

**“STUDIES OF ALKANOLAMIDES AND METALLIC
SOAPS FROM NON-TRADITIONAL OILS”**

A

Minor Research Project

Submitted

To

**UGC (WRO), GANESHKHIND,
PUNE**

***UNDER THE DEPARTMENT OF
CHEMICAL ENGINEERING***

BY

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YEAR: 2013-2015

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MINOR RESEARCH PROJECT

The minor project work entitled “Studies of Alkanolamides and Metallic Soaps from Non-Traditional oils” contains four Chapters (1) Introduction (2) Review of literature (3) Materials and methods and (4) Result and discussion followed by list of references cited throughout the project work.

Chapter1. Introduction

Oils and fats industry is one of the most important agro based industries in India, which play crucial role in our national economy. India has a rich wealth of oilseeds. Besides traditional oilseed like groundnut, cottonseed, coconut, soybean, rapeseed etc., there is a large availability of non-traditional oilseed such as karanja, mango kernel, sal seed, mahua seed, neem, pal ash, kusum, ritha, tobacco seed etc. and also ricebran as oil source.

In the early stages India was the net exporter of edible oils. With increasing population the demand for conventional vegetable oil has increased greatly resulting in large gap between demand and supply of edible oils. Since they are in heavy demand from edible sector their uses in making oleo chemicals have virtually stopped.

To overcome this Scientists and Technologists are looking for the new sources of oils to obtain oleochemicals from them for their use in soaps, detergents, lubricating greases, healthcare products, cosmetics and many more.

In this thesis attempt has been made to study alkanolamides and metallic soaps from nontraditional oils like, Mango kernel (*Mangifera indica* Linn), Sal (*Shorea Robusta*), Mahua (*Madhuca indica*), and Custard apple seed (*Annona Squamosa*) to obtain detergents and lubricating greases.

Chapter2. Review of Literature

Extensive review of literature was carried out for the study of alkanolamides and metallic soaps from nontraditional oils. Some of the references are mentioned below.

J.M. Nzikou et. Al 2010 studied the extraction and Characteristics of seed kernel oil from Mango (*Mangifera indica Linn*). They found that stearic acid was the main saturated fatty acid, while oleic acid was the major unsaturated fatty acid. Since the oil was rich in unsaponifiable matter, it could be used in cosmetic industry[1].

Saiprabha M. Mahale and A. S. Goswami-Giri, (2001) compared the composition and characterization of refined oil with its crude oil from waste obtained from *Mangifera indica Linn*. They claimed that mango fat can be used as substitute for cocoa butter and also finds its use in soaps and cosmetics [2]. J.A. Awan et. al, 1980 carried out the proximate analysis and physiochemical characterization of the seed sour soup (*Annona Muricata Linn.*) and found that oil consists of 28.07% saturated and 71.93% unsaturated fatty acids[3]. T. Anwar et.al; 2006 studied Comparative Characterization of rice bran of variety super kernel (*Oryza saliva*), muskmelon (*cucumis melo*), watermelon (*citrillus vulgaris*) and mango kernel (*Mangifera indica Linn*). Many parameters of the investigated oils were quite comparable with those of different conventional oils[4]. The use of Mahua oil (*Madhuca indica*) as a diesel fuel extender was studied by Y.C. Bhatt et. al; 2004 in which they have carried out the physicochemical analysis of Mahua oil [5].

Alkanolamide have broad spectrum of uses. They are used in shampoos, detergent, cosmetics, lubricant etc. Halconk 2004, prepared laurel oil alkanolamide from laurel oil [6]. S D Toliwal and Kalpen Patel prepared and studied the surfactant properties of diethanolamides of rice bran, soybean and rapeseed proteins. . These surfactants could have commercial potential since they are obtained from proteins of deoiled cakes and do not require fats or fatty acids which are in short supply [7]. Polyurethane foams from hydroxyl methylated oleate, linseed oil, safflower oil and their methyl esters diethanolamide were prepared by T.H.Khoe et.al; [8]. Kuan Ju Line et al 2001 studied the synthesis and kinetic analysis of hexanonyl diethanolamide (HADEA), lauryl diethanolamide (LADEA) and oleoyl diethanolamide (OADEA). *Candia antarctica* lipase (Novozym G35) was used to

catalyze the amidation of fatty acids with diethanolamine [9]. Alkanolamides from 9,10-Dihydroxy stearic acid was prepared by Roila Awang et. al; 2006. They found that these compounds were non irritants to the skin and bio degraded 60% in 20 days [10].

Metallic soaps are made by heating fatty acids with metallic oxide or carbonate. These soaps are used in the preparation of greases, paints, lacquers, textiles, inks, textiles etc. Odashima, Osamu and Kondo Osamu patented (US patent No. 4473504,1984) a method for producing granular metallic soap using cobalt and stearic acid[11]. Zucker,Friedrich J. et. al; patented (USP No. 4336203, 1982) a process for continuous production of alkali metal. Salts of fatty acids in which the ratio of fatty acids mixture to sodium hydroxide solution 1:0.285 was used at reaction temperature of 50⁰C[12]. P.Nkwoman Nene, 2008 prepared calcium, cobalt, iron and copper soaps of palm kernel oil by precipitation from aqueous solution of potassium soaps. The properties of metallic soaps were determined by boiling and weighing [13].

Vegetable oils have significant potential as a base fluid and a substitute for mineral oil in grease formulation. Grease obtained from mineral oils are non biodegradable, posing a threat to environment. Moreover, there is depletion in the fossil fuel reserves. Hence much more emphasis is given on renewable, friendly resource. The non toxic and readily biodegradable characteristics of vegetable oil based lubricants pose less danger to soil, water, flora and fauna in the case of accidental spillage or during disposal, Stempf, E. M.1998 [14].

Atanu Adhvaryu et. al; 2004 studied the preparation of soybean oil-based greases and effect of composition and structure on physical properties. They found that lithium soap composition, types of fatty acids and base oil content significantly affect the grease hardness and oxidative stability[15].Kumar Anoop et.al; 2011 studied the compatibility of vegetable oil based lubricating greases with different mineral oil based greases. They pointed out that the vegetable oil base greases evaluated so far have either been found incompatible or just border line compatible[16].

A detergent is a cleansing agent. A detergent contains an active agent that wets the fabric, emulsifies oily metal soluble grime and keeps the soil in suspension. Dhakite et. al, 2011 prepared the powder detergent and liquid detergent and tested them for the parameters – percentage moisture, percentage of alcohol soluble, percentage of alcohol insoluble, percentage of solids, foam height, surface tension and cleaning efficiency. They found that both of the samples were compatible with that of commercial detergents and also the cleaning capability of alkyl base powder detergent is better than commercial sample [17].

Chapter 3. Materials and Methods

The Mango kernel oil (*Mangifera indica* Linn), Sal oil (*Shorea robusta*), Mahua oil (*Madhuca indica*), and waste transformer oil used in this study procured from a Charbhuj Industries Pvt. Ltd. M.I.D.C., Nagpur (Maharashtra state), Jeevan Kachhi Ghani, from Dalli-Rajhara, Dist Durg, (Chhattisgarh) and local market of Jalgaon (Maharashtra state) respectively were used for the preparation of alkanolamides and metallic soaps. Preliminary studies on custard apple seed oil (*Annona Squamosa*) were also carried out. The oil used in this study was extracted from the custard apple seeds procured from the local market.

A. Physicochemical Analysis of oils

The physicochemical analysis of all the four oils were carried out using AOCS official methods [18], moisture content, specific gravity, refractive index, acid value, saponification value, iodine value, unsaponifiable matter, flash point, fire point were determined for the oils used in this study.

B. Determination of fatty acid composition oils

Following methods were used to determine the fatty acid composition of the oils used in this study

(i) Preparation of mixed fatty acids. (Twitchell's Process)

The mixed fatty acid was prepared by saponifying 100 gms of the sample oil with 5N alcoholic potassium hydroxide. The content was refluxed for 2-3 hours on water bath. After saponification, the excess alcohol was distilled off and soap was dissolved in 150-200 ml hot distilled water. The mixed fatty acids were liberated by acidifying the soap solution with 1:1 H₂SO₄ using methyl red indicator. The acid was added till pink color of lower layer was developed; the content was then boiled for 5-10 minutes and transferred to a separating funnel. The fatty acid and glycerol layer formed were separated. Fatty acid layer was dissolved in solvent ether and washed with hot water 2 to 3 times in a separating funnel, to get fatty acid as the top layer and glycerol at the bottom layer. The fatty acid layer was separated and dried over anhydrous sodium sulphate [19].

(ii) Preparation of Methyl Esters

100 mg of sample was taken in a round bottom flask. Measured amount of boron tri fluoride-methanol solution (BF₃- 125gms /liter of methanol) were added to mixed fatty acid. The mixture was heated and refluxed for 25-30 minutes at steady temperature. A 5 ml of heptanes was added through condenser and the content was boiled for 5 minutes till it dissolved .The content was transferred to a separating funnel. The lower layer formed was decanted. To the upper layer anhydrous sodium sulphate was added and traces of moisture were removed.

This dried heptanes solution was subjected to Gas-Chromatography. The ester sample was injected into gas chromatography. Packed Column was used, its film thickness was 0.31 μ m, and Column length was 2 meter. The temperature was from 160^o C heated to 250^o C (1.5^oc/min) ; injector 250^o C, detector 270^o C; carrier gas 4.0ml/min hydrogen; 6ml/min air and 4 ml/min nitrogen; manual injection volume < 1 μ l. The peak area was computed by integration software of packed column and percentage of fatty acid methyl esters were obtained as weight percent by direct internal normalization [20].

C. Greases

From mango kernel oil, sal oil, and mahua oil greases were prepared using the following procedure. They were further characterized for their color, appearance, drop point and consistency.

(i) Preparation of Alkali Soap

To 100 gm of sample oil in a round bottom flask, 200 ml of 30% alcoholic sodium hydroxide solution was added and refluxed for two hours till clear solution was obtained. The alkali soap thus prepared was used for preparation of various metal soaps.

(ii) Preparation of Metal Soap

100 gm of alkali soap free of traces of alcohol was dissolved in 150 ml of distilled water and heated to 70^oC. To it 30% barium metal salt solution at 70^oC was added slowly with continuous stirring. The precipitated metallic soap separated from the water was cooled, and washed with hot distilled water for 2 to 3 times. This was then filtered and dried in an oven at 110^oC+/- 5^oC

and further milled to get powdered barium metal salt (soap). Similarly the metallic soaps of lead, calcium, and aluminium were prepared [21].

(iii) Physicochemical properties of metallic soaps

The physical properties of metallic soaps like color, was judged with naked eyes. Moisture content, melting point, total fatty matter, metal content, ash content, pH value, bulk density were determined by standard ISO methods [22].

(iv) Physicochemical analysis of waste transformer oil

The physico-chemical parameters of waste transformer oil such as acid value, iodine value, flash point and fire point, viscosity, aniline point, refractive index, color were determined by standard methods [23].

(v) Preparation of Greases

A 35 ml of waste transformer oil was heated to 70°C. To it 35 gm of barium metallic soaps was added slowly with continuous stirring till the temperature was reached to 93°C-150°C. The mixture was cooled to room temperature. A viscous solid grease of barium metal salt obtained was mixed thoroughly. Similarly greases of lead metal salt, calcium metal salt and aluminium metal salt were prepared at temperatures 140-160°C, 70°C and 120-140°C respectively.

(vi) Characterization of greases

The greases prepared were characterized for their color, appearance and tested for drop point, and consistency as per ASTM methods and same were compared with multipurpose Castrol AP-3 grease from the local market.

D. Alkanolamides

Preparation of alkanolamides (fatty acid diethanolamide)

The mixed fatty acids of sample oil (40 gms) and diethanolamines (80 gms) were mixed properly in the ratio of (1:2w/w and on mole basis 1:5) was charged in a three necked glass reactor (with a stirrer and a thermometer) placed in heating mantle. The reaction was carried out at 150°C continuously for 7 hrs in conventional batch reactor. The whole mass was then transferred to a separating funnel. The unreacted diethanolamine and free fatty acids were removed by dissolving them in 25-50 ml solvent ether. The ether layer was separated and the alkanolamides (diethanolamide) obtained was taken into the beaker.

E. Detergent powder

(i) Preparation of detergent powder sample

Detergent powders were prepared as per the formulation given in Table- 06. Formulation A was without foam booster where as B, C, D and E were with 1% of fatty alkanolamides of Mango kernel oil, Sal oil, Mahua oil and Custard apple seed oil respectively.

(ii) Characterization of detergent powder

The prepared detergent powders were tested for various properties such as pH, percentage moisture, percentage of alcohol solubility and insolubility, bulk density, foam height and cleaning efficiency (detergency percentages).

Chapter 4. Result and Discussions

A. Physicochemical Analysis and Fatty acid Composition of oils

Physicochemical analysis and fatty acid composition of Mango kernel oil, Sal oil and Mahua oil, and Custard apple seed oil are reported in Table 1 and Table 2. The results obtained are in agreement with the reported values in the literature with change in some of the values. Such variations in the values of these parameters may be attributed to possible changes in environmental and geological conditions of the region as well as particular species of the seed.

B. Greases

Barium, Lead, Calcium and Aluminium metal soaps were obtained from mango kernel oil, sal oil, and Mahua oil using the protocol given in Chapter 3, materials and methods. The metal salts (Soaps) thus obtained were treated with waste transformer oil as per the protocol given in Chapter 3, materials and methods, thus Barium, Lead, Calcium and Aluminium metal soap greases were obtained. All these greases obtained were characterized for appearance, drop point, consistency and were compared with multipurpose greases, Table 3, Table 4 and Table 5. Results showed that Barium metal soap greases is obtained from all oils (Mango kernel, Sal and Mahua) the most compatible with the multipurpose grease, followed by Calcium, Barium, and Aluminium metal soap grease of mango kernel oil.

C. Detergent

Detergent powders were prepared as per the protocols given in Table 6 and were analyzed for the parameters moisture, alcohol solubility, alcohol insolubility, foam height and pH. The results obtained are reported in Table 7. The commercial detergent powder Surf Excel was analyzed for its foam height and the results are given in Table 8. It is observed that the detergent powders prepared using mango kernel fatty alkanolamide (diethanolamides), and mahua oil fatty alkanolamide (diethanolamides) are compatible with the commercial detergent powder Surf Excel.

Salient findings

- Physicochemical analysis of nontraditional oils (Mango kernel, Sal, Mahua and Custard apple seed) revealed that the values obtained for various parameters are in the range of that of traditional oils.
- Mango kernel oil, Sal oil, Mahua oil contains Palmitic Acid, Stearic acid, Oleic acid, Linoleic acid, Linolenic acid, and Arachidic fatty acids.
- Custard apple seed oil contains Palmitic, Stearic Oleic and Linolenic fatty acids.
- Lubricating greases obtained by using Barium, Lead, Calcium and Aluminium metal soaps from mango kernel oil fatty acids/ sal oil fatty acids/ mahua oil fatty acids and waste transformer oil can be used effectively for lubricating purpose.
- Comparison of these greases with multipurpose grease showed that Barium metal soap grease of all oils is most compatible followed by calcium and aluminium metal soap grease of mango kernel oil.
- In the formulation of detergent fatty acid alkanolamides (diethanolamides) obtained from mango kernel, sal, mahua and custard apple seed oil could be used as foam boosters and stabilizers.
- Detergent containing the fatty alkanolamides (diethanolamides) from mango kernel and sal oil are found to have good foaming and cleaning properties and found compatible with that of commercial detergent Surf Excel.

Conclusion

The study of Nontraditional oils such as Mango kernel, Sal, Mahua and Custard apple seed reveals that the nontraditional oils are potential sources of oleo chemicals which could be used in the product like greases and detergents.

The metallic soaps from these nontraditional oils and waste transformer oil could be used to prepare greases which are compatible with that of commercial greases.

The fatty acid alkanolamide (diethanolamides) formed from the non- traditional oils could be used as a foam boosters/ stabilizers in detergent powders thus enhancing the cleansing property of the detergent.

Thus the Mango kernel oil, Sal oil, Mahua oil and Custard apple seed oil could be used as potential sources of oleo chemicals; used in the preparation of greases and detergent powders.

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Table-1-Analysis of Mango-kernel, Sal, and Mahua oils and Custard apple seed oil:

Se. No.	Particulars	Results Obtained			
		Mango-kernel oil	Sal oil	Mahua oil	Custard Apple seed oil
1	Moisture (Volatile matter) %	1.12	1.21	1.05	0.66
2	Color	Pale yellow	Light yellow	Light yellow	Pale yellow
3	Acid Value (as % oleic acid)	2.41	2.6	32.05	2.49
4	Iodine Value (wiji's)	47.3	40.6	63.3	89.88
5	Saponification Value	192.4	187.6	193.7	193.91
6	Unsaponifiable Matter %	2.33	2.73	2.71	1.34
7	Peroxide Value (m.eq/Kg)	3.09	2.11	5.39	0.83
8	Sp-gravity at 30°C	0.901	0.871	0.869	0.8519
9	Flash point °C	>140 °C	>136 °C	221	>160
10	Fire Point °C	166 °C	157	236	--
11	Refractive Index at 40 °C	1.4578	1.4609	1.4610	1.4660

Table-2- Fatty Acid composition of oils

Carbon atoms	F.A.	Mango-kernel oil	Sal oil	Mahua oil	Custard Apple seed oil
16:0	Palmitic acid	6.68	5.4	25.8	15.77
18:0	Stearic acid	41.43	43.36	19.7	07.96
18:1	Oleic acid	46.08	43.30	41.6	54.79
18:2	Linoleic acid	4.63	0.36	12.3	25.48
18:3	Linolenic acid	0.37	0.23	0.2	-----
20:0	Arachidic acid	0.46	7.43	0.3	-----

Table -3 Lubricating Greases from Mango-Kernel Oil Fatty Acid

Metallic Salt - □	Ba-Salt	Pb-salt	Ca-salt	Al-salt	Multipurpose Grease
% of Salt Used	35	35	35	35	----
Appearance	Greasy	Greasy	Greasy	Greasy	Greasy
Drop Point.(°C)	85.2	79.4	81.8	81.1	82
Consistency (0.1mm)	188	190	184	194	182

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Table-4 Lubricating Greases from Sal Oil Fatty Acid

Metallic Salt - □	Ba-Salt	Pb-salt	Ca-salt	Al-salt	Multipurpose Grease
% of Salt Used	35	35	35	35	----
Appearance	Greasy	Greasy	Greasy	Greasy	Greasy

Drop Point.(°C)	86	78	83	79	82
Consistency (0.1mm)	181	191	178	182	182

Table-5 Lubricating Greases from Mahua Oil Fatty Acid

Metallic Salt - □	Ba-Salt	Pb-salt	Ca-salt	Al-salt	Multipurpose Grease
% of Salt Used	35	35	35	35	----
Appearance	Greasy	Greasy	Greasy Liquid	Greasy Hard	Greasy
Drop Pt.(°C)	84	76	81	73	82
Consistency(0.1mm)	184	189	176	192	182

Table -6- Formulation of Detergent Powder

Sr.No.	Components	A (%)	B (%)	C (%)	D (%)	E (%)
1	Acid Slurry (90%)	12	12	12	12	12
2	Sodium Carbonate	40	40	40	40	40
3	Sodium Bicarbonate	10	10	10	10	10
4	Sodium Sulphate	05	05	05	05	05
5	Sodium Tri poly phosphate	10	10	10	10	10
6	Sodium Silicate	10	10	10	10	10
7	Tri Sodium Phosphate	05	05	05	05	05
8	Sodium Lauryl Sulphate	05	05	05	05	05
9	Optical Brightener	03	03	03	03	03
10	Fatty acid Diethanolamide	00	01	01	01	01
	Total	100	100	100	100	100

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- A- Standard Detergent Powder without Using Foam Booster (Diethanolamide)
- B- Standard Detergent Powder Using Diethanolamide from MK OIL.
- C- Standard Detergent Powder Using Diethanolamide from SAL OIL.
- D- Standard Detergent Powder Using Diethanolamide from MAHUA OIL.
- E- Standard Detergent Powder Using Diethanolamide from CUSTARD OIL.

Table 7 Commercial detergent powder used

Se. No.	Name of commercial Powder	Color of Powder	Percentage of powder used	Foam Height in (mm.)	
				Initial	After 5 Minutes
1	Surf Excel	White	0.25%	96	86

			0.5%	110	100
			1.0%	118	111
Average Foam Height in (mm)				108	99

Table No. 8 Analysis of detergent powders

Sample No.	Name of Diethanolamide	Moisture %	Alcohol Solubility %	Alcohol Insolubility %	Foam Height in mm.		pH of detergent
					Immediate	After 5 minutes	
A	No amide	8.4	79	21	105	98	11.13
B	Mango kernel oil	8.2	81	19	120	113	11.34
C	Sal Oil	7.6	80	20	114	109	11.18
D	Mahua oil	8.1	84	16	117	112	11.49
E	Custard apple Seed oil	7.8	79	21	111	107	10.33

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8). EXPERIENCES:-

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B) Promoted and working as Associate Professor from January 2015 till date.

**C) Academic Experiences – 1986-1992 -- 06Years 1Month, as a P. G Teacher
2008- till date -- 08Years 01Months**

Total – 14 Years ---- 01 Months

**D) Industrial Experiences - 1985-1986 Worked from Assistant to Works, and Administrative
Manager,**

1992-2008 Manager in SEP and VOP Industries

Total -16 Years as a Capacity of Manager

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Annexure-I

List of Research work & Publications

9). PUBLICATIONS:

(A) International Publications

- **A.R.Lokhande**, K.S.Wani and V.S.Patil. “Study of lubricating greases from Mahua oil fatty acids using waste lubricating oil”. Participated in “International Congress of Chemistry and Environment” (ICCE-2011) held on 27-29, May-2011 at Port Dickson, Malaysia.
- **A.R Lokhande.**, Patil V.S. and Wani K.S. (2012), “Preparation of Greases from Metal Soaps of Nontraditional Oil using Waste Lubricating Oil”, International Journal of Chemical Engineering and Research, ISSN 0975 – 6442 Volume 4, Number 1 pp. 1-7.

- **A.R Lokhande.**, Patil V.S. and Wani K.S. (2013), “Study of Diethanolamide from Custard Apple Oil (*Annona Squamosa L.*)”, International Journal of Engineering Research & Technology (IJERT), ISSN 2278 – 0181 Volume 2, Issue 9, September 1 pp. 448-452.
- **Lokhande A.R.**, Wani K.S. and Md. Afsar, “Study of Pectin from Peels of *Magnifera Indica* and *Artocarpus Hetrophyllus*”, published in International Journal of Engineering and Trend and Technology” (IJETT),ISSN2231-5381 (Impact Factor 1.795) PP. 375-382 ,(2016.)

B) International Conferences

- **A.R.Lokhande**, K.S.Wani and V.S.Patil. “Study of lubricating greases from Mahua oil fatty acids using waste lubricating oil”. Participated in “International Congress of Chemistry and Environment” (ICCE-2011) held on 27-29, May-2011 at Port Dickson, Malaysia.
- **A.R.Lokhande**, Patil V.S. and Wani K. S. “Advance Technology in Renewable Energy”, published in International Conference on “Advances in Energy Technology” organized by SSBT’s College of Engineering and Technology, Bambhori, Jalgaon, held on March 29th, 2013, page no.114-117, Proceedings.
- **A.R. Lokhande**, Wani K.S. and Patil V.S. “Design Criterion for Extended Aeration System”, published in International Conference on “Advances in Energy Technology” organized by SSBT’s College of Engineering and Technology, Bambhori, Jalgaon, held on March 29th 2013.
- **Lokhande A.R.**, Wani K.S. and Md. Afsar, “Study of Pectin from Peels of *Magnifera Indica* and *Artocarpus Hetrophyllus*”, participated in International Conference on “Emerging Trends in Engineering, Management and Technology” ICGTETM-16, organized by SSBT’s College of Engineering and Technology, Bambhori, Jalgaon, held on January 4 to 6th, 2016

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C) National Publications:

- **A.R. Lokhande**, R.R. Khotpal, A.S. Kulkarni, Dr. H.A. Bhakre, (1989) “Alkanolamides of Ritha (*Sapindus trifoliatus*) and Watermelon Oils (*Citrullus Vulgaris*):” Soap detergent, Toiletries, Review May’ 89, PP 20-22.
- **A.R. Lokhande**, K.M. Patel, D.A. Rawal , (1989), “Studies of Metallic Soaps from Non-Traditional” Oils, Soap detergent, Toiletries, Review, Dec’89,P.P. 6-7
- **A.R. Lokhande**, A.S. Kulkarni, R.R. Khotpal, Dr. H.A. Bhakre, (1992), “Glycolipids Composition of Subabhul, Ritha & Kusum Seed Oils of Vidharbha Region” J. Food. Sc. Tech. Vol. 29, No. 3, 179-181.
- **A.R. Lokhande**, S.D. Toliwal, D.A. Rawal, and A.S. Kulkarni., (1993) “Chemical compositions of oils from some varieties of Groundnuts (*Archis Hypogiea*) “ O.T.A.I. Vol. XXXV (2) April-June.

- **A.R. Lokhande**, A.K. Dighe, D.A. Rawal , (1993), “Alkyd Resin from CuCl₂ Polymerized Argemone Seed Oil”, Research and Industry Vol. 38, P.P. 157 to 160

D) National Conference:

- **A.R.Lokhande**, K.S.Wani and V.S.Patil. “Study of Metallic Soaps from Non-Traditional Oil and their Applications as Lubricating Greases and Drier in Paints”, Published in National Conference on “Emerging Trends in Engineering, Technology and Management”, held on 29th March 2010, organized by SSBT’s C.O.E.T.,Bambhori, Jalgaon.
- **A.R.Lokhande**, K.S.Wani and V.S.Patil. “Study of Lubricating Grease from Mahua Oil Fatty Acids”, Published in National Conference on “Recent Innovations in Oil and Food Technology (RIOFT-2010)”, held on August 23, 2010, organized by Division of Oils, Fats and Waxes Technology and Division of Food Technology, Department of Chemical Technology, North Maharashtra University, Jalgaon-425001.

10) Job Responsibility:

1. **At Industry Level** : Worked as **Production Manager, Works Manager and Administration Manager** at various Industries
2. Worked in **Quality Control, Production, Administration A/c s Department**
3. **Delivered Lecture at PFA Department at Nagpur**

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At Institute Level

1. Member, of Antiragging Committee
2. Member and Coordinator of Admission Reporting Center. (ARC)
4. Member, of Library Committee
5. Member, of Central Assessment Process
6. Delivered lecture on “Laboratory Safety” in one day Workshop on Safety Awareness Organized by Chemical Engineering Dept. for non teaching staff of COET, Bambhori, Jalgaon.
7. Member of **International Conference** team of organizing committee.
8. Member of **WEB Committee**
9. Commissioning Member of **Reverse Osmosis Plant**.
10. Member of Education fair team and Carrier Guidance team.
11. In charge of Catering Committee in **Avishkar-15** organized by NMU, Jalgaon

12. In charge of Catering Committee, in **Yuvarang -2015** organized by NMU, and SSBT's C O E T , Jalgaon from 6-10th January , 2016
13. Coordinator of **Bahinabai Mahostav-2016** Organized at Sagar Park, Jalgaon from 28/02/2016 to 03/03/2016.
14. Coordinator of Catering Committee in **Parents Meet -2016**
15. Member of Education Fair at Nagpur in 2015 and Conducting Seminar on DTE new rules and carrier Guidance Seminar at **Khandesh and Vidarbha Region**
16. Delivered Seminar on 'Career in Engineering Education' for 12th Science students. At "MAHENDRA'S CHEMISTRY" Classes at Jamner on April.26,2016

11) AT DEPARTMENTAL LEVEL:

1. Coordinator, of conducting Workshop on Aspen Hysis.
2. Laboratory In Charge of Computer Laboratory, Library, Research & Project Laboratory.
3. Member, of Syllabus framing team of department
4. Departmental Time Table in charge.
5. Departmental Member, of Accreditation and NAAC Committee
6. Contributed in Preparation of S.E., T.E. & B.E. Chemical Engineering New Syllabus (CGPA system)
7. Class Teacher for T.E. Chemical Engineering
8. Member of Teacher Guardian Scheme.

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12) Research Funds Granted:

1. Department and Science and Technology, New Delhi was sanctioned grant of Rs. 1,00,000/- under Innovation and Entrepreneurship Development Cell (IEDC) for the project of "Preparation of Lubricating Greases from fatty acids of Nontraditional oils and its applications", and has been completed successfully during the year 2012-13
2. Travel grant of Rs 22,656/-was received by AICTE and received for participation and presenting a paper in International Conference organized by International Congress of Chemistry and Environment(ICCE-2011) held on 28-29th May 2011 at Glory beach resort, Port Dickson, Kuala Lumpur, Malaysia
3. Under UGC, minor research project grant of Rs. 1,45,000/- is received for the project of "Study of alkanolamide and metallic soap from Nontraditional oils" in March 2013, and has been completed successfully during the year 2013-15
4. Shram Sadhana Research Promotion Scheme SSBT's COET, Bambhori, was sanctioned grant of Rs. 1,52,000/- for the project of "An evolutionary approach to reuse of environmentally nuisance

discarded tyre rubber as concrete aggregate” and has been completed successfully during the year 2012-14.

5. Department of Science and Technology, New Delhi was sanctioned grant of Rs. 1,00,000/- under Innovation and Entrepreneurship Development Cell (IEDC) for the project of “Recycling of paper from Paper Waste” , during the year 2014-2015.

Total grant received for the Department – Rs. 5, 19,656/-

13) Membership of professional bodies

1. Life member of Oil Technological Association of India.(LOTAI)
2. Fellow Member of Institute of Engineers (M.I.E.) (Chemical).
3. Fellow Member of International Conference of Chemistry and Environment. (FICCE).
4. Fellow Member of Institute of Chemical Engineers. (I. Ch.E.)

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14) WORKSHOPS / STTP / SEMINARS ATTENDED:

(A) Conference/Seminars

Name of the Seminar/Conference	Name of the Sponsoring Agency	Place & Date
1. One day seminar on British Indian Standards.	M.S. University Baroda	Baroda Feb 1988
2. Participated and Presented Paper on “Studies of Metallic Soap and its Use as Drier in Paint Industries From Nontraditional Oils”.	National Conference on Emerging Trends in Engineering, Technology and Managements”.	C.O.E.T., Bambhori, Jalgaon on 29/03/2010
3. Participated Paper on “Lubricating Grease from Mahua Oil Fatty Acids”.	National Conference on “Recent Innovations in Oil and Food Technology (RIOFT-2010)”,	Division of Oils, Fats and Waxes Technology and Division of Food Technology, Department of Chemical Technology, NMU, Jalgaon on August 23, 2010.
4. One day seminar Recent Trends in Oils and Oleo chemicals.	Oil technological Association of India, L.I.T. Nagpur Branch	Nagpur 09/01/2011
5. Participated in National Level Conference on Green & Clean Technology	National Level Conference on Green & Clean Technology	Organized by Chemical & Civil Engg. Dept. of C.O.E.T., Bambhori, Jalgaon .on Mar.11 th , 2012.

6. International Conference	International Conference of Chemistry and Environment	Glory Beach Resort, Malaysia on 27-29/05/2011
7. International conference	International Conference on Advances in Energy Technology.	COET Bambhori on 29/03/2013
8. Published paper on, "Chemical Process Engineering for Sustainability" in proceedings of International Conference page no.400-404.	International Conference on "Sustainable Development"	SSBT's College of Engineering and Technology, Bambhori, Jalgaon held on February, 25-26 th 2014,
9. International Conference	International Conference on Global Trend in Engineering, Technology and Managements.	SSBT's COET Bambhori on 9-10 th Jan 2015
10. International Conference	International Conference on Global Trend in Engineering, Technology and Managements.	SSBT's COET Bambhori on 4-5 th Jan 2016

(B) Workshop/Symposium

Name of the workshop / Symposium	Name of the Sponsoring Agency	Place & Date
1. Gujrat Science Congress	M.S. University Baroda	Baroda , 1987
2. Three days Teachers Training Workshop	Deepstambha Foundation , Jalgaon	SSBT's C.O.E.T. Bambhori, on July 9-11, 2009
3. One day Scientific Meeting cum Visit to RCF, Thal Raigarh	National Safety Council Maharashtra Chapter	Mumbai 22/09/2009
4. Confederation Meeting as Principal Nominee	Training and Placement Officer , Under NMU	SSVP's College of Engg. Dhulia, on 03/02/2010
5. One day Workshop on Disaster Management.	National Safety Council, Mumbai	C.O.E.T., Bambhori Jalgaon, on 23/01/2010
6. One day Symposium: Academic Excellence: Challenge and Opportunities.	G.H. Raisonni College of Engineering, Nagpur	G.H. Raisonni College of Engineering, Nagpur on 11 th June 2011
7. Two days Workshop	National Workshop on Mat lab Application	E&TC Dept of C.O.E.T., Bambhori Jalgaon, on 5, 6/ 03/ 2011
8. Workshop	Research Methodology,	Mechanical & MBA Dept. C.O.E.T., Bambhori Jalgaon, on 17-19/10/2011
9. Two days workshop	Aspen Hysis	Chemical & Biotech Dept From 2010-2014 Except 2013
10. Two days workshop	Aakash 2 Tablet	COET Bambhori on 10 & 11 th / 11/2012
11. Two day workshop	Industrial Automation	Technocrat Academy of Automatic & Control System on 12/3/2015 to 13/3/2015 at COET, Bambhori.

(C) List of Training and Others:

Name of the Training and others	Name of the Sponsoring Agency	Place & Date
1. Two days Customer Training Program	Alpha Laval (I) Ltd Poona	Poona, Oct'94
2."Best Citizen of India award 2001"	International Publishing House	New Delhi-2001
3.Three day training course on Aspen Hysys Process Modeling	Aspen Tech, Pune	Pune , 16-18 March 2009
4.Awareness & Auditing Practices Courser for ISO-9001-2008	Max Certification Pvt Ltd , Mumbai	C.O.E.T., Bambhori, Jalgaon on 22/02/2010
5. Judge for Aviskar	NMU Festival, Aviskar 2012	School of Environmental & Earth Sciences, NMU Jalgaon.
6. Lecturer Series	B.Y. Rao. Lecture series.	L.I.T. Nagpur on 17 th Jan 2015

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ANNEXURE – III**Industrial and Academic Experiences**

Name of the Company	Post Held	From	To	Duration
1.SSBT's College of Engineering and Technology, Bambhori, Jalgaon	Associate Professor Assistant Professor.	January 2015 July'2008	Till date December2014	8.01Y
2. Rasoya Proteins Ltd. Nagpur	Manager (Production & Administrations)	April'2006	March'2008	2.00Y
3. Anupam Extraction Pvt. Ltd, Wardha	Production Manager	October,2005	March'2006	0.06Y
4.Unique Agro Processors Pvt Ltd, Ridhora, Nagpur	Works Manager	October,2003	September, 2005	2.00Y
5. Khandesh Extraction Pvt Ltd., Chalisgaon.	Production Engineer	May'2003	September, 2003.	0.05 Y
6.Madhur Agro Proteins Ltd, Dumari, Nagpur.	Works Manager	December' 2002	March'2003	0.04Y
7.Jaiswal NECO (AGRO DIV), Wadoda , Nagpur	Works Manager	May '2002	Nov'2002	0.05Y
8. Anand Mohata Agro Industries Pvt Ltd, Panchagaon. Nagpur	Works Manager	July'1998	May '2002	3.11Y
9. NECO (AGRO DIV) / JNECO, Wadoda, Nagpur.	Prod. Manager. (Refinery)	December'199 3	July'1998	4.07Y

10. Umred Agro Complex Ltd. Kolari, Nagpur.	Assistant Manager, (Q.C)	October' 1992	December'1993	1.03Y
11.V.P. & RPTP Science College VV Nagar, Gujrat (S. P. University, Vallabh Vidyanagar)	Lecturer in Industrial Chemistry (Post B.Sc. Diploma Course)	September 1986	September'1992	6.01Y
12. M/s Liberty Oil Mills , Sholapur Dist Thane	Oil Technologist	October'19 85	August '1986	0.11Y

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16) **ANY OTHER:**

1. Visited Kakinada port for discussing the problem in DOC(Soybean) in Dec'93.
2. Delivered Lecture on Solvent extracted oil and Flour Mills arranged by P.F.A. Department Nagpur, in 1993 & 1999 .
3. Received 2nd Prize, in Experiences, organized by Alpha Laval India Ltd. at Pune.
4. Received 'BEST CITIZEN OF INDIA AWARD' from International Publishing House, New Delhi in 2001.
5. Appointed Judge for Aviskar 2012, By School of Environmental & Earth Science, NMU Jalgaon.
6. Received and collected "Best Teaching Award" on the behalf of College organized by Indo Global Chamber of Commerce Industries and Agriculture Pune in 2015.
7. Certificate of Recognition from SSBT's COET Bambhori, Jalgaon for achieving above 80 % Result in the E.E and CAPEDMS subject of B.E. Examination.
8. Certificate of Recognition from LMC for achieving 100% result in November 2015 Examinations.

I solemnly declare that the information declare that the information given above is true to the best of knowledge.

Place: Jalgaon

Date: 30/06/2016

(Dr. A. R. Lokhande)

