaranteed increment/raise, any deferred payment etc committed)

- No Commitment

- **PERKS:**

(Pl confirm any non-cash perks like travel category, mobile handset reimbursement etc)

- No Commitment

- **PROMOTIONS:**

(Pl confirm if any deferred promotion is committed)

- No Commitment

- **ANY OTHER COMMITMENTS:**

- You have to sign a three (3) years' service agreement with organization.
- You will be eligible for next increment in April 2019 as per company norms on successful completion of probation period.

Mr. Babu G. Dalvadi
(Offered – ZB, Zydus)

Mr. Rejoice Thomas
Assistant Manager – Human Resources

Date: _____

Place: _____

zydus
Dedicated To Life

Ref. No.: CHL/ANK/OFFER-2022/May
Mr. Kadivar SahilKumar Bharatbhai,
Shiv Palace , Shyam Park
Avani Chokdi
District : Morbi | **Pin code** : 363641
State : Gujrat

Dear Mr. Kadivar,

With reference to your application for the suitable position and the subsequent interview you had with us, we are pleased to offer you the position of **FTE – Production** at our Strategic Business Unit - API Division of Ankleshwar on the mutually agreed terms and conditions.

We shall be issuing the regular letter of appointment on your joining the organization. Our offer is subject to your being found medically fit after examination by a medical practitioner appointed by us. You will have to follow all Personal Hygiene norms as fixed by the company during your employment with the organization Cadila Healthcare Limited.

We shall thank you to kindly confirm this arrangement and communicate to us the date of your joining along with a copy of the acceptance of your resignation letter at the earliest.

At the time of joining, we expect you to bring the following documents:

1. Resignation letter of the previous company.
2. Relieving letter issued from your previous employer.
3. Last salary certificate from your employer.
4. Other experience letters. (all previous employers if any)
5. Copy of testimonials of academic qualifications with school leaving certificate. **(Attested)**
6. Five nos. of passport size photographs
7. PAN card photocopies-2 nos. (Compulsory).
8. Aadhar card photocopies – 2 nos. (Compulsory)
8. Identification & Residential Proof photocopies (Election Card, Driving License, and Passport).

We look forward to a long and mutually rewarding relationship.

With best wishes,

For, **Zydus Lifesciences Ltd.,**
(Formerly Known as Cadila Healthcare Ltd.)

Jigneshsinh Gohil,
Manager-Human Resource

Offer Acceptance by:
(Mr. Kadivar SahilKumar Bharatbhai)

18/09/2022
(Signature with Date)

I accept and shall join on or before: 18 / 10 / 2022 (Pl. mention tentative date of joining)

Zydus Lifesciences Limited
(formerly known as Cadila Healthcare Limited)
Ankleshwar Unit-2 : 5/1-B, GIDC Industrial Estate, Ankleshwar, Gujarat 393002, India
Phone : +91-2646-660110, 660197, 660400, 660510

Regd. Office :
Zydus Corporate Park, Scheme No. 63, Survey No. 536, Khoraj (Gandhinagar), Nr. Vaishnodevi Circle, S. G. Highway, Ahmedabad-382 481, Gujarat, India.
Phone : +91-79-71800000, +91-79-48040000
website : www.zyduslife.com | CIN : L24230GJ1995PLC025878

zydus
Dedicated To Life

Ref. No.: CHL/ANK/OFFER-2022/May
Mr. Vanagra Montu Hareshbhai,
B-404 , Shree Krishna Palace
Sandhya Park Society , Ravapar Road
District : Morbi | **Pin code** : 363641
State : Gujrat

Dear Mr. Vanagra,

With reference to your application for the suitable position and the subsequent interview you had with us, we are pleased to offer you the position of **FTE – Production** at our Strategic Business Unit - API Division of Ankleshwar on the mutually agreed terms and conditions.

We shall be issuing the regular letter of appointment on your joining the organization. Our offer is subject to your being found medically fit after examination by a medical practitioner appointed by us. You will have to follow all Personal Hygiene norms as fixed by the company during your employment with the organization Cadila Healthcare Limited.

We shall thank you to kindly confirm this arrangement and communicate to us the date of your joining along with a copy of the acceptance of your resignation letter at the earliest.

At the time of joining, we expect you to bring the following documents:

1. Resignation letter of the previous company.
2. Relieving letter issued from your previous employer.
3. Last salary certificate from your employer.
4. Other experience letters. (all previous employers if any)
5. Copy of testimonials of academic qualifications with school leaving certificate. **(Attested)**
6. Five nos. of passport size photographs
7. PAN card photocopies-2 nos. (Compulsory).
8. Aadhar card photocopies – 2 nos. (Compulsory)
8. Identification & Residential Proof photocopies (Election Card, Driving License, and Passport).

We look forward to a long and mutually rewarding relationship.

With best wishes,

For, **Zydus Lifesciences Ltd.,**
(Formerly Known as Cadila Healthcare Ltd.)

Jigneshsinh Gohil,
Manager-Human Resource

Offer Acceptance by:
(Mr. Vanagra Montu Hareshbhai)

M.H.Patel
18/05/2022

(Signature with Date)

I accept and shall join on or before: DD / MM / 2022 (Pl. mention tentative date of joining)

Zydus Lifesciences Limited
(formerly known as Cadila Healthcare Limited)
Ankleshwar Unit-2 : 5/1-B, GIDC Industrial Estate, Ankleshwar, Gujarat 393002, India
Phone : +91-2646-660110, 660197, 660400, 660510

Regd. Office :
Zydus Corporate Park, Scheme No. 63, Survey No. 536, Khoraj (Gandhinagar), Nr. Vaishnodevi Circle, S. G. Highway, Ahmedabad-382 481, Gujarat, India.
Phone : +91-79-71800000, +91-79-48040000
website : www.zyduslife.com | CIN : L24230GJ1995PLC025878

"Internship in Quality Control Department At Anlon Health Care Pvt. Ltd."

A INTERNSHIP REPORT

SUBMITTED TO

THE FACULTY OF SCIENCE

FOR THE DEGREE OF

MASTER OF SCIENCE (M.Sc.)

IN

CHEMISTRY

BY

Mr. Patel Vishv Jatinbhai

UNDER THE GUIDENCE OF

Dr. Pratik A. Ambasana

SHRI M. & N. VIRANI SCIENCE COLLEGE (AUTONOMOUS)
Affiliated to SAURASTRA UNIVERSITY
RAJKOT-360005 (INDIA)

2020-2021

SARVODAY KELAVANI SAMAJ MANAGED
Shri Manibhai Virani and Smt. Navalben Virani Science College (Autonomous), Rajkot
Affiliated to Saurashtra University, Rajkot
[YOGIDHAM GURUKUL, Kalawad Road, Rajkot-360 005]

CERTIFICATE

This is to certify that the Internship entitled "**Internship in Quality Control Department At Anlon Health Care Pvt. Ltd**" was successfully carried out by **Mr. Patel Vishv Jatinbhai** a post graduate student of Department of Chemistry, Atmiya University in M.Sc. Chemistry (**Analytical Chemistry**) during academic year 2020-21.

Dr. Pratik A. Ambasana — **Dr. P. B. Nariya**

(Guide) — **(Head)**

Date: 03/05/2021 — **Place: Rajkot**

Acknowledgement

It is a great experience for me to prepare a project report. I thank to all those persons who are involved in the making of project.

Firstly, I would like to thank the management of Anlon Healthcare Private Limited, Pipaliya, Rajkot, Gujrat for providing all facilities and allow us to use the required equipment and knowledgeable guide for complete our industrial training.

I also thankful to company guide Mr. Jayshingh Thorat, QC manager, Department of Quality Control, Anlon Healthcare Pvt. Ltd. To providing us a usefull guidance and whole QC department member.

I would you like to specially thank my training colleagues Ms. Parita D. Kakkad, Jayesh Dhrangu and Sweta Hinshu for helping me in each and every stage of my work.

I am thank to my college- Shree Virani Science College to give a best opportunity to start to build up mycarrier.

I am also thankful to our external guide for our industrial training is Dr. Pratik A. Ambasana, and also Dr. Pankaj D. Nariya, Dr. Satishkumar D. from department of Chemistry.

Company Profile

Name of Organization	: - Anlon Healthcare Private Limited
CIN	: - U2430GJ2013PTCO77543
Registration No.	: - 77543
Website	: - www.anlon.in
Email address	: - info@anloncro.com
Class of Company	: - Private
Date of Incorporation	: - 19 November, 2013
Area of location	: - Survey No. 36/2, Near Bharudi Toll Plaza, Gondal Road NH27, Pipaliya, Rajkot, Gujarat
Activity	: -Manufacture the API and its Intermediate

Loxoprofen Sodium Dihydrate,

Amoxapine

Tolfenamic acid

Favipiravir

Rupatadine Fumarate

Loxapine Succinate

Loxoprofen acid

Benzamide

NB-03

Glyclazide

What is the Quality Control (QC) department? What is the role of Quality Control department?

Quality Control is a procedure or set of procedure intended to ensure that a manufactured product or performed service adheres to a define set of quality criteria or meets the requirements of the client or customer.

QC department is the part of GMP concerned with sampling, specification and testing and with organization, documentation and release procedures which ensure that the necessary and relevant tests are performed and the product is released for only after ascertaining its quality.

Quality Control department functions for assuring the quality of all the batch manufactured, at every stage of manufacturing/processing drug product.

Quality Control is to test and verify the product quality against the predefine standard.

The term quality control refers to the sum of all procedures undertaken to ensure the identity and purity of a particular product.

The main function of Quality Control department to prepare and maintain the raw material, packing material and finished product.

COMPONENTS OF QUALITY CONTROL

QC labs

Retained sample

Analysis of Finished product

Sampling

Validation

Records

Instrument in QC wet and instrument laboratory

Sr. No.	Name of Instruments	Company Name
1.	Weighing balance	Shimadzu
2.	Karl-Fischer titrator	Lab India
3.	Auto titrator	Lab India
4.	Ultrasonic sonicator bath	Leela Sonic
5.	Melting point apparatus	Lab India
6.	Moisture analyzer (for LOD)	Radwag
7.	IR spectrophotometer	Shimadzu
8.	UV spectrophotometer	Shimadzu
9.	HPLC	Shimadzu
10.	HS GC	Shimadzu
11.	Muffle furnace	Today Tech
12.	Hot Air Oven	Equitron
13.	colorimeter	Konica Minolta
14.	PH meter	Lab India
15.	TDS meter	labtronics
16.	Conductivity meter	Labman
17.	Water purification system	Milli Q

Training Overview

Week 1	Read the SOP and visit all department of company
Week 2	Read the SOP and sampling of DM water from API plant
Week 3	Understand the all instruments and that's location
Week 4	Understanding the weight balance calibration and Handling under guide
Week 5	Understand the operating procedure of Karl- Fischer instrument and all three method of that 1)Blank titration 2)Factor determination 3)Find the % of moisture
Week 6	Understand and handling pH meter, melting point apparatus under the guide
Week 7	Solution preparation and labelling of the solution and perform TLC
Week 8	Understand the operation of Auto titrator and perform how to find the % assay of HCl
Week 9	Karl- Fischer handling under the guide
Week 10	Understand and perform the LOD and ROI
Week 11	Received the basic information of IR, UV, HPLC, and GC
Week 12	Perform the Complete analysis of Amoxapine for stability study under the guide

Complete Analysis

Product name	Discription	Solubility	pH	Water content by Karl - Fischer	LOD	ROI	TLC	UV	IR	Residue and Assay by HPLC
Loxoprofen Sodium Dihydrate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Benzamide	✓	✓	✓	✓	✓	✓	✓		✓	✓
Amoxapine	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Rupatadine Fumarate	✓	✓	✓	✓	✓		✓	✓		✓
NB - 0	✓	✓		✓			✓		✓	✓
Loxoprofen acid	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Tolfenamic acid	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

ANALYTICAL WEIGHING BALANCE

Analytical balances are highly sensitive lab instruments designed to accurately measure mass. The measuring pan of an analytical balance is inside a transparent enclosure with doors so that dust does not collect and so any air currents in the room do not affect the balance's operation. This enclosure is often called a draft shield.

Weighing Balance
Brand - Shimadzu
Model Number - ATX 224

CALIBRATION OF WEIGH BALANCE

Calibration is the process of testing the scale, to ensure the level of accuracy you require.

In QC department, results are dependent upon exact weights, so calibration is of particular importance.

Properly calibrated balance give accurate results.

For calibration a reference weight is placed on the pan and check the reading of balance. With increasing and decreasing weight, we can check whole range in several steps. That's called calibration of weigh balance.

Following steps for calibrate the weigh balance:

- Operate the instrument as per respective Standard Operating Procedure.
- Switch 'ON' the instrument.
- Switch 'ON' the balance.
- The display will blink with 8.8.8.8.8.8.
- After few seconds, the display will show 0.0000mg.
- If display is not stable, press the tare key and wait till the display shows 0.0000mg.
- Put the 10mg standard weight and wait till the display is stable note down the display result.
- Repeat the above steps using 20mg, 50mg, 100mg, 200mg, 500mg standard weight.
- Press the 'UNIT' key and change to 'mg' from 'g'.

- Put the 1g standard weight and wait till the display is stable note down the display result.
- Repeat the above steps using 2g, 5g, 10g, 20g, 50g standard weight.

$$\%\text{Variation} = \frac{\text{Display weight result} - \text{standard weight}}{\text{Standard weigh}} \times 100$$

KARL – FISCHER TITRATOR

- Karl - Fischer is a fully automatic titrator. Karl - Fischer titration is an accurate, rapid and efficient method for determining the water content in sample.
- When the sample is titrated in the presence of SO_2, I_2, and organic base, moisture from the sample extracted in the solvent can be quantitatively estimated.
- Dry methanol is used as a solvent in Karl - Fischer titrator.
- The two pin platinum electrode is used for end point determination.

Karl – Fischer Autotitrator
BRAND - LABINDIA

What is the Karl Fischer Reaction?

$$ROH + SO_2 + R'N \rightarrow [R'NH]SO_3R + H_2O + I_2 + 2R'N \rightarrow 2[R'NH]I + [R'NH]SO_4R$$

Alcohol Base Alkylsulfite salt Water Iodine Hydroiodic acid salt Alkylsulfate salt

- The alcohol reacts with sulfur dioxide (SO2) and base to form an intermediate alkylsulfite salt, which is then oxidized by iodine to an alkylsulfate salt. This oxidation reaction consumes water.

- The reactive alcohol is typically methanol or 2-(2-Ethoxyethoxy)ethanol, also known as diethylene glycol monoethyl ether (DEGEE), or another suitable alcohol.
- Classic Karl Fisher reagents contained pyridine, a toxic carcinogen, as the base. The reagents most frequently used today are pyridine-free and contain imidazole or primary amines.

CALIBRATION OF KARL-FISCHER INSTRUMENT

1. Add accurately weighed 100mg of disodium tartrate into the titrate vessel containing neutralized methanol and test for water content.
2. Calculate the % water by using the formula given below.

$$\% \text{ Water (w/w)} = \frac{\text{Volume of KFR consumed in mL}}{\text{Weight of disodium tartrate in mg}} \times 100 \times \text{Factor}$$

3.

4. The performance of the instrument is satisfactory if the difference the between the obtained values is within the tolerance limit of 15.66 ±5% i.e. 14.87%-16.44, otherwise follow the SOP.
5. Repeat the step 1&2 and take total five reading.
6. Record the results.
7. Frequency of calibration: Once in a month.

CALIBRATION OF KARL-FISCHER REAGENT / FACTOR DETERMINATION OF KARL- FISCHER REAGENT

- Factor determination is needed to check working of KF reagent. Whenever, we use new bottle of KF reagent first of all is determined.
- For factor determination, place 0.3 g (30 mg) to 0.8 (80 mg) water in titration beaker, which filled up with methanol.
- Then display shows amount of KF reagent used and % of moisture calculated automatically in instrument.
- Repeat, same process for three times.

BLANK TITRATION FOR METHANOL AS A SOLVENT OF KARL-FISCHER AUTOMETIC TITRATION

- Switch on the instrument.
- Press start key to neutralize the blank moisture from the methanol, while the reagent is added to the titration beaker the display shows the amount of reagent added in the titration beaker.
- Platinum electrode is used for end point determination.
- The magnetic stirred is a part of the system in which the sample is stirred vigorously to extract the moisture efficiency.

HOW TO FIND % OF MOISTURE IN SAMPLE

- Place methanol in titration beaker then neutralize the methanol then add near about 0.3 g sample.
- Press the start key. End point is determine by platinum electrode. When microVolt (µV) is not increase that indicate end point. Then display shows % of moisture present in sample.

$$\% \text{ Water} = \frac{\text{B.R.} \times \text{Factor} \times 100}{\text{Wt.} \times 1000}$$

Where,
B.R. = volume of Karl – Fischer reagent consume in mL
Factor = Karl – Fischer reagent factor in mg/mL
Wt. = weight of sample taken in gm

What is Titration?

Titration is a quantitative chemical analysis. It is used to determine an unknown concentration of a known substance in a sample. The basic principle of the titration is the following: A solution - a so called titrant or standard solution - is added to sample to be analyzed. The titrant contains a known concentration of a chemical which reacts with the substance to be determined. The titrant is added by means of a burette. A burette is a device which allows to exactly measure the quantity (volume) of the titrant added. Due to the chemical reaction taking place in the sample to be analysed, the characteristics of the sample changes.

AUTO TITRATOR

- A Titrator consists basically of an electric burette, a sensor whose signal is amplified with a preamplifier and a microcomputer. During a titration, the titrator measures the signal of the sensor and uses this information to control the addition of the titrant with the electric burette.
- Once an endpoint is reached, the microcomputer calculates the volume of titrant added and converts this value to a result (e.g. a concentration like the concentration of table salt in soy sauce) based on formulas.
- The formulas needed for this calculation can be programmed and depend on type of analysis.
- In automatic titrator, First prepare sample as per guideline for example: For finding % of HCl in autotitrator, taken 1.0 g of HCl and add 50 mL of water.

- Then place sample in equipment, aquouses electrode for end point determination.
- Electric burette add slowly titratant to sample electrode work like a indicator. Then display show result.

Auto Titrato
Brand – LabIndia

SONICATOR

Sonication uses sound waves to agitate particles in a solution. It converts an electrical signal into a physical vibration to break substances apart. These disruptions can mix solutions, accelerate the dissolution of a solid into a liquid, such as sugar into water, and remove dissolved gas from liquids.

Ultrasonic Sonicator Bath
Brand – Leela Sonik

Ultrasonic Sonicator Bath is used in QC, R&D and analytical labs, scientific and pharmaceutical labs. The use of Ultrasonic Sonicator Bath offers gentle yet effective cleaning action ensuring that no contaminants are left from the previous process.

COD(CHEMICAL OXYGEN DEMAND)(For information)

The chemical oxygen demand test (COD) determines, the oxygen required for chemical oxidation of organic matter with the help of strong chemical oxidant. The COD is a test which is used to measure pollution of domestic and industrial waste. The waste is measure in terms of equality of oxygen required for oxidation of organic matter to produce CO_2 and water. It is a fact that all organic compounds with a few exceptions can be oxidizing agents under the acidic condition. COD test is useful in pinpointing toxic condition and presence of biological resistant substances.

The result of the COD calculation is in mg/L.

COD digester

Chemicals required

0.25N Potassium dichromate ($K_2Cr_2O_7$)
Sulphuric acid solution= H_2SO_4 + Silver sulphate (Ag_2SO_4)
Mercuric sulphate ($HgSO_4$) powder
N Ferrous ammonium sulphate (FAS)
$[Fe(NH_4)_2(SO_4)_2]$Ferroin indicator

Chemical preparation

Take 12.259 g $K_2Cr_2O_7$ dissolved in 1 liter distilled water, the concentration of prepared solution is 0.25N $K_2Cr_2O_7$.

22g silver sulphate dissolve in 1 liter sulfuric acid and to keep it for 24 hr then after it is ready to use for COD test.

Weight 39.212 g of FAS(Ferrous ammonium sulphate) and dissolve in previously cooled mixture of 20mL sulphuric acid with 200mL distilled water. After the make up 1000mL with water.

Standardization of FAS

- Take an iodine flask containing 90 mL of water.
- Take 10 mL of 0.1N Potassium dichromate solution (prepare 0.1N Potassium dichromate solution by dissolving about 0.5 g potassium dichromate in 100 mL of water).
- Add 12 mL of conc. sulphuric acid. Cool the content in the flask to laboratory temperature.
- Add 3 to 5 drops of ferrion indicator solution.
- Titrate against 0.1N ferrous ammonium sulphate solution until the color changes from blue to red.
- Note down the initial burette reading (I) and note down the final burette reading(F).

- **Calculate the normality of FAS**

$$\text{Normality of FAS} = \frac{W}{TV \times 0.04904 \times 10}$$

Where ,

TV= (F-I) volume of ferrous ammonium sulphate solution consumed in titration
W= weight of potassium dichromate taken.

Sample preparation

Take 1 mL of sample solution and dilute upto 100 mL with water.

In some cases the sample required further dilution.

- **Test procedure**

- Take 10 mL solution from diluted sample solution in COD tube.
- Add 10 mL 0.25N $K_2Cr_2O_7$ in all sample tube.
- Take 0.4 g accurate weight of mercuric sulphate and add into sample tube.
- Add 10 mL distilled water and then after add 30 mL H_2SO_4+$AgSO_4$ solution slowly.
- All prepared sample tube put in the COD digester at 140-150 ℃ temperature for 2 hr.
- After 2 hr, reaction was completed. Add 40 mL distilled water in all tube. Remove the condenser from tube and cool it down.
- Solution come to room temperature. Add 2-3 drops of Ferroin indicator and titrant against FAS (ferrous ammonium sulphate)
- Note the colour change green to reddish brown.
- Note down the burret reading. Take blank titration same as this procedure.

Calculation

$$\text{COD(Chemical Oxygen Demand)} = \frac{a - b \times N \times 8000}{\text{-----------}}$$

mL of sample

Where,
A = mL of FAS use for blank
B = mL of FAS use for sample
N = Normality of FAS
8000 = milliequivalent weight of oxygen ×1000 mL/L

MELTING POINT APPARTUS

The Visual Melting Point Apparatus allows the researcher to get an indication of the compound or element's purity. The entire operations of the melting point apparatus are controlled by the central processing unit and the printer provides the necessary prints of calibration and accurate, precision and repeatable results.

One of the analytical techniques applied to the characterization of pure chemicals and pharmaceutical drugs (from raw material, to scale-up, to finished form) is the melting point (MP) determination. Carefully choosing the MP determination procedure is important for generating certifiable results for chemical quality control (QC) and quality assurance (QA).It is used in Analytical QC/QA laboratories, pharmaceutical labs and chemical analysis.

CALIBRATION OF MELTING POINT APPARATUS

- Ensure that all the connections of the instrument are proper.
- Operate the instrument as per the operating instructions and determine the melting point of the following reference substances.
- Take the reference substance from lowest range to highest range at a time for calibration.

Reference Standard	Standard Range
Vanillin	81.0 ℃ - 83.0 ℃
Urea (finely crushed)	132.0 ℃ - 135.0 ℃
Sulphanilamide	164.5 ℃ - 166.5 ℃
Caffeine (dried at 100 ℃)	234.0 ℃ - 237.0 ℃

- The melting point of a reference substance should be within standard range.
- Calibrate once in a month.
- When the instrument does not comply with the requirement range specified above , the instrument should be labelled ” OUT OF CALIBRATION “ and should be repaired.
- After repair calibrate the instrument.

Melting Point Apparatus

Visual Melting Point Apparat

WHAT IS LOD?

- A method commonly used for moisture content determination is the loss on drying method or LOD it is used to specify many major quality specification this is based on the principle, in which a substance is completely dry.
- At the beginning and after dryness is achieved, the weight of the substance is measured.
- The final weight loss is calculated and represents the moisture content of the sample.
- Here, moisture refers to all matter within and sample which can be vaporized. So, its includes not just water but volatile solvents, alcohols etc.
- Its perform in two way : 1) Manual
  2) Other one is Automatic in moisture analyser machine.

Procedure for LOD by manual

- Weight a prepared crucible with lid and record weight (W_1).
- Place approx. 1.0g of sample into the crucible and tap carefully, record the weight (W_2).
- Place the crucible into the drying oven and wait according to sample.
- After the time period, take the crucible out of the oven and place the crucible in the desiccator and allow for cooling.
- Reweigh the crucible with closed lid (W_3).

❖ Calculation

$$\% \text{ of Loss On Drying} = \frac{W_2 - W_3}{W_2 - W_1} \times 100$$

Where,

W_1 = Weight of empty crucible

W_2 = Weight of crucible with sample

W_3 = Weight of crucible after drying the sample

MOISTURE ANALYSER

The moisture analyzer works according to the thermo-gravimetric principle, also often referred to as the 'Loss on Drying' (LOD) principle. The moisture analyzer consists of two components, a balance unit and a heating unit.

Moisture Analyzer
Brand – Radwag

ROI (Residue On Ignition)

The Residue on Ignition test is the method to measure the mass of residual substance not volatilized when the sample is ignited. This test is use for determining the content of inorganic substances contained as impurities in an organic substance.

Procedure for test

Previously ignite a crucible of porcelain to constant mass between 700 – 800 ° C in muffle furnace, and weight accurately after cooling.

Take 1 gm sample in previously ignite crucible. Add few drops of sulfuric acid for chairing and heat gently on hot plate until white fumes are evolved.

Then put it in muffle furnace at 800 ° C until the residue is completely burned. Cool the crucible and reweight accurately. Use the desiccator for the cooling.

Calculation:

$$\text{ROI (Residue on Ignition)} = \frac{W3 - W1}{W2 - W1} \times 100$$

Where,
W1 = Empty weight of previously ignite crucible
W2 = Weight of crucible with sample
W3 = Weight of crucible with residue on ignition

MUFFLE FURNACE

A muffle furnace or muffle oven (sometimes retort furnace in historical usage) is a furnace in which the subject material is isolated from the fuel and all of the products of combustion, including gases and flying ash.

After the development of high-temperature heating elements and widespread electrification in developed countries, new muffle furnaces quickly moved to electric designs.

Muffle furnace
Brand - Todaytech

PH METER

A pH meter is used to determine the acidity or alkalinity of the solution. pH is the concentration of hydrogen ions in the solution.

A solution containing more H^+ ion in the remains acidic while the solution containing more OH^- ions remains alkaline.

pH value of solution range from 1 to 14.

pH meter is used to determine the pH of different solutions in pharmaceuticals. It is more accurate method then the pH strip.

A pH meter contains a pH probe that passes the electrical signals to the pH meter and the electrical signals to the pH meter and pH meter displays the pH value of the solution.

The glass pH probe contains two electrodes, a sensor electrodes and a reference electrode. One is contains pH 7 buffer and other contains saturated potassium chloride solution.

Working principle of pH sensor and pH meter depends upon the exchange of ions from sample soluition (pH 7 buffer) of glass electrode through the glass membrane.

pH meter
Labindia

Calibration of pH meter

Switch on the instrument and stable for the 15 min then after rinse the electrode with deionized water.

If instrument is calibrate, display ‘1’ in right side.

If not calibrate, display ‘N’ in right side.

Press the ‘MODE’ key then press ‘ENTER’ key choose the calibration key and press then put the password and again press the ‘ENTER’ key.

Add step by step buffer solution in beaker to lower concentration to higher concentration of pH.

Add buffer solution 1.68 pH and dip the electrode it in and pH is stable then press the 'ENTER' key.

Repeat this step for 4.01pH, 6.86pH, 9.18pH, 12.45pH buffer.

What is TDS ?

Total dissolved solids (TDS) is a measure of the dissolved combined content of all inorganic and organic substances present in a waste water in molecular, ionized, or micro-granular (colloidal sol) suspended form.

TDS concentrations are often reported in parts per million (ppm) or parts per trillion (ppt).

Water TDS concentrations can be determined using a digital TDS meter.

TDS METER

TDS meter is use to determine the total dissolved solid in west water of production department and equalization tank plant(E.T.P.),Wonder tank , Blow down, Hot water of pharma company.

Since dissolved ionized solids, such as salts and minerals, increase the conductivity of a solution, a TDS meter measures the conductivity of the solution and estimates the TDS from that reading.

TDS meter
Brand - Labtronics

HOT AIR OVEN

EQUITRON's Laboratory Ovens find extensive applications in microbiology laboratories, research, pharmaceuticals, healthcare, material testing, quality control and several other general laboratory applications.

An excellent temperature control system, offers a wide array of laboratory ovens and laboratory incubators depending on the application requirements.

Hot Air Oven
Equitron

COLORIMETER

A colorimeter is a device used in colorimetry that measures the absorbance of particular wavelengths of light by a specific solution.

It is commonly used to determine the concentration of a known solute in a given solution by the application of the Beer–Lambert law, which states that the concentration of a solute is proportional to the absorbance.

Colorimeter

Brand – Konica Minolta

WATER PURIFICATION SYSTEM MILLI - Q

The Milli-Q system is a compact, ergonomic, mercury-free and intelligent water purification solution that delivers consistently high-quality pure water on demand.

The Milli-Q Water Purification System produces pure water.

In Milli Q the intelligent pure water storage tank allows maximum protection from any external source of contamination.

Milli Q water use For critical lab applications such as: microbiology culture media preparation, staining solutions for histology and cytology, immunohistochemistry (IHC), electrophoresis gel and buffers, western blotting, immunoassays (ELISA, RIA), drug dissolution testing, biological oxygen demand (BOD), chemical oxygen demand (COD), UV/Vis spectroscopy, titration, etc

Milli Q water use For general lab applications: Sample preparation (dilution, extraction...), buffer and reagent preparation, glassware rinsing, etc.

To feed laboratory instruments like autoclaves, dishwashers, weathering and stability test chambers, clinical analyzers and slide stainers, hydrogen generators, and ultrapure water systems

Features and Benefits

Delivers pure water quality that meets Pharmacopeia and ISO requirements.

Easy to use with carefree maintenance.

Delivers reliable pure water with continuous quality monitoring.

Compact with space-saving installation options.

Mercury-free ech2o® lamps use UVC-LED technology to inactivate bacteria.

Intelligent pure water storage solution provides multi-targeted protection from bacterial, particulate, and CO2.

contamination by using bactericidal UV lamp, a vent filter, automatic sanitization module (ASM), and an overflow sensor.

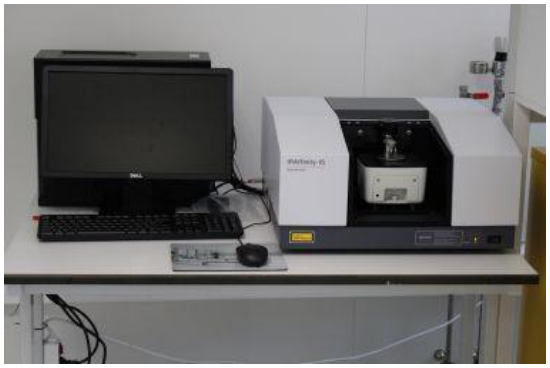
Milli Q

IR SPECTROPHOTOMETER

Infrared spectroscopy (IR spectroscopy or vibrational spectroscopy) is the measurement of the interaction of infrared radiation with matter by absorption, emission, or reflection. It is used to study and identify chemical substances or functional groups in solid, liquid, or gaseous forms. The method or technique of infrared spectroscopy is conducted with an instrument called an infrared spectrometer (or spectrophotometer) which produces an infrared spectrum. An IR

spectrum can be visualized in a graph of infrared light absorbance (or transmittance) on the vertical axis vs. frequency or wavelength on the horizontal axis. Typical units of frequency used in IR spectra are reciprocal centimeters (sometimes called wave numbers), with the symbol cm−1. Units of IR wavelength are commonly given in micrometers (formerly called "microns"), symbol μm, which are related to wave numbers in a reciprocal way. A common laboratory instrument that uses this technique is a Fourier transform infrared (FTIR) spectrometer. Two-dimensional IR is also possible as discussed below.

The infrared portion of the electromagnetic spectrum is usually divided into three regions; the near-, mid- and far- infrared, named for their relation to the visible spectrum. The higher-energy near-IR, approximately 14,000–4,000 cm-1 (0.7–2.5 μm wavelength) can excite overtone or combination modes of molecular vibrations. The mid-infrared, approximately 4,000–400 cm-1 (2.5–25 μm) is generally used to study the fundamental vibrations and associated rotational–vibrational structure. The far-infrared, approximately 400–10 cm-1 (25–1,000 μm) has low energy and may be used for rotational spectroscopy and low frequency vibrations. The region from 2–130 cm-1, bordering the microwave region, is considered the terahertz region and may probe intermolecular vibrations. The names and classifications of these sub regions are conventions, and are only loosely based on the relative molecular or electromagnetic properties.

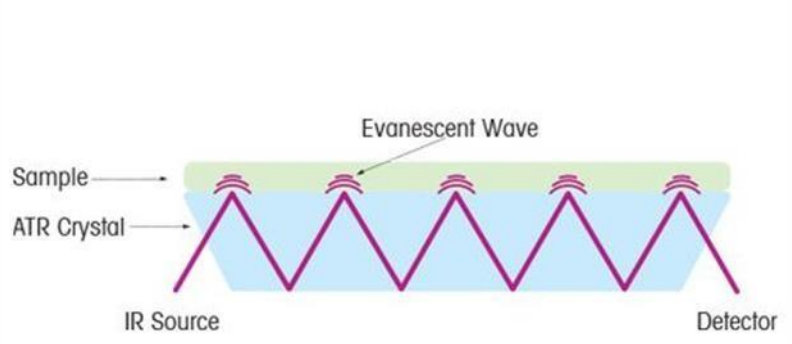


FTIR SPECTROPHOTOMETER

Brand – Shimadzu

What is the FTIR-ATR?

ATR stands for attenuated total reflection and has become the standard technique for the measurement of FT-IR spectra. The infrared light passes through a crystal of a certain material (diamond, ZnSe or germanium) and interacts with the sample, which is pressed onto the crystal. Be advised, that good contact between sample and crystal is very important.



From this a spectrum is obtained, that shows all substance specific characteristics, while the intensity ratio of the observed absorption bands might differ from a traditional transmission spectrum due to physical effects.

But this does not mean that ATR spectra are more difficult to interpret, on the contrary. ATR and transmission spectra can be easily converted into each other. This is especially useful, if you want to compare recently acquired ATR data with older spectra contained in a spectral reference library.

ATR (Attenuated Total Reflection)

UV SPECTROPHOTOMETER

Principle of ultraviolet–visible absorption

Molecules containing bonding and non-bonding electrons (n-electrons) can absorb energy in the form of ultraviolet or visible light to excite these electrons to higher anti-bonding molecular orbitals. The more easily excited the electrons (i.e. lower energy gap between the HOMO and the LUMO), the longer the wavelength of light it can absorb. There are four possible types of transitions (π–π*, n–π*, σ–σ*, and n–σ*), and they can be ordered as follows : σ–σ* > n–σ* > π–π* > n–π*.

UV spectroscopy is a work on the principle of Beer- Lambert's law.

The Beer–Lambert's law states that the absorbance of a solution is directly proportional to the concentration of the absorbing species in the solution and the path length. Thus, for a fixed path length, UV/Vis spectroscopy can be used to determine the concentration of the absorber in a solution.

$$A = \log_{10} (I_0/I) = \varepsilon cL$$

Where,

A = The measured absorbance (in Absorbance Units (AU))

I_0 = The intensity of the incident light at a given wavelength

I = The transmitted intensity

L = The path length through the sample

c = The concentration of the absorbing species

ε = A constant known as the molar absorptivity or extinction coefficient

UV Spectrophotometer

Brand – Shimadzu

Component of UV spectrophotometer

- Light Source
- Monochromator
- Sample and Reference cell
- Slit
- Detector
- Amplifier
- Recording device

A spectrophotometer can be either single beam or double beam. In a single beam instrument , all of the light passes through the sample cell. Io must be measured by removing the sample. This was the earliest design and is still in common use in both teaching and industrial labs.

In a double-beam instrument, the light is split into two beams before it reaches the sample. One beam is used as the reference; the other beam passes through the sample. The reference beam intensity is taken as 100% Transmission (or 0 Absorbance), and the measurement displayed is the ratio of the two beam intensities. Some double-beam instruments have two detectors (photodiodes), and the sample and reference beam are measured at the same time. In other instruments, the two beams pass through a beam chopper, which blocks one beam at a time. The detector alternates between measuring the sample beam and the reference beam in synchronism with the chopper. There may also be one or more dark intervals in the chopper cycle. In this case, the measured beam intensities may be corrected by subtracting the intensity measured in the dark interval before the ratio is taken.

CONCLUTION

The main objective of the industrial training is to provide an opportunity to understood to identify, observe and practice what different between the real industrial practical work and college practical work. It is not only to experience on technical practices but also observed management practices and to interact with colleagues. I learnt the way in an organization, the importance of being punctual, the importance of maximum commitment and the importance of team spirit. I get huge experience of instruments like Karl – fischer, Moisture analyzer, pH meter etc. and testing of raw material, finished good products, in –process material and intermediate.

Shri M. & N. Virani Science College (Autonomous) Rajkot
Report of the activity under the MoU with The Guru Chela

Introduction:
The Guru Chela is a global e-learning platform for the integration and networking of the expertise in multiple disciplines of pure and applied sciences. The college has a functional MoU with the platform for the easy, subsidized and quality online learning and problem solving.

Activity
An orientation session for the faculties as well as the students was organized by the college in collaboration with TGC. Both the faculties and the students were briefed about the functionalities of the app, its features, benefits of registration, available features and the subscription rates. The faculties were also encouraged to be mentors and subject experts on this platform.

Date: 4th March 2023

Venue: For faculties: AV ROOM No. 212
For students: Seminar Hall No. 2

Resource Person: Dr. Dharmesh Adhyaru, the founder of the platform

No. of students attended the session: 130

Outcome of the activity: Under the MoU, the students were offered a subsidized subscription to the platform


Shot on OnePlus


Shot on OnePlus


Shot on OnePlus


OnePlus

18-19 (1)

250

SSIP Activity Report

1. **Title of the Activity:** State level poster presentation on "Chemistry for Mankind"

2. **Venue:** Shree M. & N. Virani Science College (Autonomous) , Rajkot

3. **Brief Description of the Activity:** State level poster presentation on "Chemistry for Mankind"

4. **Activity Schedule:** 10:30 am to 01:30 pm on 29/09/2018

5. **Activity Coordinator:** Dr. Pratik Ambasana

6. **Activity Organizers:** Department of Chemistry, Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot and Student Statup & Innovation Policy (SSIP)

7. **Participants' Details:** 247 Students of UG/PG (From different college, Rajkot Region)

8. **Outcome of the Activity:**

- Students got exposure to current trends in chemistry.
- Students got an idea on the presentation skills.
- Students interacted with company professionals.
- Students got immediate feedback from other academicians.
- Students had developed effective communication skills.

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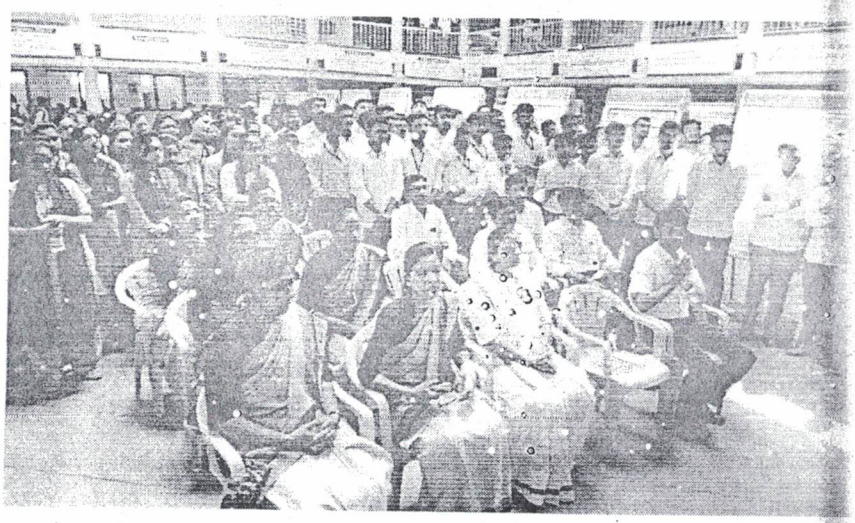
Shri Manibhai Virani and
Smt. Navalben Virani Science Co
(Autonomous) Rajkot.

9. Photographs:

Principal
Shri Manibhai Virani and
Smt. Hevalben Virani Science Coll
(Autonomous) Rajkot.



Chemistry for mankind
Poster Presentation Registration

Sr.No	Group No.	No. of Students	Name of Student
1	1	3	Hirpara Harikrushn
2			Rabadiya Pratik
3			Ranpariya Jasmin
4	2	3	Padaliya Gautum
5			Kamani Naimish
6			Parakhiya Smit
7	3	2	Jasani Neel
8			Dhameliya Bhavik
9	4	3	Kanabar Neel
10			Shah Hill
11			Maheta Preet
12	5	4	Pathak Mansi
13			Thumber Isha
14			Jadhav Aswini
15			Satasiya Disha
16	6	3	Dhudak Bhavin
17			Vaishnani Krupali
18			Gambhava Santosh
19	7	3	Chhaniyara Neel
20			Dodiya Arti
21			Varul Ila
22	8	3	Sapariya Mavji
23			Vegad Yogesh
24	9	4	Thumar Rinish
25			Ramani Bhargav
26			Vaghasiya Tarang
27			Rathod Dhaval
28	10	3	Makati Shreya
29			Kalariya Riya
30			Shihora Ava
31	11	3	Chovatiya Meet
32			Isoriya Yash
33			Joshi Lakshya
34	12	3	Sirsiya Shivani
35			Sauda Mansi
36			Ramani Jinkal
37	13	3	Upadhyay Harshil
38			Jivani Sachin
39			Dhameliya Bhumit

40	14	3	Raiyani Hitakshi
41			Ansari Shirin
42			Makadia Darshi
43	15	2	Goswami Jensi
44			Bimani Pragati
45	16	3	Chauhan Rohit
46			Karani Dhariya
47			Nakum Mukesh
48	17	3	Depani Banti
49			Hirpara Sanket
50			Jadav Hiten
51	18	4	Rupareliya Dwanshi
52			Vasoya Nikita
53			Shah Milika
54			Patel Khushboo
55	19	3	Rangani Keyur
56			Thumar Priyank
57			Pambhar Dhruvit
58	20	2	Trivedi Krishna
59			Bavadiya Priyanka
60	21	3	Kandoriya Pakesh
61			Khachar Vishwajeet
62			Vadhika Sagar
63	22	4	Charola Divyesh
64			Kotadiya Yash
65			Keraliya Kuldeep
66			Bhalodiya Jasy
67	23	4	Jethva Bhargav
68			Kachhadiya Paras
69			Radadiya Akash
70			Pindoriya Parth
71	24	2	Hemani Sonali
72			Kumbhani Vimanshi
73	25	3	Patel Mahak
74			Dudani Karan
75			Marthak Deep
76	26	3	Jabvani Kajal

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77			Jobanputra Aastha
78			Patodiya Pinal
79	27	3	Umaradiya Swati
80			Zalavadiya Bhoomi
81			Mungra Kshitij
82			Bhatt Vatsal
83	28	3	Kachhadiya Jeel
84			Kasundera Nilan
85			Borochiya Jeel
86	29	3	Dadhania Bhautik
87			Sanavada Savan
88			Vasani Raj
89	30	2	Ranpariya Jay
90			Vadnagara Meet
91	31	2	Handa Krishna
92			Shigh Neetu
93	32	3	Suvagiya Akshita
94			Mendapara Tejasvi
95			Patel Kinjal
96	33	3	Trambadi Shivan
97			Desai Tisha
98			Deshani Hetal
99	34	3	Rajpara Mansi
100			Chavda Krishbna
101			Sharma Navdeep
102	35	4	Disha Doshi
103			Hemali Ramchandani
104			Aarti Godahni
105			Payal Bhalodiya
106	36	2	Priya Harsora
107			Foram Joshi
108	37	1	Chhatbar Drashti J.
109	38	2	Chauhan Nivruti
110			Gohel Vruti
111	39	3	Vyas Tanvi P.
112			Bhatti D.
113			Dixita V.
114	40	3	Mansi M.
115			Khushboo R.
116			Dalsaniya Lipsa H.
117	41	4	Dodiya Foram R.
118			Vanpariya Krishna P.
119			Magalpara Bansri
120			Santoki Happy

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121	42	3	Gor Vaishakhi M.
122			Rank Nikita
123			Thakar Dhroomi
124	43	4	Jani Khushali H
125			Nandha Nayan H
126			Jadeja Vijaysinh
127			Nandasana Abhishek
128	44	4	Parmar Pooja B
129			Borad Arjun G
130			Makadiya Nirav P.
131			Vaishnav Dep J.
132	45	3	Bhatt Nirmal N.
133			Dudharejiya Gaurang R.
134			Vekariya Nimesh H.
135	46	2	Mohit Pipaliya
136			Kaushik Parmar
137	47	2	Hapaliya Radhika
138			Krishna Padiya
139	48	2	Ayaan Admal
140			Bhavati Chandraly
141	49	4	Vaghasiaya Mayur
142			Shivangiba Jadeja
143			Amrutiya Nancy
144			Vachani Ruchi
145	50	3	Kathirya Ekta
146			Kansagara Mona
147			Hirapara Parita
148	51	4	Dekavadiya Sagar
149			Panara Yash
150			Malasama Dinesh
151			Ramani Amar
152	52	3	Makasana Mangal
153			Jethva Rohit
154			Pabari Utsav M.
155	53	3	Rayani V
156			Bhal Vaghamshi R.
157			Sarla Savan J.
158	54	4	Shiyada Dharti
159			Patel urvi
160			Marvaniya Dimple
161			Rakholia Ami
162	55	3	Snesha Vaghasiya
163			Bansi Mori
164			Tanisha Ladani

165	56	2	Trada Banshi
166			Dave Nainshree
167	57	3	Jakasaniya Hardik
168			Moghariya Anand
169			Virani Ridhhi
170	58	4	Barasiya Praful
171			Gharadushiya Soham
172			Sabhani Hardik
173			Nadapara Neha
174	59	2	Dangi Jay
175			Odedara Yash
176	60	2	Priyanka Solanki
177			Alisha Bamrolia
178	61	3	Ghodasara Krishna
179			Ajudiya Pooja
180			Mori Janki
181	62	4	Rinku Bhagiya
182			Piludiya Reshmabanu
183			Nithani Chirag
184			Kardiya Monali
185	63	4	Hapani Nimisha
186			Patel Kajal
187			Parmar Lish
188			Gabriel Rohit
189	64	3	Raiyanee Mohit
190			Ashish Barasara
191			Kakasaniya Payal
192	65	5	Dave Siddharth
193			Pipaliya Krishna
194			Dave Rachana
195			Soni Rajvi
196			Lakhani Heena
197	66	4	Monik Vaishnav
198			Bhuva Raj
199			Ranipa Hardik
200			Monik Vaibnav
201	67	2	Gohel Dushyant
202			Raja Maulik
203	68	5	Sugashiya Heena
204			Hemanshi Satodiya
205			Aditi Singh
206			Riddham Hadvani
207			Dharam Padaliya
208	69	3	Vaghasiya Nikhil

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209			Peghadiya Pankaj
210			Desai Vivek
211	70	3	Parmar Kripalsinh R.
212			Jayraj Jatiya
213			Mgangav Dhola
214	71	3	Ramani Mansi R.
215			Trambadiya Priya R.
216			KugstharaShruti A.
217	72	3	Mankodiya Deep
218			Asodiya Yash
219			Panguthiya Raviraj
220	73	3	Kalola Jinal K
221			Raval Ujjavala V
222			Sakhiya Radhika M
223	74	2	Devmorari Vishvraj V.
224			Rohilla Bhuneshwari
225	75	1	Gandhi Raheb S.
226	76	1	Koradiya Niddhi
227	77	4	Sutariya Bansi
228			Vadodariya Akash
229			Barnat Uamng
230			Ram Kishor
231	78	3	Vasani Doli
232			Thanki Nehal
233			Unagar Jaykishan
234	79	3	Kevin variya
235			Nidish Trivedi
236			Pratik Garach
237	80	3	Zalawadiya Harshil
238			Patel Pooja
239			Jadeja Rajeshreeba
240	81	2	Padmani Mitul
241			Sakhiya Gopal
242	82	4	Tammanna Patel
243			Aghara Priti
244			Kachrola Bansi
245			Bhimani Nisha
246	83	5	Rajani Akshari
247			Pooja Tailor
248			Himati Gondaliya
249			Ramesh Sonagara
250			Bhardvaj Kubavat

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State Level Poster Presentation on

'Chemistry for Mankind'

(29th September, 2018)

Certificate of Appreciation

This is to certify that .....

of ..... has presented poster on

..... in the State Level Poster Presentation Event

'Chemistry for Mankind' - A Golden Jubilee Celebration Event of Shree M. & N. Virani Science College, Rajkot organized by Department of Chemistry; and supported by Atmiya University, Rajkot and Student Startup & Innovation Policy (SSIP), Government of Gujarat.

Organized by:

ATMIYA UNIVERSITY
सहृदं सर्वभूतानाम्

Department of Chemistry

SSIP

Dr. Kartik. D. Ladva
Principal

18-19

(2) 120

Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Awareness Drive

Date: 15/09/2018 , Time: 10.00 AM, Venue: Room No. 106, 1st Floor

S. No	Name of Student	Enrolment No
1.	Krupa N. Godhani	16BBC015
2.	Mariyam S. Lokhandwala	16BBC026
3.	Panchasara Bhakti J.	16BBC037
4.	Parmar Dhara M.	16BBC039
5.	Ranpariya Amisha M.	16BBC042
6.	Vekariya Khushali C.	16BBC056
7.	Madhani Krena M.	16BBC028
8.	Thoriya Dhruv A.	16BBC053
9.	Rathod Uday M.	16BBC044
10.	Busa Ronak K.	16BBC008
11.	Dungarani Pranav N.	16BBC010
12.	Savaliya Parth	16BBC049
13.	Jadav Vijay A.	16BBC018
14.	Pooja Sharma T.	16BBC050
15.	Hetvi Bhindora	16BBC005
16.	Shubhangini Mori	16BBC032
17.	Nancy Pipapliya	16BBC040
18.	Dhruvi Paija	16BBC035
19.	Dharini Katariya	16BBC025
20.	Jasmine Morsaniya	16BBC033
21.	Morayani Kamlesh G.	16BBC034

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22.	Hirpara Rimal A.	16BBC016
23.	Vasani Harsh A.	16BBC055
24.	Gangadiya Naimish B.	16BBC013
25.	Ganatra Shivam N.	16BBC012
26.	Sarvaiya Nikunj R.	16BBC048
27.	Kachhot Ajaykumar B.	16BBC023
28.	Sindhav Rahul D.	16BBC051
29.	Darshana K. Kalavadiya	16BBC024
30.	Jadav Pratiksha A.	16BBC017
31.	Rathod Kajal M.	16BBC043
32.	Lunagariya Kinjal R.	16BBC027
33.	Pambhar Disha B.	16BBC036
34.	Boda Sapna	16BBC006
35.	Poriya Bhakti V.	16BBC041
36.	Raval Dhruvi S.	16BBC045
37.	Sadhariya Ekta K.	16BBC047
38.	Javiya Hiral V.	16BBC020
39.	Vagheliya Ravina J.	16BBC054
40.	Javiya Krupa C.	16BBC021
41.	Chadamiya Nikita R.	16BBC009
42.	Ankita C. Kachhetiya	16BBC022
43.	Adroja Hariyali V.	16BBC001
44.	Meva Riddhi	16BBC031
45.	Mehta Khushboo B.	16BBC030
46.	Jay Katudiya	16BCH032
47.	Jadav Abhishek	16BCH028
48.	Chetan Sonagara	16BCH054
49.	Parth Mayani	16BCH036
50.	Jadav Pragnesh	16BCH029
51.	Sidhdharth Katariya	16BCH031

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52.	Yash Chauhan	16BCH011
53.	Gohel Bhavin	16BCH023
54.	Zala Arjunsinh	16BCH062
55.	Tolia Kushal	16BCH057
56.	Sirja Keyur	16BCH052
57.	Tanna Arjun	16BCH055
58.	Nandaniya Gaurav	16BCH043
59.	Hirapara Rohil	16BCH027
60.	Rokad Mansi	16BCH048
61.	Ramani Riddhi	16BCH046
62.	Mungra Devangi	16BCH040
63.	Kalsara Chhaya	16BCH030
64.	Gajera Chetna	16BCH020
65.	Nakum Shruti D.	16BCH041
66.	Vyas Tanvi K.	16BCH061
67.	Godhani Niral K.	16BCH022
68.	Dave Nainshree A.	16BCH014
69.	Bopaliya Dharti D.	16BCH008
70.	Ranva Mita D.	16BCH047
71.	Trada Banshi C.	16BCH058
72.	Gadara Arpita S.	16BCH018
73.	Rakholiya Dixita V.	16BCH045
74.	Butani Divya S.	16BCH009
75.	Pansuriya Kajal V.	16BCH044
76.	Dalsaniya Lipsa H.	16BCH013
77.	Khunt Mansi M.	16BCH034
78.	Bhalodiya Khushbu R.	16BCH003
79.	Akbari Pinal K.	16BCH002
80.	Dodiya Foram R.	16BCH016
81.	Mehta Vaibhavi M.	16BCH037

82.	Shekh Nagma A.	16BCH051
83.	Chavda Anjali C.	16BCH012
84.	Mungalpara Banshri R.	16BCH039
85.	Goswami Dhara B.	16BCH024
86.	Bhatiya Pratikkumar Mahadevbhai	'17BCH002
87.	Chhaniara Neel Dipakbhai	'17BCH003
88.	Chudasama Hardiksinh Gambhirsinh	'17BCH004
89.	Dhaduk Bhavin Harsukhbhai	'17BCH006
90.	Dhamsaniya Kishankumar Avacharbhai	'17BCH007
91.	Dodiya Artiben Pravinbhai	'17BCH008
92.	Gambhava Santosh Rajeshbhai	'17BCH009
93.	Gami Ami Kantilal	'17BCH010
94.	Godhani Sejal Shivlalbhai	'17BCH011
95.	Godhaviya Nikul Chandubhai	'17BCH012
96.	Gondaliya Jay Sureshkumar	'17BCH013
97.	Handa Krishna Amarshibhai	'17BCH014
98.	Harnesha Jatin Pravinbhai	'17BCH015
99.	Jadeja Dhananjaysinh Chandrasinh	'17BCH016
100.	Jayswal Janvi Priteshbhai	'17BCH018
101.	Joshi Nikunj Sunilbhai	'17BCH020
102.	Joshi Vandanaben Shantilal	'17BCH021
103.	Kagathara Dhavalkumar Govindbhai	'17BCH022
104.	Kasundra Janviben Jayeshbhai	'17BCH023
105.	Kasundra Shwet Gordhanbhai	'17BCH024
106.	Khambhara Ramesh Mavjibhai	'17BCH025
107.	Koringa Dhruv Narendrabhai	'17BCH026
108.	Lalakiya Heta Vijaybhai	'17BCH027
109.	Lokhil Uday Hemantbhai	'17BCH028
110.	Lunagariya Vishva Samirbhai	'17BCH029
111.	Makadia Khushbu Nitinbhai	'17BCH030
112.	Makwana Chintankumar Narotambhai	'17BCH031
113.	Nadapara Kashyap Dinesh Bhai	'17BCH033
114.	Nakum Jeetkumar Manish	'17BCH034
115.	Patadiya Vidhi Kishorbhai	'17BCH036
116.	Patel Zeelkumar Sanjaykumar	'17BCH037
117.	Ramani Krishna Nitinbhai	'17BCH039
118.	Rasadiya Nirman Nitinbhai	'17BCH040
119.	Sarvaiya Dhaivat Rajeshbhai	'17BCH041
120.	Sheth Vrushali Kamleshbhai	'17BCH042

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Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Awareness Drive for M.Sc. Students

Date: 14/09/2018 , Time: 11.30 to 01.30, Venue: Room No. 302

Sr_No	Student ID	Student Name	Gender	Mobile No
1	15614018003	Devmurari Vishvraj Vijaybhai	Male	8128195874
2	15614018007	Kalola Jinal Virendrakumar	Female	9924836313
3	15614018010	Patel Tamannaben Mukeshbhai	Female	8128427872
4	15614018011	Bhimani Nisha Dalsukhbhai	Female	9974236257
5	15614018013	Bhalani Dixitkumar Prakashbhai	Male	9427408160
6	15614018014	Garach Pratik Shaileshbhai	Male	9909484443
7	15614018015	Patel Poojaben Pravinbhai	Female	9737692463
8	15614018023	Dhola Madhav Arvindbhai	Male	8511045152
9	15614018025	Makawana Khushbu Jayeshkumar	Female	9904160211
10	15614018026	Sakhiya Radhika Maheshbhai	Female	7600054554
11	15614018027	Sanghani Dhruti Shantilal	Female	9727410497
12	15614018029	Jivani Nilam Shantilal	Female	7623818979
13	15614018031	Mitesh Rameshbhai Dodiya	Male	9974077582
14	15614018033	Trivedi Nidhish Atul	Male	9974438129
15	15614018034	Bhadaniya Camey Prafulbhai	Female	7874573899
16	15614018035	Unagar Jaykishan Bharatkumar	Male	9426435021
17	15614018036	Thanki Nehalkumari Nareshbhai	Female	9586889968
18	15614018037	Jadeja Rajeshreeba Arvindsinh	Female	8511066443
19	15614018038	Jatiya Jayraj Nitinbhai	Male	9723131102
20	15614018040	Sanghani Khushbu Harsukhbhai	Female	9426318198
21	15614018042	Patel Anjanaben Prahaladbhai	Female	6352387375

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22	15614018043	Kachrola Bansibahen Manishbhai	Female	9409354756
23	15614018045	Bhimani Harsh Mansukhbhai	Male	9409404757
24	15614018046	Kasundra Shubham Rameshbhai	Male	9687527709
25	15614018047	Aghara Priti Pravinbhai	Female	9558480377
26	15614018048	Zalavadiya Harshil Kiritbhai	Male	
27	15614018049	Bhalara Aejaz Hushen	Male	6351900815
28	15614018050	Nandasana Jalpa Laljeebhai	Female	9033482365
29	15614018051	Pandya Vaibhavi Kiritkumar	Female	9979035545
30	15614018052	Sutaria Bansi Hareshbhai	Female	9099507307
31	15614018053	Pansuriya Raviraj Dilipbhai	Male	7069817009
32	15614018054	Busa Akshaykumar Kantilal	Male	9638720506
33	15614018055	Kagathara Hardik Ashokbhai	Male	7990720120
34	15614018056	Barhat Umang Chhatrashalbhai	Female	8141412168
35	15614018057	Padmani Mitulbhai Pravinbhai	Male	7069224962
36	15614018058	Mehta Dhara Pankajbhai	Female	8154002200
37	15614018059	Kanajariya Jaysukh Ravjibhai	Male	9824576461
38	15614018060	Ramani Mansi Raghavjibhai	Female	7265054725
39	15614018061	Trambadiya Priya Prafulbhai	Female	9687181923
40	15614018062	Maghodiya Dhara Sureshbhai	Female	7600055700
41	15614018063	Asodariya Yash Pravinbhai	Male	8141722535
42	15614018064	Vadodariya Akashkumar Mansukhbhai	Male	9714808939
43	15614018065	Ram Kishor Mensibhai	Male	9512501125
44	15614018066	Bhalodia Maheshkumar Devjibhai	Male	9725567616
45	15614018068	Raval Ujjvalaben Vijaykumar	Female	9664658699
46	15614018069	Sagarkumar Navanitbhai Ghetiya	Male	9727515968
47	15614018070	Kachhetiya Mital Chandulal	Female	6355114478

48	15614018072	Ajudiya Mayankkumar Harsukhbhai	Male	9879365389
49	15614018073	Variya Kevin Tarulbhai	Male	7600404873
50	15614018074	Gandhi Rabab Saifuddin	Female	8488027733
51	15614018075	Koradiya Nidhiben Pravinbhai	Female	8460405157
52	15614018076	Vasani Doli Prakashbhai	Female	9998158752
53	15614018077	Butani Dharmik Ashokbhai	Male	8347368168
54	15614018078	Kagathara Shruti Amarsheebhai	Female	
55	15614018079	Sakhiya Gogan Jayantibhai	Male	9426589990
56	15614018080	Parmar Kripalsinh Rajendrasinh	Male	7600780187
57	15614018081	Makadiya Deepkumar Rajeshbhai	Male	8136849858
58	15614018082	Zalavadia Bhumi Maheshbhai	Female	
59	15614018084	Satani Krishna Jayprakashbhai	Female	9227852141
60	15614018085	Butani Himanshu Sundarjibhai	Male	8365065628

ATMIYA UNIVERSITY
&
Shree M. & N. Virani Science College
(Autonomous)

jointly organizes

Workshop
on
"IPR: Practical approach and current trend in Patenting"

Speaker : Mr. Suhas R Kulkarni
Examiner of Patent and Design,
Office of Controller General of Patents,
Designs & Trade Marks
Boudhik Sampada Bhavan, Antop Hill,
Mumbai

Date : 6th December 2018
Venue : Auditorium 1
Time : 2:00 – 4:00 PM
Participants : PG students and Faculty

Principal
Shri Manibhai Virani and
Smt. Navalben Virani Science Colleg
(Autonomous) Rajkot.

Interested participants may send their names to sabhatt@vsc.edu.in latest by 3rd December 2018.

ATMIYA UNIVERSITY
सुहृदं सर्वभूतानाम्

ATMIYA UNIVERSITY

Organizes Workshop

on

"IPR: Practical approach and current trend in Patenting"

S.No.	Name of the students	Department	Signature
1.	DEEP V. SORATHIYA	CHEMISTRY	
2.	GAURANG R. DUDHAREJIYA	CHEMISTRY	
3.	Milan R. Aghera	chemistry	
4.	Nimesh H. Vekariya	Chemistry	
5.	Bhatt Ninad u.	chemistry	
6.	Piyush.D.Chandrala	chemistry	
7.	Rahul R Pamsuriya	Ind. chem(PG)	
8.	Jaydip R Limbasiya	M.Sc microbiology	
9.	Bhanderi Rinkalkumari	M.Sc Microbiology	
10.	Savaliya Rohit B.	M.Sc Microbiology	
11.	Sondarva Sagar R.	M.Sc Microbiology	
12.	Vaghani Deep Kumar	M.Sc Microbiology	
13.	Dobariya Ishan L.	M.Sc I.C	
14.	Kundan Solanki	M.Sc B.T.	
15.	Hareesh Bhaliya	M.Sc. B.T sem-1	
16.	Urmi Milan	M.Sc. B.T sem-1	
17.	Sahil Patel	MSC BT sem-1	
18.	Aghera Nilesh	MSC BT Sem-2	
19.	Jay Lila	MSC BT sem-2	
20.	Harsh Dhakan	MSC BT sem-2	
21.	Mohit V. Raiyanee	M.Sc chemistry (III)	
22.	Gajipara happy K.	M.Sc Chemistry	
23.	Nandha Nayan H.	"	
24.	Vaishnav Deep J.	"	
25.	Nihav Makadia	"	
26.	Abhishek Nandasana	"	
27.	Chavda Jasmini	M.Sc-BT sem-1	
28.	Savaliya Dipta	M.Sc BT Sem-1	
29.	Bavliya Kinjal	Msc BT sem-1	
30.	Kateshiya Hina C.	M.Sc. Microbiology sem-1	
31.	GOJARIYA JANKI	M.Sc (micro) sem-I	
32.	Jetani Priya	M.Sc (micro) sem I	
33.	Esotiya Dhaval	MSC (BT) sem I	
34.	Acharya Pooja	M.Sc (BT) Sem IV	
35.	Chetrani Divya	M.Sc " "	
36.	Nambata Singh	" " "	

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.No.	Name of the students	Department	Signature
37.	Parmar Dhruti K.	M.Sc. B-I	
38.	Thakkar Neeti R.	M.Sc Micro-I	
39.	OZA VARD N.	M.Sc Micro-I	
40.	Kasundra Kushali R.	M.Sc micro-I	
41.	Sakhiya Archana M.	"	
42.	Patel Srushti H.	M.Sc micro-I	
43.	Pancrou Shruti K.	M.Sc micro-I	S.L.Pangrou
44.	Choksi Vrunda	M.Sc BT. IV	
45.	Vamja Payal	M.Sc BT. II	
46.	Umraniya Khyati	M.Sc BT. I	
47.	Kakasaniya Payal	M.Sc. Chem. -4	
48.	Keshwala Riddhi	M.Sc. Chem -4	Riddhi
49.	Sondagar Nikita	M.Sc. Chem. -4	
50.	vadaliya Ritu	MSc micro-4	Ritu
51.	vanpariya madhuri	"	
52.	Agravat urvi	"	
53.	Kavani Surbhi	"	Surbhi
54.	Rathod Hiral	"	
55.	Zoya Pooram	M.Sc. micro-I	
56.	Koyani Mansi	"	Mansi
57.	Gadhani Pooja	"	
58.	Kathiriya Ekta	M.Sc. POC	
59.	Nadapara Neha	M.Sc. POC	
60.	Chungani Shital	B.Voc MMDT IV	Shital
61.	Pithadiya Ravina	B.Voc (MLSMDT)(I)	Ravina
62.	Ghanchi Shiya Saheim	M.Sc. POC	
63.	Sabhani Hardik	"	
64.	Bavasiya Parth	"	
65.	Jakasaniya Ravi	M.Sc IC	
66.	Delvadiya Ronak	MSc IC	
67.	Patel Mandvie P.	M.Sc IC	
68.	Parmar Atul H.	MSc(IC)	
69.	Makwana Hardik J.	MSc(IC)	Harsh
70.	Darshan N Ladva	M.Sc. (IC)	
71.	Parmar Divyesh	M.Sc. CIC)	Divyesh
72.	Paresh Karan	M.SC(IC)	
73.	Piyuniy Parth	M.SC(IC)	
74.	KHANPARA NIKHIL P.	M.Sc.(IC)	K. Nikhil
75.	AKBARI VIVEK B.	"	
76.	TARPARA MILAN P.	" "	
77.	VARSANI RONAK	"	
78.	HIRANI SANDIP	"	
79.	VORA MILAN	"	
80.	SUDANI KEVIN	"	
81.	SOJITRA BRIJESH	"	
	Kachchhi Mohit	"	
	Bakhariya Nikunj	"	

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S.No.	Name of the students	Department	Signature
82.	Akash Patel .C.	M.Sc I.C	
83.	Varun Upadhiyay .D	"	
84.	Chaniyara Urva S.	M.Sc I.C	
85.	Pagdar Navnit P.	M.Sc. IC	
86.	Dadhaniya Bhavik H.	"	
87.	Dalsaniya Uday C.	"	
88.	Rajodiya Mehul. M.	"	
89.	Deshai Usvesh.	"	
90.	Kumbhani Dharmesh	"	
91.	Vivek Pansuras	"	
92.	Bhuva Vaibhav	"	
93.	Bhut Dhruvit	"	
94.	Babari Palak H.	M.Sc. Micro	
95.	Vekariya Dixita M.	"	
96.	Vasani Ripal R.	"	
97.	Govani Ruchi	"	
98.	Bambharoliya Divya	M.Sc. Micro. (4)	
99.	Solathiya Dhara	"	
100.	Chothani Naimisha	"	
101.	Mungra Krishna.	"	
102.	Dave Riddhi	"	
103.	Vaghasiya Kruti P.	M.Sc. BT (1)	
104.	Satkiya Jay N.	M.Sc. - BT (1)	
105.	Pambhar Rajnni G.	M.Sc - BT (1)	
106.	Popat Charmi M.	MSC BT (I)	
107.	Vora Krishna P.	MSC BT (I)	Riddhi
108.	Vyas Riddhi M.	MSC BT (I)	Krishna
109.	Parekh Prachi	MSC BT (I)	
110.	Ambani Rupali M.	M.Sc Micro. (4)	
111.	Pandya Himalee P.	"	H. P Pandya
112.	Visana Arti B.	"	
113.	Parmar Aveni B.	"	A.B. Parmar
114.	THAKAR DHROOMI R.	MSc CHEMISTRY	
115.	CHAUHAN NIVRUTI B.	MSc CHEMISTRY	
116.	GOHEL VRUTI H.	MSC CHEMISTRY	
117.	Vaishnani Neney H.	MSC Biotech	
118.	Khanpara Nidhi P.	"	
119.	Sucheck Heli	"	
120.	Nimisha Kanabar	MSC BT-4	
121.	Rutu Kalavadia	"	
122.	Richa Nichani	"	
123.	Dhwani Chandarana	"	
124.	Shivani Jani.	"	
125.	Alisha Bambhaliya	MSC Micro-4	
126.	Dr. Mehul L. Savaliya	IC-1	
127.	Dr. Dhaval A. Tank	IC-1	
128	Prof Mohit A. Lakhani	Mech-AITS	
129	Prof Keyur. V. Parmar	Mech-AITS	
130	Pinka Solanki	M.Sc Micro-4	

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18-19

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Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

organizes

ROBINTRO - A One Day Workshop on Robotics

under SSIP Sensitization Activity

on 06/12/2018

Time: 10.00 AM to 05.00 PM

Venue: Computer Lab

Resource Person:

Dr. Ashish Kothari,

Head, EC Department,

ATMIYA University, Rajkot

Event Coordinator:

Dr. Pratik Ambasana

SSIP Coordinator & Asst. Professor,

Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

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GLOBAL SKILL ACADEMY (ATMIYA UNIVERSITY)

SR NO.	NAME	CONTACT NO.	SIGNATURE
1	Arjun Vasoya	7818080072	A....
2	Varun Pithiya	9725995815	Varun
3.	Harsh Chudasma	9601029785	Harsh
4.	Jemin Bhalala	9106893600	J.P.Bhalala
5.	Paras Bhalala	9537869522	P.S. Bhalala
6.	Jay Sardhara	7698794037	Jay ...
7.	~~Jayraj~~ Sagar Gajera	8825807573	Sagar
8.	Dobariya Milan	7567199602	M. patel
9.	Dhruvil Gajera	8320652339	Dhruvil
10.	Sagar Savaliya	7435958684	Sagar
11	Neel Vaghela	8511174594	Neel
12	Jenish Topiya	8460961472	J.T.
13	Jaydeep Vyas	9664575475	Jaydeep
14	Kangad Parth	98959 74546	
15	Malik Chavda	9728790990	
16	Jayraj Zala	8238728288	Zala
17	Vaviyani Yusuf		Yusuf
18	Sakshi M. Dhaduk		Dhaduk
19	પ્રણવ કે. પ્રજાપતિ	9898022122	P.K.S.
20	Jaikishan Motwani	7298206472	

Parkavan..

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19-20

(1)

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Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Awareness Drive (M.Sc. Chemical Science Students)

Date: 21/09/2019 , Time: 10.00 to 01.00, Venue: Room No. 124, 1st Floor

Sr No	Student's Name	Class / Semester
1.	Sheth Dharti Dharmendrabhai	M.Sc. (IChemistry) - Semester-I
2.	Shingala Jeel Ashokbhai	M.Sc. (IChemistry) - Semester-I
3.	Solanki Bharati Naranbhai	M.Sc. (IChemistry) - Semester-I
4.	Tala Hiten Dineshbhai	M.Sc. (IChemistry) - Semester-I
5.	Thummar Bhavesh Girish Bhai	M.Sc. (IChemistry) - Semester-I
6.	Undaviya Krutika Shaileshbhai	M.Sc. (IChemistry) - Semester-I
7.	Vadodariya Avanik Vinod Bhai	M.Sc. (IChemistry) - Semester-I
8.	Vaishnani Nirali Natvarlal	M.Sc. (IChemistry) - Semester-I
9.	Vaishnani Swati Kishorbhai	M.Sc. (IChemistry) - Semester-I
10.	Vala Urvashiba Pradyumansinh	M.Sc. (IChemistry) - Semester-I
11.	Varotariya Kamlesh Mandanbhai	M.Sc. (IChemistry) - Semester-I
12.	Akabari Pinal Kishorbhai	M.Sc. (IChemistry) - Semester-I
13.	Ashar Khyati Ashwiwnikumar	M.Sc. (IChemistry) - Semester-I
14.	Bhatt Karan Atulbhai	M.Sc. (IChemistry) - Semester-I
15.	Chauhan Jatin Chaturbhai	M.Sc. (IChemistry) - Semester-I
16.	Chovatiya Janak Praful Bhai	M.Sc. (IChemistry) - Semester-I
17.	Dobariya Kishan Jagdishbhai	M.Sc. (IChemistry) - Semester-I
18.	Dodiya Foram Rajendrabhai	M.Sc. (IChemistry) - Semester-I
19.	Faldu Keval Vithalbhai	M.Sc. (IChemistry) - Semester-I
20.	Gajipara Divyesh Rameshbhai	M.Sc. (IChemistry) - Semester-I
21.	Ghodasara Nilkumar Sanjaybhai	M.Sc. (IChemistry) - Semester-I
22.	Ghodasara Rajkumar Hareshbhai	M.Sc. (IChemistry) - Semester-I
23.	Harsoda Nikunj Rameshbhai	M.Sc. (IChemistry) - Semester-I
24.	Jethva Bhargav Jiteshbhai	M.Sc. (IChemistry) - Semester-I
25.	Joshi Payal Rajubhai	M.Sc. (IChemistry) - Semester-I
26.	Kapuriya Naimish Dhirajbhai	M.Sc. (IChemistry) - Semester-I
27.	Kasampara Yagnik Pravinbhai	M.Sc. (IChemistry) - Semester-I
28.	Katariya Sidhdharth Vinodbhai	M.Sc. (IChemistry) - Semester-I

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Smt. Navalben Virani Science College
(Autonomous) Rajkot.

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Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Awareness Drive (M.Sc. Chemical Science Students)

Date: 21/09/2019 , Time: 10.00 to 01.00, Venue: Room No. 124, 1st Floor

Sr No	Student's Name	Class / Semester
1.	Bapodara Rupalben Kumarbhai	M.Sc. (Chem:OC/AC) - Semester-I
2.	Baraiya Needhi Rajeshbhai	M.Sc. (Chem:OC/AC) - Semester-I
3.	Barochiya Jeel Bharatbhai	M.Sc. (Chem:OC/AC) - Semester-I
4.	Bathani Maitry Rajeshkumar	M.Sc. (Chem:OC/AC) - Semester-I
5.	Bavarava Tapan Rajeshbhai	M.Sc. (Chem:OC/AC) - Semester-I
6.	Bhalodiya Jay Kiritbhai	M.Sc. (Chem:OC/AC) - Semester-I
7.	Bhatt Rajeshvariben Shaileshbhai	M.Sc. (Chem:OC/AC) - Semester-I
8.	Bhuva Nirali Sunil	M.Sc. (Chem:OC/AC) - Semester-I
9.	Chauhan Siddharth Navinchandra	M.Sc. (Chem:OC/AC) - Semester-I
10.	Chetariya Nilesh Rajabhai	M.Sc. (Chem:OC/AC) - Semester-I
11.	Chopda Alfez Asharafbhai	M.Sc. (Chem:OC/AC) - Semester-I
12.	Davariya Nandini Jayeshbhai	M.Sc. (Chem:OC/AC) - Semester-I
13.	Dedania Drashti Arvindbhai	M.Sc. (Chem:OC/AC) - Semester-I
14.	Desai Vivek Rameshvarbhai	M.Sc. (Chem:OC/AC) - Semester-I
15.	Dhebariya Vidhiben Pravinbhai	M.Sc. (Chem:OC/AC) - Semester-I
16.	Dhrangu Jayesh Bhayabhai	M.Sc. (Chem:OC/AC) - Semester-I
17.	Gadara Happyben Rasikbhai	M.Sc. (Chem:OC/AC) - Semester-I
18.	Gangadia Mitva Rajeshkumar	M.Sc. (Chem:OC/AC) - Semester-I
19.	Ghodasara Nil Sanjaybhai	M.Sc. (Chem:OC/AC) - Semester-I
20.	Gohil Adityasinh Pruthvirajsinh	M.Sc. (Chem:OC/AC) - Semester-I
21.	Goti Kartik Rasikbhai	M.Sc. (Chem:OC/AC) - Semester-I
22.	Gupta Sonali Dineshbhai	M.Sc. (Chem:OC/AC) - Semester-I
23.	Hinsu Sweta Bharatbhai	M.Sc. (Chem:OC/AC) - Semester-I
24.	Joshi Minal Pradipbhai	M.Sc. (Chem:OC/AC) - Semester-I
25.	Kachhadiya Nisha Prakashbhai	M.Sc. (Chem:OC/AC) - Semester-I
26.	Kakkad Parita Dipakkumar	M.Sc. (Chem:OC/AC) - Semester-I
27.	Kalariya Meera Jayantibhai	M.Sc. (Chem:OC/AC) - Semester-I
28.	Kaliyaniya Pradeep Jentibhai	M.Sc. (Chem:OC/AC) - Semester-I
29.	Kanani Kishan Ashvinbhai	M.Sc. (Chem:OC/AC) - Semester-I
30.	Kanjiya Rinkal Jentilal	M.Sc. (Chem:OC/AC) - Semester-I
31.	Kantariya Avani Pankajbhai	M.Sc. (Chem:OC/AC) - Semester-I
32.	Kapuriya Bansi Ramnikbhai	M.Sc. (Chem:OC/AC) - Semester-I
33.	Kasundra Prathvi Gopalbhai	M.Sc. (Chem:OC/AC) - Semester-I
34.	Kateshiya Jitendra Keshavajibhai	M.Sc. (Chem:OC/AC) - Semester-I
35.	Khavadiya Krishna Chandubhai	M.Sc. (Chem:OC/AC) - Semester-I
36.	Kotadiya Hitarthi Kanubhai	M.Sc. (Chem:OC/AC) - Semester-I

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37.	Ladani Disha Aravindbhai	M.Sc. (Chem:OC/AC) - Semester-I
38.	Ladva Piyush Pravinbhai	M.Sc. (Chem:OC/AC) - Semester-I
39.	Lunagariya Akashkumar Gopalbhai	M.Sc. (Chem:OC/AC) - Semester-I
40.	Madam Savan Hardashbhai	M.Sc. (Chem:OC/AC) - Semester-I
41.	Makadiya Dhruvi Santibhai	M.Sc. (Chem:OC/AC) - Semester-I
42.	Mandaliya Tejas Rajeshbhai	M.Sc. (Chem:OC/AC) - Semester-I
43.	Meghanathi Janki Manojgeeree	M.Sc. (Chem:OC/AC) - Semester-I
44.	Mendapara Trusha Atulbhai	M.Sc. (Chem:OC/AC) - Semester-I
45.	Movaliya Bhautikkumar Dhanjibhai	M.Sc. (Chem:OC/AC) - Semester-I
46.	Nakum Chandni Khushalbhai	M.Sc. (Chem:OC/AC) - Semester-I
47.	Panara Meera Vinodbhai	M.Sc. (Chem:OC/AC) - Semester-I
48.	Parmar Ajaykumar Atulbhai	M.Sc. (Chem:OC/AC) - Semester-I
49.	Parmar Alpaben Narshibhai	M.Sc. (Chem:OC/AC) - Semester-I
50.	Parmar Nileshkumar Jethabhai	M.Sc. (Chem:OC/AC) - Semester-I
51.	Parsaniya Shiv Prafulbhai	M.Sc. (Chem:OC/AC) - Semester-I
52.	Patel Siddharth Anilbhai	M.Sc. (Chem:OC/AC) - Semester-I
53.	Patodia Prince Jayantibhai	M.Sc. (Chem:OC/AC) - Semester-I
54.	Pipaliya Jenil Kiritbhai	M.Sc. (Chem:OC/AC) - Semester-I
55.	Pipaliya Mohit Navinbhai	M.Sc. (Chem:OC/AC) - Semester-I
56.	Pitroda Hardik Ashvinbhai	M.Sc. (Chem:OC/AC) - Semester-I
57.	Radadiya Akash Nitinbhai	M.Sc. (Chem:OC/AC) - Semester-I
58.	Ranpariya Jay Rameshbhai	M.Sc. (Chem:OC/AC) - Semester-I
59.	Sadatiya Disha Jayntilal	M.Sc. (Chem:OC/AC) - Semester-I
60.	Sanathara Rahul Umedbhai	M.Sc. (Chem:OC/AC) - Semester-I
61.	Sarsavadiya Dhruvi Hareshbhai	M.Sc. (Chem:OC/AC) - Semester-I
62.	Savaliya Divyeshkumar Jaysukhbhai	M.Sc. (Chem:OC/AC) - Semester-I

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Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Awareness Drive for UG (Chemical Science Students)

Date: 14/10/2019 , Time: 10.00 to 01.00, Venue: Room No. 124, 1st Floor

Sr No	Enr. No.	Student's Name	Student's Email	Student's Mobile
1	180702001	AGOLA ABHIKUMAR SURESHBHAI	Patelabhi4838@gamil.com	7265090881
2	180702002	BADI MOHAMADAKIL MANJURHUSHEN	akilbadi56@gmail.com	9624493451
3	180702003	BAKORI UTTAM RAMESHBHAI	uttampatel0406@gmail.com	7041511600
5	180702005	BALDHA DHRUVINKUMAR GOVINDBHAI	dhruvinbaldha@gmail.com	7621837334
6	180702006	BALDHA DIXITKUMAR RATILAL	dixitbaldha001@gmail.com	7698440669
7	180702007	BAVARVA ZENISH SURESHBHAI		7567599933
9	180702009	BHALODIA RUSHIKUMAR PRAKASHBHAI	bhalodiarushi30@gmail.com	7201830900
10	180702010	BHETARIYA DEVASHISH JAGMALBHAI	bhetariyadevashish360@gmail.com	6354374413
11	180702011	BHIMANI HARSH ASHOKBHAI	Harshbhimani1111@gmail.com	9824050342
12	180702012	BHUT SHREYAS BHUPATBHAI	shreyp001@gmail.com	9558646474
13	180702013	BHUVA AKSHAY VINODBHAI	akshaybhuva2208@gmail.com	8140272547
14	180702014	CHANGELA PRANAV DILIPBHAI	pranavdchangela@gmail.com	9409405152
15	180702015	CHAUHAN CHINTAN BABUBHAI	chauhanchintan54@gmail.com	9662274562
16	180702016	CHAUHAN UDAYBHAI KANAKBHAI	ukchauhan8618@gmail.com	9033550184
17	180702017	CHETARIYA ABHISHEK KESHURBHAI	chetariyaabhishek2336@gmail.com	9924664814
18	180702018	CHHOTALA GAUTAM RAMESHBHAI	gautamchhotala18@gmail.com	8160953112
22	180702022	DETROJA VIMAL VALLABHBHAI	vimaldetroja098@gmail.com	9265199925
24	180702024	DHOLARIYA MAULIK MANUBHAI	maulikdholariya3144@gmail.com	9824481150
25	180702025	DOBARIYA SMARK JENTIBHAI		6353885667
26	180702026	FALDU NIMESH DINESHBHAI	faldunimeshkumar@gmail.com	9408509416
27	180702027	GADARA MAULIKKUMAR DAYALAL	maulikg13@gmail.com	6353219932
28	180702028	GAJERA CHETAN BHAVESHBHAI	chetangajera72@gmail.com	9724412992
29	180702029	GAJERA ASHRAY RAMESHBHAI	ashraypatel9@gmail.com	7698007498
30	180702030	GAJERA MEET DHIRJABHAI	meetgajera5382@gmail.com	8200902835
31	180702031	GAJERA PARTH VITHALBHAI	Gajeraparth789@gmail.com	9913413929
33	180702033	HINGU HIREN BHAVESHBHAI	hirenhingu7181@gmail.com	6356230535
34	180702034	JADEJA JAYRAJSINH INDRAVIJAYSINH		8980519443
36	180702036	JADEJA LUCKYRAJSINH GHANSHYAMSINH	lgjadeja007@gmail.com	6353514686
37	180702037	JADEJA SURYADIPSINH VIKRAMSINH	jadejasuryadipsinh2001@gmail.c	9687470921

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38	180702038	JAKHOTRA JAYDIP JAGMALBHAI	Jakhotrajaydip723@gmail.com	6354088344
39	180702039	JESADIA KEVAL LALITBHAI	kevaljesadia002@gmail.com	9408218121
40	180702040	KADAVLA AJEETKUMAR HARESHBHAI	ajeetkadavla199@gmail.com	6353958901
42	180702042	KAKADIYA JAIVIN KESHUBHAI	jaivinpatel1314@gmail.com	9033238339
43	180702043	KAKADIYA MAULIK HARESHBHAI	maulikkakdiya0@gmail.com	7226950670
44	180702044	KALATHIYA PARTH RAJESHBHAI	parhkalathiya1037@gmail.com	8128338590
45	180702045	BHAUTIK KUMAR KALAVADIYA	bhautikkalavadiya545@gmail.com	8511659568
46	180702046	KAPADIYA YASH GOPALBHAI	kapadiyayash417@gmail.com	8401567171
47	180702047	KARENA RAVI RAMESHBHAI	karenaravi117@gmail.com	8849349311
48	180702048	KHUNT KRUSHIT BHARATBHAI	krushitkhunt9090@gmail.com	6353849315
49	180702049	KHUNT MEET MAHESHBHAI	meetkhunt2011@gmail.com	9825171902
50	180702050	KORAT KEVAL BHUPATBHAI	keval1019patel@gmail.com	6355340711
51	180702051	KOTADIYA NAYAN JAMANBHAI	nayankotadiya0361@gmail.com	6353477053
52	180702052	MAGUNIYA HARSH PRAVINBHAI	maguniyaharsh@gmail.com	6354366922
53	180702053	MAKHELA ARJUN DILIPBHAI	arjunmakhela2807@gmail.com	9998933660
54	180702054	MANDORA VIKEN HASMUKHBHAI		9687443223
55	180702055	MARKANA DENISH SURESHBHAI	denishmarakana18@gmail.com	7096365738
56	180702056	MARAKANA KHODU DHIRAJBHAI	marakanakhodu@gmail.com	9601626460
57	180702057	MARDIYA KULDIP DINESHBHAI	kuldipmardiya101@gmail.com	6354377101
58	180702058	MARU VAIBHAV MUKESHBHAI	maruvaibhav7494@gmail.com	9104617945
59	180702059	MATIYA GAUTAMBHAI KARANBHAI	matiya909@gmail.com	7778809977
61	180702061	MENDAPARA BHAUTIKKUMAR HARSHADBHAI	bhautikmendapara14@gmail.com	6354059302
62	180702062	MITHAPARA ARPIT MANSHUKHBHAI	arpitpatel7047@gmail.com	7046472221
63	180702063	MODHVADIYA NIRAV VANRAJ	niravmodhvadiya45@gmail.com	9998338688
64	180702064	NAKIYA PANKAJ KARSHANBHAI	pankajnakiya8051@gmail.com	9824282386
65	180702065	NAKUM HARSHKUMAR DHIRUBHAI	harshnakum604@gmail.com	7359557604
66	180702066	PADALIYA ABHI KANTILAL		9998915761
67	180702067	PADARIYA KELVIN RAMESHBHAI	kelvinpadariya2438@gmail.com	9016936064
69	180702069	PADARIYA PRASHANT KANTIBHAI	prashant.padariya123@gmail.com	9727626389
71	180702071	PANELIYA DARSHIL VIPULBHAI	dvpatel7599@gmail.com	6354097092
72	180702072	PARAKHIYA JAY LALITBHAI	Parakhiyajay1604@gmail.com	7096807929
73	180702073	PAREJIYA ANKITKUMAR SANJAYBHAI	ankitpatela64989019@gmail.com	9054694303
74	180702074	PAREJIYA BECHARKUMAR RAMESHBHAI	bechar5354@gmail.com	9081525354
75	180702075	PARMAR BHAVESH HARESHBHAI	Bhaveshparmar8571@gmail.com	9428318571
76	180702076	PARMAR YUVRAJSINH ARVINDSINH	yuviparmar1410@gmail.com	8469828625
77	180702077	PATEL BRIJESH GHANSHYAMBHAI	b2patel118@gmail.com	9601056589
78	180702078	PATEL HARSH SANJAYBHAI	harsh01409@gmail.com	7041117383
79	180702079	PATEL JAYESHKUMAR JAGDISHBHAI	jayrasdiya0110@gmail.com	9723940744
80	180702080	PATEL KEYUR NITINKUMAR	patelkeyur9925@gmail.com	9484995100
81	180702081	PITHADIYA SAVANKUMAR ATULBHAI	pithadiyasavan30@gmail.com	9574490192
82	180702082	RADADIYA JAYDEEP RASIKBHAI	radadiyajaydeep72@gmail.com	7283984572
83	180702083	RADADIYA JEMI RAJESHKUMAR	jemeeradadiya1112@gmail.com	9727627854
84	180702084	RADADIYA URVESH CHANDUBHAI	urveshradadiya007@gmail.com	7878761952
85	180702085	RAMANI BRIJESH MAHESHBHAI	rbm11092001@gmail.com	7202068554

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86	180702086	RAMANI HARESH ASHOKBHAI	harupatel178@gmail.com	6353299254
87	180702087	RAMANI RONAK HARSHUKHBHAI	Ramanironak38@gmail.com	8154888714
89	180702089	RASADIYA DEEPKUMAR SHANKARBHAI	deeprasadiya333@gmail.com	7435058758
90	180702090	RATHOD BHAVDEEP PRAHLADBHAI	bhavdeeprathod1999@gmail.com	9664796138
91	180702091	SABHANI RITESH KISHORBHAI	riteshpatel9181@gmail.com	9913628869
92	180702092	SAKARIYA NIRAV VALLABHBHAI	niravsakaria888@gmail.com	9925160916
93	180702093	SANARIYA SHYAM HITESHBHAI	shyamsanariya17@gmail.com	6351856192
94	180702094	SANGANI AVANIT AMRUTBHAI	avanitsangani123@gmail.com	9712631740
95	180702095	SANGANI CHIRAG GIRDHARBHAI	csangani02@gmai.com	9408392189
96	180702096	SAVANI DARSHANKUMAR ARVINDBHAI	darshansavani78@gmail.com	7201978556
97	180702097	SAVSANI AJAYKUMAR MANISHBHAI		7359540902
98	180702098	SORATHIYA PRASHANT GHANSHYAMBHAI	prashantpatel99259@gmail.com	9723044770
99	180702099	SUTARIYA MIHIRKUMAR BHARATBHAI	mihirsutariya12@gmail.com	8128385183
100	180702100	SUVAGIYA SMITKUMAR HITENDRABHAI	smitsuvagiya26@gmail.com	7434032844
101	180702101	TADA VANSHILKUMAR RAJESHBHAI	tadavanshilkumar9212@gmail.com	6354434059
102	180702102	TANK VIVEK MAHENDRABHAI	vivektank7@gmail.com	9016570369
103	180702104	TARAPARA KEVALBHAI NARBHERAMBHAI	keval3622@gmail.com	8182818079
104	180702106	THUMMAR HEMANG MANSUKHBHAI	hemangthummar33@gmail.com	8141832500
105	180702107	THUMMAR PARIMALKUMAR HARASUKHBHAI	Parimalthummar40@gmail.com	8980441537
106	180702108	VADHER BHARGAV PRAFULBHAI	bhargavvadher8002@gmail.com	6353222193
107	180702111	VASOYA PRASHANT RAMNIKBHAI	prashantrv20@gmail.com	9998852670
108	180702113	VEKARIYA AKASH HITESH BHAI	akashvekariya555@gmail.com	8320248585
109	180702114	VIRADIYA ALPIT ASHOKBHAI	alpitviradiya3637@gmail.com	8347304112
110	180702117	VORA JENISH THAKARSHIBHAI	jenishvora21600@gmail.com	9696960448
111	180702118	VORA RAHUL DILIPBHAI	rahulvora2016@gmail.com	9426229183
112	180702119	ZAPDIYA RAHUL KISHORBHAI	rahulzapdiya191@gmail.com	9510668458

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Sar. Navalbhai Vora Science Colle
(Autonomous) Jetpur.

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Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Sensitization Drive for UG Students

Date: 14/10/2019 Time: 08.30 to 10.30

Venue: Room No. 124 (AV Room) RP: Dr. Pratik Ambasana

Sr. No.	Course / Class	Student_ID	Name	Gender
1.	B.Sc. Math. - Sem-I	1448519001	Aervadiya Pragati Rajeshbhai	Female
2.	B.Sc. Math. - Sem-I	1448519002	Bhanderi Mayur Jitendrabhai	Male
3.	B.Sc. Math. - Sem-I	1448519003	Mehta Suhasi Bhaveshbhai	Female
4.	B.Sc. Math. - Sem-I	1448519004	Gondaliya Drashti Sanjaybhai	Female
5.	B.Sc. Math. - Sem-I	1448519005	Katariya Sahil Subhashbhai	Male
6.	B.Sc. Math. - Sem-I	1448519006	Kamani Mohitkumar Ghanshyambhai	Male
7.	B.Sc. Math. - Sem-I	1448519007	Bhadja Krinal Manojbhai	Female
8.	B.Sc. Math. - Sem-I	1448519008	Bhadja Darshana Prakashbhai	Female
9.	B.Sc. Math. - Sem-I	1448519009	Bhoraniya Rutviben Jayeshbhai	Female
10.	B.Sc. Math. - Sem-I	1448519010	Bhensdadiya Vivek Sureshbhai	Male
11.	B.Sc. Math. - Sem-I	1448519011	Chauhan Niyati Ashokbhai	Female
12.	B.Sc. Math. - Sem-I	1448519012	Kalariya Aneri Yogeshbhai	Female
13.	B.Sc. Math. - Sem-I	1448519013	Kasundra Julee Kantilal	Female
14.	B.Sc. Math. - Sem-I	1448519014	Trivedi Rushita Pravinbhai	Female
15.	B.Sc. Math. - Sem-I	1448519015	Jadeja Yuvrajsinh Hitendrasinh	Male
16.	B.Sc. Math. - Sem-I	1448519016	Padsumbiya Vaibhavkumar Sureshbhai	Male
17.	B.Sc. Math. - Sem-I	1448519018	Vadodariya Vrutika Prakashbhai	Female
18.	B.Sc. Math. - Sem-I	1448519019	Kasundra Rajaniben Jagdishbhai	Female
19.	B.Sc. Math. - Sem-I	1448519020	Dhakan Khushi Dharmendrabhai	Female
20.	B.Sc. Math. - Sem-I	1448519021	Jadeja Bhargaviba Bhikhubha	Female
21.	B.Sc. Math. - Sem-I	1448519022	Kathrotiya Sakshi Ghanshyambhai	Female
22.	B.Sc. Math. - Sem-I	1448519023	Limbasiya Nikitaben Jiteshkumar	Female
23.	B.Sc. Math. - Sem-I	1448519024	Parmar Sagar Ratilal	Male
24.	B.Sc. Math. - Sem-I	1448519025	Rathod Paresh Jagubhai	Male
25.	B.Sc. Math. - Sem-I	1448519026	Dhamsaniya Yash Pravinbhai	Male

Shri Manibhai Virani and Smt. Navalben Virani Science College (Autonomous) Rajkot.

26.	B.Sc. Math. - Sem-I	1448519027	Chauhan Mitali Dineshbhai	Female
27.	B.Sc. Math. - Sem-I	1448519028	Parmar Nancy Vasantbhai	Female
28.	B.Sc. Math. - Sem-I	1448519029	Kugasiya Sanjeev Manvirbhai	Male
29.	B.Sc. Math. - Sem-I	1448519030	Dhandhukiya Hemali Bhikhubhai	Female
30.	B.Sc. Math. - Sem-I	1448519031	Chavada Hemali Rajeshbhai	Female
31.	B.Sc. Math. - Sem-I	1448519032	Boda Snehaben Kiritbhai	Female
32.	B.Sc. Math. - Sem-I	1448519033	Chauhan Rutvi Maheshbhai	Female
33.	B.Sc. Math. - Sem-I	1448519034	Savseta Uday Jivanbhai	Male
34.	B.Sc. Math. - Sem-I	1448519035	Mungara Ekta Kanjibhai	Female
35.	B.Sc. Math. - Sem-I	1448519036	Kalena Palak Rajeshbhai	Female
36.	B.Sc. Math. - Sem-I	1448519037	Khokhar Vipasha Pankajbhai	Female
37.	B.Sc. Math. - Sem-I	1448519038	Pungera Bansi Rameshbhai	Female
38.	B.Sc. Math. - Sem-I	1448519039	Sapariya Riddhi Kantibhai	Female
39.	B.Sc. Math. - Sem-I	1448519041	Divecha Vandan Bhaveshbhai	Male
40.	B.Sc. Math. - Sem-I	1448519042	Basiya Sahil Jitendra	Male
41.	B.Sc. Math. - Sem-I	1448519043	Vala Pooja Gautamsinh	Female
42.	B.Sc. Math. - Sem-I	1448519044	Detroja Khyati Jaysukhbhai	Female
43.	B.Sc. Math. - Sem-I	1448519045	Aghera Darshan Hasmukhbhai	Male
44.	B.Sc. Math. - Sem-I	1448519046	Bhimani Mayur Prabhulal	Male
45.	B.Sc. Math. - Sem-I	1448519048	Lakhani Purva Dilipbhai	Female
46.	B.Sc. Math. - Sem-I	1448519049	Vachhani Yashvi Ashokbhai	Female
47.	B.Sc. Math. - Sem-I	1448519050	Viramgama Jayesh Kantilal	Male
48.	B.Sc. Math. - Sem-I	1448519051	Maravaniya Satyam Ashokbhai	Male
49.	B.Sc. Math. - Sem-I	1448519052	Garaiya Akshay Ghanshyambhai	Male
50.	B.Sc. Math. - Sem-I	1448519053	Fatepara Jaykumar Ghanshyambhai	Male
51.	B.Sc. Math. - Sem-I	1448519054	Bhatt Shreya Upendrabhai	Female
52.	B.Sc. Math. - Sem-I	1448519056	Ashara Krupali Vijaybhai	Female
53.	B.Sc. Math. - Sem-I	1448519057	Padiya Ajay Nalinbhai	Male
54.	B.Sc. Math. - Sem-I	1448519058	Kukadiya Hardik Dhanjibhai	Male
55.	B.Sc. Math. - Sem-I	1448519059	Jakasaniya Hiteshkumar Rajeshbhai	Male
56.	B.Sc. Math. - Sem-I	1448519060	Kothiya Satyam Jagdishbhai	Male
57.	B.Sc. Math. - Sem-I	1448519061	Joshi Nilay Jayesh	Male
58.	B.Sc. Math. - Sem-I	1448519062	Parmar Viraj Anilbhai	Male
59.	B.Sc. Biochem-Sem-I	1448619001	Arvadiya Arti Kantilal	Female
60.	B.Sc. Biochem-Sem-I	1448619003	Kotak Adit Jigneshbhai	Male
61.	B.Sc. Biochem-Sem-I	1448619004	Piparava Bansiben Ramjibhai	Female
62.	B.Sc. Biochem-Sem-I	1448619005	Vaghasiya Yashviben Jamanbhai	Female
63.	B.Sc. Biochem-Sem-I	1448619006	Mathukiya Ektaben Bharatbhai	Female
64.	B.Sc. Biochem-Sem-I	1448619008	Kavar Mitalben Mansukhbhai	Female

Shri Manibhai Virani & Smt. Navalben Virani Science College (Autonomous), Rajkot

SSIP Sensitization Drive for UG Students

Date: 15/10/2019 Time: 08.30 to 10.30

Venue: Room No. 124 (AV Room) RP: Dr. Pratik Ambasana

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1.	B.Sc. Biochem-Sem-I	1448619011	Pipaliya Shreenaben Nileshbhai	Female
2.	B.Sc. Biochem-Sem-I	1448619012	Aghara Dhruvi Maheshbhai	Female
3.	B.Sc. Biochem-Sem-I	1448619013	Bodar Dhara Rameshbhai	Female
4.	B.Sc. Biochem-Sem-I	1448619014	Kacchi Mariya Turab	Female
5.	B.Sc. Biochem-Sem-I	1448619016	Donga Kishan Rameshbhai	Male
6.	B.Sc. Biochem-Sem-I	1448619017	Vadher Hemali Shileshkumar	Female
7.	B.Sc. Biochem-Sem-I	1448619018	Dadhaniya Ayushi Vasantbhai	Female
8.	B.Sc. Biochem-Sem-I	1448619019	Makvana Daksha Ishavarbhai	Female
9.	B.Sc. Biochem-Sem-I	1448619021	Gambhava Santoshben Dineshbhai	Female
10.	B.Sc. Biochem-Sem-I	1448619022	Pambhar Drashti Rasikbhai	Female
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12.	B.Sc. Biochem-Sem-I	1448619024	Bhalodiya Khushaliben Bhagavanjibhai	Female
13.	B.Sc. Biochem-Sem-I	1448619025	Bhimani Drashti Harsukhbhai	Female
14.	B.Sc. Biochem-Sem-I	1448619026	Hinsu Madhavi Jaysukhbhai	Female
15.	B.Sc. Biochem-Sem-I	1448619027	Tank Dimpal Jagadishbhai	Female
16.	B.Sc. Biochem-Sem-I	1448619029	Ajani Dhruv Rasikbhai	Male
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18.	B.Sc. Biochem-Sem-I	1448619031	Sidpara Avsar Nilashbhai	Male
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25.	B.Sc. Biochem-Sem-I	1448619038	Rank Khushali Ben Hasmukhbhai	Female
26.	B.Sc. Biochem-Sem-I	1448619039	Manani Bhumi Hiteshbhai	Female

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28.	B.Sc. Biochem-Sem-I	1448619042	Timbadiya Miral Upendrabhai	Female
29.	B.Sc. Biochem-Sem-I	1448619043	Ganatra Nirali Sanjaybhai	Female
30.	B.Sc. Biochem-Sem-I	1448619044	Babariya Bhumi Hirabhai	Female
31.	B.Sc. Biochem-Sem-I	1448619045	Dadhaniya Hemali Kishorbhai	Female
32.	B.Sc. Biochem-Sem-I	1448619046	Chatwani Shubham Chetanbhai	Male
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55.	B.Sc. Micro - Sem-I	1448419002	Zalavadiya Bhumi Hasmukhbhai	Female
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76.	B.Sc. Micro - Sem-I	1448419028	Dobariya Krupali Arvindbhai	Female
77.	B.Sc. Micro - Sem-I	1448419029	Baldha Nirali Kamleshbhai	Female
78.	B.Sc. Micro - Sem-I	1448419030	Bhalodiya Bhumi Sureshbhai	Female
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88.	B.Sc. Micro - Sem-I	1448419041	Lakhani Krushali Kumarbhai	Female
89.	B.Sc. Micro - Sem-I	1448419042	Parmar Aditi Vinodray	Female
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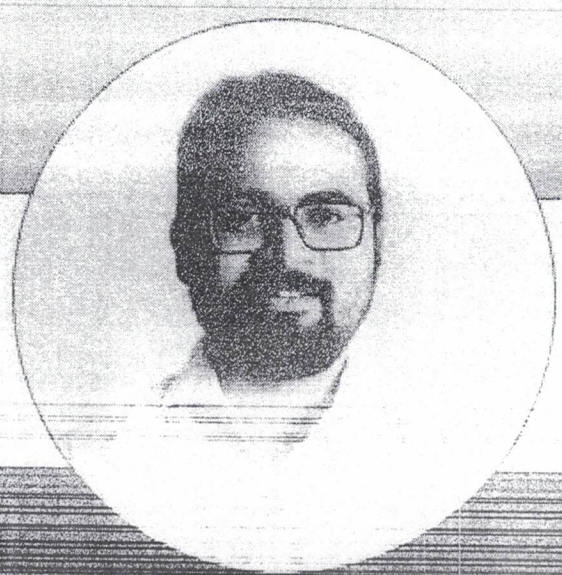

Dr. Hitesh Chauhan
Managing Director, Vivan Health Care
Former Research Scientist, Himalaya Drug Research
(A young Entrepreneur)

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229	AMIPARA DHAVAL	Shri M. & N. Virani Science College, Rajkot	7777952336	dhaval15398@gmail.com	Male
230	THUMMAR GAURANGKUMAR ARVINDBHAI	Shri M. & N. Virani Science College, Rajkot	8401728143	gaurangthummar1@gmail.com	Male
231	Kishan Panara	Atmiya University, Rajkot	7043989383	panarakishan98@gmail.com	Male
232	Gadara yashkumar mansukhbhai	Atmiya University, Rajkot	9664618140	yash.gadara20@gmail.com	Male
233	Parth bhalodi vipulbhai	Atmiya University, Rajkot	9106789828	parthbhalodi100@gmail.com	Male
234	Bhut Jaykumar Bharatbhai	Shri M. & N. Virani Science College, Rajkot	9904398328	jaybhut6@gmail.com	Male

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Shree M. & N. Virani Science College (Autonomous), Rajkot

SSIP Awareness Programme

Class: M.Sc. Chemistry Sem-1

Date : 09/10/2021

Sr no	Name of Student / Participant	Signature
1	ADROJA DIVYESH DINESHBHAI	
2	AGHERA MANANKUMAR VIJAYBHAI	
3	BAMANIYA AJAY DEVABHAI	
4	BARAD ANJANABEN ARAJANBHAI	
5	BARAD KANAKSINH BHUPATBHAI	
6	BHADANIA RAVI MAHENDRABHAI	
7	BHANDERI HARSHKUMAR DILIPBHAI	
8	BHIMANI AARTIBEN HARSUKHBHAI	
9	BHIMANI YASH JAGDISHBHAI	
10	BHUT VASU SANDIPBHAI	
11	BORAD ROHIT GANDUBHAI	
12	BUMTALIA USHMA N.	
13	BUSA SARTHAK BHIMJIBHAI	
14	CHHAIYA KISHANBHAI BHIKHUBHAI	
15	CHHATRALA PRITKUMAR RAMESHBHAI	
16	CHORERA MEET VINESHBHAI	
17	DANGAR DHAVALKUMAR DEVANANDBHAI	
18	DELVADIYA VIRENKUMAR SURESHBHAI	
19	DEVARIYA SHYAM RASIKBHAI	
20	DHAMELIYA BHUMIT YOGESHKUMAR	
21	DHOKIA DHRUV JAYESHKUMAR	
22	DONGA MITKUMAR GOPALBHAI	
23	DUDHATRA GRECY GOVINDBHAI	
24	DUDHATRA KEVAL BHARATBHAI	
25	FACHARA DHRUV HITESHBHAI	
26	FALDU RONAK RAJESHBHAI	
27	FEFAR RADHIKA CHIMANBHAI	
28	GADARA AYUSH RAMESHBHAI	
29	GADARA ROMISH VIRJIBHAI	
30	GADHAVI NIYATI KISHANDAN	

Coordinator

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Shri Manibhai Virani and
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Shree M. & N. Virani Science College (Autonomous), Rajkot

SSIP Awareness Programme

Class: M.Sc. Chemistry Sem-1 Date: 09/10/21

Sr no	Name of Student / Participant	Signature
31	GAJERA NIMISH PARSOTAMBHAI	
32	GAJERA SAVANKUMAR RAJESHBHAI	
33	GHETIYA BHAGYESH DEVJIBHAI	
34	GONDALIYA RONAK BHAVESHBHAI	
35	GOSAI RIDDHIBEN JAYESHBHAI	
36	HINSU JALPABEN MAHESHBHAI	
37	HIRANI PRATIKKUMAR NITESHBHIA	
38	HIRPARA SANKETKUMAR BHARATBHAI	
39	JIVANI PARAS RASIKLAL	
40	JIVANI SACHIN ARVINDBHAI	
41	JOSHI BHARGAV PARESHKUMAR	
42	JOSHI HEMANGI NEERAJBHAI	
43	KACHA AKASH RAMESHBHAI	
44	KALAVADIYA ARMY ASHOKBHAI	
45	KALAVADIYA HEPIKUMAR NARSHIBHAI	
46	KAMANI VIVEK BHARATBHAI	
47	KANSAGRA MANSI ARVINDBHAI	
48	KATHIRIYA SMIT RASIKBHAI	
49	KHACHAR VISHWAJEETBHAI UMEDBHAI	
50	KHANDHAR JAY DILIPBHAI	
51	KHANT PARTHKUMAR KARSHANBHAI	
52	KHANT SUMAN ANILBHAI	
53	KHER SANJAYBHAI DEVABHAI	
54	KODINARIYA BRIJESH SANJAYBHAI	
55	KOTHIYA JENISH NILESHBHAI	
56	KUMARKHANIYA HEMAXI J.	
57	LILA KISHAN VIJAYBHAI	
58	MAKAVANA CHANDRIKABEN MOTIBHAI	
59	MARADIYA FENABEN DILIPBHAI	
60	MARAKANA SURAJ MANSUKHBHAI	

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Shree M. & N. Virani Science College (Autonomous), Rajkot

SSIP Awareness Programme

Class: M.Sc. Chemistry Sem-1 Date: 09/10/21

Sr no	Name of Student / Participant	Signature
61	MARAVANIYA JENIL VINODBHAI	
62	MEHTA NANDANI KALPESHKUMAR	
63	MOLIYA PARTH AMITKUMAR	
64	MORI PRIYAL SANJAYBHAI	
65	MORI SUHASI ANIRUDDHSINH	
66	MOVALIYA ROHAN JITESHBHAI	
67	PAGHDAL VEDANSHI CHETANBHAI	
68	PANELIYA JAIMIN JAYSUKHBHAI	
69	PARMAR URVISHABEN RAMSINHBHAI	
70	PATANVARIYA HARSHAL VINODBHAI	
71	PATEL DIPTI BHIKHABHAI	
72	PATHAK YASHKUMAR ASHWINBHAI	
73	PETHANI RUTIKKUMAR MUKESHBHAI	
74	PETHANI YASHKUMAR ASHVINBHAI	
75	PITHIYA KARSHANKUMAR NARANBHAI	
76	PRAJAPATI LALIT OMPRAKASH	
77	RACHHADIYA KEVAL CHANDUBHAI	
78	RAIYANI NIRALI RAMNIKBHAI	
79	RAMANI BHAVIN CHANDUBHAI	
80	RANGANI DARSHIK JAGDISHBHAI	
81	RANGANI HARDIKKUMAR KANJIBHAI	
82	RANGANI HARSHIT RASIKBHAI	
83	RATHOD VAISHALIBEN KESHUBHAI	
84	SANGANI MANALIBEN KAMLESHBHAI	
85	SANKHAVARA YASH	
86	SARADVA JAYKUMAR MAHENDRABHAI	
87	SAVANT KHUSHI	
88	SETA SUHASI MANISHBHAI	
89	SODHA NEVIL MANSUKHBHAI	
90	SOLANKI NITIN KARSHANBHAI	

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Shree M. & N. Virani Science College (Autonomous), Rajkot

SSIP Awareness Programme

Class: M.Sc. Chemistry Sem-1 Date: 09/10/21

Sr no	Name of Student / Participant	Signature
91	SOLANKI SAMIR ANVARBHAI	Samir
92	TERAIYA KRUNAL PANKAJBHAI	
93	THAKRAR PUNIT BHARAT	Punit B.T
94	THAKRAR RAJ DILIP BHAI	
95	THUMAR PRIYANK ASHOKBHAI	
96	VADHER MANOJKUMAR DINESHBHAI	vadher M.D.
97	VADHER SUNIL KHIMJIBHAI	
98	VAGHELA KAUSHAL ASHWINBHAI	
99	VAGHELA SIDDHARTH MAHESHBHAI	
100	VALA JAYRAJ BAHADURSINH	J.B.Vala
101	VANIYA KINJAL PARBATBHAI	
102	VAROTARIYA SAGARBHAI JODHABHAI	S.J.Varotariya
103	VIRAMGAMA PINALIBEN VINODBHAI	Pinal
104	WADHER PUNIT BHARATBHAI	V.Punit
105	ZANKAT PRAGNABEN VARSINGBHAI	
106	Juviyu Ronak Hareshbhai	Ronak
107	Depani Banti J.	Banti
108	Paghdar Sanket R.	Sanket.
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Dr. Pratik Ambasana Ambasana 09/10/21

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Shri M. & N. Virani Science College (Autonomous)		
SSIP Awareness Programme - List of Participants		
Date: 08/10/2021		
Sr No	Student Name	Class
1	Adroja Yash Kantilal	F.Y. B.Sc.
2	Bhimani Araju Pravinbhai	F.Y. B.Sc.
3	Bhimani Raj Jasmatbhai	F.Y. B.Sc.
4	Bhoraniya Avadhkumar Prakashbhai	F.Y. B.Sc.
5	Chauhan Shubham Kirtikumar	F.Y. B.Sc.
6	Dobariya Raj Jayantibhai	F.Y. B.Sc.
7	Gadara Keyur Shantibhai	F.Y. B.Sc.
8	Gadhiya Kyana Manishbhai	F.Y. B.Sc.
9	Gambhava Yash Sureshbhai	F.Y. B.Sc.
10	Gohel Nidhi Jitenbhai	F.Y. B.Sc.
11	Gopani Shyam Kantilal	F.Y. B.Sc.
12	Goswami Krishgiri Mukeshgiri	F.Y. B.Sc.
13	Halvadiya Karan Brijeshbhai	F.Y. B.Sc.
14	Harsoda Aevanshi Dineshbhai	F.Y. B.Sc.
15	Jadeja Arjunraj Anuruddhasinh	F.Y. B.Sc.
16	Jakhotra Jigar Hardasbhai	F.Y. B.Sc.
17	Jani Ishakumari Bhaveshbhai	F.Y. B.Sc.
18	Kacha Sujal Anilbhai	F.Y. B.Sc.
19	Kapuriya Yash Chandresh	F.Y. B.Sc.
20	Karkar Jalak Ashokbhai	F.Y. B.Sc.
21	Kasundra Prince Ramesh Bhai	F.Y. B.Sc.
22	Khant Prince Rasikbhai	F.Y. B.Sc.
23	Makwana Gordhan Prabhatbhai	F.Y. B.Sc.
24	Marakana Yashkumar Bhupatbhai	F.Y. B.Sc.
25	Markana Yash Vipulbhai	F.Y. B.Sc.
26	Monpara Havan Lalitbhai	F.Y. B.Sc.
27	Morasada Nikunj Rajeshbhai	F.Y. B.Sc.
28	Odedara Rahul Karsanbhai	F.Y. B.Sc.
29	Pan Yash Arvindbhai	F.Y. B.Sc.
30	Pansuriya Vrushti Hareshbhai	F.Y. B.Sc.
31	Parmar Dilip Parbat	F.Y. B.Sc.
32	Parsana Akshay Jagdishbhai	F.Y. B.Sc.
33	Parsana Parth Dineshbhai	F.Y. B.Sc.
34	Patel Rashminkumar Dalsukhbhai	F.Y. B.Sc.
35	Popat Tej Kumarbhai	F.Y. B.Sc.

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SSIP Awareness Programme - List of Participants		
Date: 08/10/2021		
Sr No	**Student Name**	**Class**
36	Rachhadiya Dhruvkumar Trilokbhai	F.Y. B.Sc.
37	Rajpurohit Surendrasinh Durgasinh	F.Y. B.Sc.
38	Ramani Daksh Arvindbhai	F.Y. B.Sc.
39	Rathod Arman Arifbhai	F.Y. B.Sc.
40	Rathod Bhagirathsinh Dolatsinh	F.Y. B.Sc.
41	Rathod Mohit J	F.Y. B.Sc.
42	Rupareliya Umang Dineshbhai	F.Y. B.Sc.
43	Sadavrati Ditsa Hiteshkumar	F.Y. B.Sc.
44	Sangadiya Arshil Vinodbhai	F.Y. B.Sc.
45	Sangadiya Tushal Hasmukhbhai	F.Y. B.Sc.
46	Shekhada Het Girdharbhai	F.Y. B.Sc.
47	Sindhav Jay Rajubhai	F.Y. B.Sc.
48	Sirja Keval Rajnishbhai	F.Y. B.Sc.
49	Thakar Dhruv Vijaybhai	F.Y. B.Sc.
50	Thummar Bhaunit Rajeshbhai	F.Y. B.Sc.
51	Tilara Nency Rajnikant	F.Y. B.Sc.
52	Timbadiya Divy Mansukhbhai	F.Y. B.Sc.
53	Umretiya Akshit Jagdishbhai	F.Y. B.Sc.
54	Vaghela Alpa Karshanbhai	F.Y. B.Sc.
55	Vaishnani Jasmin Hemendrabhai	F.Y. B.Sc.
56	Vala Tejas Sureshbhai	F.Y. B.Sc.
57		
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60		
Resource Person & Coordinator: Dr. Pratik Ambasana		Pambasana 08/Oct/2021

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Shree M. & N. Virani Science College (Autonomous), Rajkot		
SSIP Awareness Programmes		
Class: B.Sc. Biochemistry Semester- I		
Sr. No.	**Name of Student/Participant**	**Signature**
1	Dhruvi Chauhan	Dhruvi
2	Mandal Rashmipriya	Rashmi
3	Pachani Masti	Masti
4	Detroja Hitiksha	Detroja
5	Shah Twinkle	Twinkle
6	Bhatt Nidhi	Nidhi
7	Hadiyal Niddhi	Niddhi
8	Mehta yatri	Yatri
9	Bagda Ankita	Ankita
10	Vaghela mital	mital
11	Vaja Jansi	Jansi
12	Verma Ankita	Ankita
13	Javiya Rima P.	Rima
14	Mahuri mansi D.	Mansi
15	Sariya Payal J.	P.J. Sariya
16	Sariya Ankita M.	A.M. Sariya
17	Sariya Ankita J.	A.J. Sariya
18	Hingurajiya Zarna	Zarna
19	Ghodricha Mitali	
20	Chapaia Sakshi	Sakshi
21	Hinsu Anandi	
22	Kavar Disha	Vaishal
23	Vagapara Anny	Anny
24	Vayeda Kruti	Kruti
25	Pandya Shruti	Shruti
26	Kasundra priya	priya
27	Bodu Bansi	Bansi
28	Kavar Rajeshri	
29	Bapodra Ayushi T	Ayushi

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30	Fefar Naulik Bhaveshbhai	N.B. Patel
31	Adroja Prince Rajnikantbhai	
32	Kaila Parth Bipin	Parth
33	DEVMURARI KHUSHAL	
34	Chandegara Abhishek	
35	Rathod Akshat	
36	Goswadiya Devam	
37	Jadeja Ravirajsinh	
38	Sanghani Pratik	
39	Dhaval Parmar	
40	Thakor Yash	Yash
41	Gajera Harshil	
42	Korat Vidhi	
43	Heer Pambhar	HEER
44	Rizya Kalola	
45	Krishna Gorasiya	
46	Zalak Trivangadiya	Zalak
47	Vala Hemangi K.	
48	Rathod Khushiba G	
49	Kanani Meera H.	
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