



Fatty acids profiling through gc/ms in oils of Borsali seeds and Rayan seeds collected from Motibaug Botanical Garden, Junagadh Gujarat

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Abstract

Experiments was conducted at Food testing laboratory of Junagadh agricultural university, both borsali and Rayan seeds were extracted from mature fruits course crushed it with seed cover and put in to thimble for oil extraction units then after it was used for high throughput GC MS plate form. Analyzed data were compared with metabolomics work bench and named as Ref Met. The result showed a higher amount of unsaturated fatty acids in both the seed oils than the saturated fatty acids. It was found to be higher in Borsali seed oils then the rayan seed oils. The total number of fatty acids also detected to be higher in 20 and 19 respectively in borsali and rayan seed oils. Similarly, O/L ratio also shown higher (4.93) in borsali then the Rayan seed oils (4.3) In summary, when comparing Borsali and Rayan seed oils based on the fatty acid's composition, Borsali oil generally showed a slightly higher O/L ratio, lower SFA content, higher UnFA content, higher MUFA content, slightly lower PUFA content, and a higher MUFA/PUFA ratio compared to Rayan seed oil.

Keywords: Borsali, Rayan, fattyacids, GCMS

Introduction

Mimusops elengi Linn. (M. elengi) is also known as Borsali, Indian native plant used for a long time in the history of the medicine. Because of its high potential medicinal value (Gami *et al*, 2012) ^[4]. Similarly, the Manilkara hexandra having seed like sapota and known as rayan or Khirni. Fruits are oval & bright yellow. This plant is native to South Asia. *Manilkara hexandra* (Roxb.) Dubard is an indigenous underutilized fruit tree belonging to the family Sapotaecae. It is locally known as 'khirni' or 'rayan' and is generally distributed in states such as Rajasthan, Gujarat, Madhya Pradesh and Maharashtra wild condition, it is found in dry deciduous forests of western and central India. Chemistry and biology of the triterpenes and saponins from seeds of *Mimusops elengi* were presented by Sahu *et al*. (2001), Minzangi *et al* (2011) Shukla *et al*. (2020). ^[5, 6, 7]

The profiling of fatty acids in various oil sources has garnered significant attention due to its implications for nutrition, health, and industrial applications. This study focuses on the fatty acid composition of oils extracted from tree species of borsali seeds and rayan seeds, both of which are indigenous to the Junagadh region of Gujarat, India. The importance of these seeds lies not only in their potential nutritional benefits but also in their role as a sustainable source of bioactive compounds. (Singh and Jha (2020) ^[8] Gas Chromatography-Mass Spectrometry (GC/MS) is a powerful analytical technique that allows for the detailed characterization of complex mixtures, such as fatty acids in oils. This method quantifies individual fatty acids present in seeds, thus by analysis it can providing insights into their nutritional value and potential health benefits. The fatty acid profile is crucial for understanding the functional properties of oils too including their stability, flavour, and health effects. For instance, certain fatty acids are known to have

anti-inflammatory properties or play a role in cardiovascular health. Therefore, this research aims to contribute valuable data regarding the lipid composition of these lesser-known seed oils from Junagadh, potentially paving the way for their utilization in food products and nutraceuticals. The findings can generate the information for researchers and industry stakeholders regarding the economic viability of these seeds as alternative oil sources.

Materials and methods

Both the samples were collected from botanical Garden in Motibaug, Junagadh Agricultural University, and Borsali and Rayan fruits outer covered were removed. Black seeds were collected, remove moisture from them by keeping in a hot air oven for overnight, and 3 gm weight was used for soil extraction with hexane for 6 hours. Remove the hexane portion by keeping overnight. The next day oil was used for the analysis for GC MS. Standard condition for GC MS:

Extracted oils was used for derivatives and make methyl ester and applied in autosampler tubes. GC-MS analyses were performed using a DB-5MS capillary column (30 m × 0.25 mm i.d., film thickness 0.25 µm, Agilent Technologies, Santa Clara, CA, USA). The chromatographic runs were started as per the following details conditions [GC-2010]. The GCMS conditions as per table indicated: ionization mode, electron ionization (EI) mode; ionization current, 60 µA; ionization voltage, 70 eV. Each sample was analysed. Eluted compounds were identified using the NIST (<http://www.nist.gov/srd/nist1a.cfm>), the Wiley NBS, the mass spectral data as well as used pubmed and other data sources for detection.

Fatty acids and compounds were used for google search, NIST library for the potential application for food and industrial application.

Instruments protocol for analysis of GCMS-FAME

Column Oven Temp.	40.0 °C	MS table: Start Time :3.50min, End Time :54.67min, ACQ Mode: Scan, Event Time :0.50sec, Scan Speed 1428, Start m/z :50.00, End m/z :700.00, Sample Inlet Unit: GC "[GCMS-QP2010 Plus], Ion Source Temp :200.00 °C, Interface Temp.:290.00 °C, Solvent Cut Time :2.00 min, Detector Gain Mode: Relative Detector Gain: +0.00 kV, Threshold 100"
Injection Temp.	:250.00 °C	
Injection Mode	: Split	
Flow Control Mode	: Pressure	
Pressure	:49.5 kPa	
Total Flow	:54.0 mL/min	
Column Flow	:1.00 mL/min	
Linear Velocity	:36.1 cm/sec	
Purge Flow	:3.0 mL/min	
Split Ratio	:50.0	
High Pressure Injection	: ON	
High Press. Inj. Pressure	:250.0 kPa	
High Press. Inj. Time	:1.00 min	
Carrier Gas Saver	: OFF	
Splitter Hold	: OFF	
Oven Temp. Program		
Rate	Temperature(°C)	Hold Time(min)
-	40.0	3.00
6.00	290.0	10.00

Results and Discussion

The Number of Fatty acids detected in oils of borsali seeds and Rayan seeds are presented in table 1 to 4.

The results showed the comparing the same fatty acids in both seeds except cis-11,14,17-Eicosatrienoic acid (C20:3n3) at Peak no 17. At RT of 36.12 but it was prominently higher or in detectable limit in Rayan seeds oils. The comparison between these two seed oil analyses indicated the variability in composition with area % of the fatty acids only. Oleic acid (C18:1n9c) 61.29 % and Linoleic acid (C18:2n6c) 12.42% was found in borsali seed oils similarly Oleic acid (C18:1n9c) 55.05% and Linoleic acid (C18:2n6c)12.80% was found in Rayan seed oils. The ratio of O/L was found to be 4.93 and4.3 respectively similarly SFA 25.23%), UnFA (74.77%), MUFA (61.65%), PUFA (12.58%), MUFA/PUFA (4.9%) was measured in Borsali seed oils while Rayan seed oils composed of SFA (31.46%), UnFA(68.32%)MUFA(55.33%), PUFA(13.09%), MUFA/PUFA(4.23%),Thus it can be proved that this oils can be used for foods as well as in pharmaceutical value too. No toxic compound was reported in these oils.

Palmitoleic acid (C16:1), Oleic acid (C18:1n9c), Arachidic acid (C20:0),

cis-11-Eicosenoic acid (C20:1), Behenic acid (C22:0), Tricosanoic acid (C23:0), Lignoceric acid (C24:0), Nervonic acid (C24:1) were found to be positively higher amount in borsali seeds then the rayan seeds and highest change was observed in Oleic acids, it was 6.24 % higher than the rayan seeds and least change was observed in Tricosanoic acids (0.01 %). Similar fatty acids also reported *Mimusops elengi* Linn in by Dutta and Chandra (2014) [3] and Minzangi, (2012) [6], Baky *et al.*,2016 [1] in Rayan with GC MS.

Similarly, negative change means Rayan seeds had higher amount of Myristic acid (C14:0), Palmitic acid (C16:0), Margoric acid (C17:0), Stearic acid (C18:0), Linoleic acid (C18:2n6c), alpha-Linolenic acid (C18:3n3), cis-11,14,17-Eicosatrienoic acid (C20:3n3) the least change was Myristic acid (C14:0), and alpha-Linolenic acid (C18:3n3). The rayan seeds oil had higher amount of both the fatty acids viz., Palmetic acids (4.51%) and stearic acids (2.32%). Overall showed similar fatty acids composition except in cis-11,14,17-Eicosatrienoic acid (C20:3n3). Even though authors are advised not to use for edible purpose because of seed coat showed darker oils. These results are in agreements with Baky *et al.*, (2016) [1] in *Manilkara hexandra* (Roxb.) Dubard.

Table 1: Comparison of fatty acids profiles in the both Borsali and Rayan seed oils

	Borsali			Rayan seed oils				
Peak	Ret.Time	Area%	Fatty acids Name	Chemical formula Mass	Class	RT	Area%	change in area %
1	10.98	0.02	Caproic acid (C6:0)	C ₆ H ₁₂ O ₂	SFA	10.985	0.02	0
2	12.124	0.03	Caprylic acid (C8:0)	C ₈ H ₁₆ O ₂	SFA	12.12	0.03	0
3	19.472	0.09	Myristic acid (C14:0)	C ₁₄ H ₂₈ O ₂	SFA	19.456	0.12	-0.03
4	21.305	0.04	Pentadecanoic acid (C15:0)	C ₁₅ H ₃₀ O ₂	SFA	21.287	0.04	0
5	23.299	13.8	Palmitic acid (C16:0)	C ₁₆ H ₃₂ O ₂	SFA	23.301	18.31	-4.51
6	24.658	0.26	Palmitoleic acid (C16:1)	C ₁₆ H ₃₀ O ₂	UnSFA	24.644	0.03	0.23
7	25.153	0.08	Margaric acid (C17:0)	C ₁₇ H ₃₄ O ₂	SFA	25.139	0.1	-0.02
8	27.225	9.3	Stearic acid (C18:0)	C ₁₈ H ₃₆ O ₂	SFA	27.206	11.62	-2.32
9	28.066	0.04	Elaidic acid (C18:1n9t)	C ₁₈ H ₃₄ O ₂	UnSFA	28.049	0.04	0
10	28.625	61.29	Oleic acid (C18:1n9c)	C ₁₈ H ₃₄ O ₂	UnSFA	28.588	55.05	6.24
11	30.327	12.42	Linoleic acid (C18:2n6c)	C ₁₈ H ₃₂ O ₂	UnSFA	30.311	12.8	-0.38
12	30.923	1.03	Arachidic acid (C20:0)	C ₂₀ H ₄₀ O ₂	SFA	30.901	0.75	0.28
13	32.121	0.49	cis-11-Eicosenoic acid (C20:1)	C ₂₀ H ₃₈ O ₂	UnSFA	32.103	0.3	0.19
14	32.381	0.07	alpha-Linolenic acid (C18:3n3)	C ₁₈ H ₃₀ O ₂	UnSFA	32.367	0.08	-0.01
15	34.561	0.5	Behenic acid (C22:0)	C ₂₂ H ₄₄ O ₂	SFA	34.537	0.26	0.24
16	35.702	0.06	Erucic acid (C22:1n9)	C ₂₂ H ₄₂ O ₂	UnSFA	NA	NA	
17	36.12	0.09	cis-11,14,17-Eicosatrienoic acid (C20:3n3)	NA	NA	36.112	0.21	-0.12
18	36.319	0.03	Tricosanoic acid (C23:0)	C ₂₃ H ₄₆ O ₂	SFA	36.299	0.02	0.01

19	38.155	0.31	Lignoceric acid (C24:0)	C ₂₄ H ₄₈ O ₂	SFA	38.13	0.19	0.12
20	39.374	0.05	Nervonic acid (C24:1)	C ₂₄ H ₄₆ O ₂	UnSFA	39.353	0.02	0.03
	O/L ratio	4.93			O/L ratio		4.3	0.63
	SFA	25.23			SFA		31.46	-6.23
	UnFA	74.77			UnFA		68.32	6.45
	MUFA	61.65			MUFA		55.33	6.32
	PUFA	12.58			PUFA		13.09	-0.51
	MUFA/PUFA	4.9			MUFA/PUFA		4.23	0.67

Table 2: Number of Fatty acids with types or classes detected in oils of borsali seeds

Peak	Ret.Time	Name	Area%	Chemical formula Mass	Mass	Class
1	10.980	Caproic acid (C6:0)	0.02	C ₆ H ₁₂ O ₂	116.0837	SFA
2	12.124	Caprylic acid (C8:0)	0.03	C ₈ H ₁₆ O ₂	144.115	SFA
3	19.472	Myristic acid (C14:0)	0.09	C ₁₄ H ₂₈ O ₂	228.2089	SFA
4	21.305	Pentadecanoic acid (C15:0)	0.04	C ₁₅ H ₃₀ O ₂	242.2246	SFA
5	23.299	Palmitic acid (C16:0)	13.80	C ₁₆ H ₃₂ O ₂	256.2402	SFA
6	24.658	Palmitoleic acid (C16:1)	0.26	C ₁₆ H ₃₀ O ₂	254.2246	UnSFA
7	25.153	Margaric acid (C17:0)	0.08	C ₁₇ H ₃₄ O ₂	270.2559	SFA
8	27.225	Stearic acid (C18:0)	9.30	C ₁₈ H ₃₆ O ₂	284.2715	SFA
9	28.066	Elaidic acid (C18:1n9t)	0.04	C ₁₈ H ₃₄ O ₂	282.2559	UnSFA
10	28.625	Oleic acid (C18:1n9c)	61.29	C ₁₈ H ₃₄ O ₂	282.2559	UnSFA
11	30.327	Linoleic acid (C18:2n6c)	12.42	C ₁₈ H ₃₂ O ₂	280.2402	UnSFA
12	30.923	Arachidic acid (C20:0)	1.03	C ₂₀ H ₄₀ O ₂	312.3028	SFA
13	32.121	cis-11-Eicosenoic acid (C20:1)	0.49	C ₂₀ H ₃₈ O ₂	310.2872	UnSFA
14	32.381	alpha-Linolenic acid (C18:3n3)	0.07	C ₁₈ H ₃₀ O ₂	278.2246	UnSFA
15	34.561	Behenic acid (C22:0)	0.50	C ₂₂ H ₄₄ O ₂	340.3341	SFA
16	35.702	Erucic acid (C22:1n9)	0.06	C ₂₂ H ₄₂ O ₂	338.3185	UnSFA
17	36.120	cis-11,14,17-Eicosatrienoic acid (C20:3n3)	0.09			
18	36.319	Tricosanoic acid (C23:0)	0.03	C ₂₃ H ₄₆ O ₂	354.3498	SFA
19	38.155	Lignoceric acid (C24:0)	0.31	C ₂₄ H ₄₈ O ₂	368.3654	SFA
20	39.374	Nervonic acid (C24:1)	0.05	C ₂₄ H ₄₆ O ₂	366.3498	UnSFA

Table 3: Class or types of Fatty acids detected in oils of Rayan seeds

Peak	Ret.Time	Name	Area%	Chemical formula	Mass	Class
1	10.985	Caproic acid (C6:0)	0.02	C ₆ H ₁₂ O ₂	116.0837	SFA
2	12.120	Caprylic acid (C8:0)	0.03	C ₈ H ₁₆ O ₂	144.115	SFA
3	19.456	Myristic acid (C14:0)	0.12	C ₁₄ H ₂₈ O ₂	228.2089	SFA
4	21.287	Pentadecanoic acid (C15:0)	0.04	C ₁₅ H ₃₀ O ₂	242.2246	SFA
5	23.301	Palmitic acid (C16:0)	18.31	C ₁₆ H ₃₂ O ₂	256.2402	SFA
6	24.644	Palmitoleic acid (C16:1)	0.03	C ₁₆ H ₃₀ O ₂	254.2246	UnSFA
7	25.139	Margaric acid (C17:0)	0.10	C ₁₇ H ₃₄ O ₂	270.2559	SFA
8	27.206	Stearic acid (C18:0)	11.62	C ₁₈ H ₃₆ O ₂	284.2715	SFA
9	28.049	Elaidic acid (C18:1n9t)	0.04	C ₁₈ H ₃₄ O ₂	282.2559	UnSFA
10	28.588	Oleic acid (C18:1n9c)	55.05	C ₁₈ H ₃₄ O ₂	282.2559	UnSFA
11	30.311	Linoleic acid (C18:2n6c)	12.80	C ₁₈ H ₃₂ O ₂	280.2402	UnSFA
12	30.901	Arachidic acid (C20:0)	0.75	C ₂₀ H ₄₀ O ₂	312.3028	SFA
13	32.103	cis-11-Eicosenoic acid (C20:1)	0.30	C ₂₀ H ₃₈ O ₂	310.2872	UnSFA
14	32.367	alpha-Linolenic acid (C18:3n3)	0.08	C ₁₈ H ₃₀ O ₂	278.2246	UnSFA
15	34.537	Behenic acid (C22:0)	0.26	C ₂₂ H ₄₄ O ₂	340.3341	SFA
16	36.112	cis-11,14,17-Eicosatrienoic acid (C20:3n3)	0.21	-	-	-
17	36.299	Tricosanoic acid (C23:0)	0.02	C ₂₃ H ₄₆ O ₂	354.3498	SFA
18	38.130	Lignoceric acid (C24:0)	0.19	C ₂₄ H ₄₈ O ₂	368.3654	SFA
19	39.353	Nervonic acid (C24:1)	0.02	C ₂₄ H ₄₆ O ₂	366.3498	UnSFA

Application of this compositional fatty acids

- 1. Caproic Acid (C6:0):** also known as hexanoic acid, is a medium-chain fatty acid that is primarily used in the production of esters for artificial flavourings and fragrances. It has applications in the food industry as a flavoring agent due to its strong Odor reminiscent of goats. Additionally, caproic acid is utilized in the synthesis of certain pharmaceuticals and as an intermediate in organic synthesis.
- 2. Caprylic Acid (C8:0):** or octanoic acid, is another medium-chain fatty acid known for its antimicrobial properties. It is commonly used in dietary supplements and health products aimed at supporting gut health and fighting infections. In addition to its health benefits,

caprylic acid is used in the production of esters for flavourings and fragrances, as well as in cosmetics and personal care products due to its emollient properties.

- 3. Myristic Acid (C14:0):** is a saturated fatty acid found naturally in nutmeg, palm oil, and coconut oil. It has applications in the cosmetic industry as an emulsifier and thickening agent. Myristic acid is also used in the formulation of soaps and detergents due to its ability to enhance lathering properties. Furthermore, it serves as a precursor for various surfactants.
- 4. Pentadecanoic Acid (C15:0):** is less common but has garnered interest for its potential health benefits. Research suggests that it may play a role in reducing

inflammation and improving metabolic health. It can be found in dairy fats and some fish oils, leading to its use in nutritional studies focusing on dietary fats.

5. **Palmitic Acid (C16:0):** is one of the most prevalent saturated fatty acids found in animals and plants. It is widely used in food products as a stabilizer and thickener. In cosmetics, palmitic acid acts as an emollient and emulsifier. Additionally, it serves as a key ingredient in the production of soaps, candles, lubricants, and surfactants.
6. **Palmitoleic Acid (C16:1):** is a monounsaturated fatty acid that occurs naturally in certain animal fats and plant oils like macadamia oil. Its primary uses include being incorporated into dietary supplements for cardiovascular health benefits due to its potential role in reducing cholesterol levels. It also finds application within cosmetic formulations for skin conditioning.
7. **Margaric Acid (C17:0):** Margaric acid has limited commercial applications but can be found naturally occurring alongside other fatty acids. Its primary use lies within research contexts rather than widespread industrial applications.
8. **Stearic Acid (C18:0):** Stearic acid is widely utilized across various industries; it serves as an emulsifier or thickener in cosmetics and personal care products. In food processing, stearic acid acts as a stabilizer for margarine and chocolate products. Moreover, it plays a significant role in soap manufacturing due to its ability to produce stable lather.
9. **Elaidic Acid (C18:1n9t):** Elaidic acid is a trans-fat derived from partially hydrogenated oils; however, it has been largely phased out due to health concerns associated with trans fats. Historically used for frying oils or margarine production, current regulations limit its presence significantly due to adverse health effects linked with cardiovascular diseases.
10. **Oleic Acid (C18:1n9c):** Oleic acid is an omega-9 monounsaturated fatty acid commonly found in olive oil and avocados. It has numerous applications including cooking oil production due to its heart-healthy properties. Oleic acid also features prominently within cosmetic formulations for skin hydration purposes.

11. **Linoleic Acid (C18:2n6c):** Linoleic acid is an essential omega-6 fatty acid critical for human nutrition; it must be obtained through diet since humans cannot synthesize it themselves. Its uses extend into cooking oils such as sunflower oil while also being incorporated into skincare products owing to its moisturizing properties.
12. **Arachidic Acid (C20:0):** Arachidic acid has limited direct applications but can be utilized within specialized industrial contexts such as lubricant formulations or plasticizers.
13. **cis-11-Eicosenoic Acid (C20:1):** This monounsaturated fatty acid finds use primarily within research settings focused on lipid metabolism rather than widespread commercial applications.
14. **alpha-Linolenic Acid (C18:3n3):** Alpha-linolenic acid (ALA) is an essential omega-3 fatty acid important for human health; it supports cardiovascular function among other benefits when included within diets rich in flaxseed oil or walnuts.
15. **Behenic Acid (C22:0):** serves mainly within cosmetic formulations where it's valued for emollient properties; it's often included within hair conditioners or lotions aimed at enhancing moisture retention.
16. **Erucic Acid (C22:1n9):** primary application lies within industrial contexts such as lubricant manufacturing or biodiesel production rather than food consumption due to safety concerns regarding high intake levels.
17. **cis-11,14,17-Eicosatrienoic Acid (C20:3n3):** polyunsaturated fatty acids are primarily studied within research frameworks focusing on their potential anti-inflammatory effects rather than having established commercial uses at this time.
18. **Tricosanoic Acid (C23:0) & Lignoceric Acid (C24:0) & Nervonic Acid (C24:1)**
These long-chain fatty acids have niche applications mainly researched concerning their roles within biological systems rather than widespread industrial usage patterns observed elsewhere among shorter chain counterparts.

Table 4: Summary of the fatty acids of both oils in potential application

Caproate	Flavouring agents.
Caprylate	Antimicrobial supplements.
Myristate	Emulsifiers/thickeners.
Pentadecanoate	Nutritional studies.
Palmitate	Stabilizers/emulsifiers.
Palmitoleate	Cardiovascular supplements.
Margarate	Research contexts.
Stearate	Soap/cosmetic ingredients.
Elaidate	Limited use due to health concerns.
Oleate	Cooking/oil production.
Linoleate	Essential dietary component.
Arachidate	Specialized industrial uses.
Eicosenoate & ALA	Research-focused studies on nutrition and health
Behenate & Erucate	Cosmetic/lubricant industries.
Eicosatrienoates & Long-chain Fatty Acids	Biological role

Conclusion

This research endeavours to provide a comprehensive analysis of the fatty acid profiles through GC/MS techniques applied to borsali and rayan seed oils collected from Junagadh, Gujarat. The outcomes were expected to enhance our understanding of Both oils' have nutritional significance or not and purpose of promoting sustainable agricultural practice. Results showed the presence of Short Chain fatty acids too, viz., Caproic acid (C6:0), Caprylic acid (C8:0), Myristic acid (C14:0), and Pentadecanoic acid (C15:0) and it was commonly found in many foods too and are generally recognized as safe for consumption. Palmitic acid (C16:0) and Stearic acid (C18:0) was also detected and can be used as vegetable oils. Though excessive consumption of saturated fats can contribute to health issues but not considered as toxic too. Margaric acid (C17:0), Arachidic acid (C20:0), Behenic acid (C22:0), Tricosanoic acid (C23:0), and Lignoceric acid (C24:0) like fatty acids also found in this oil it is longer chain saturated fatty acids and less common in the diet. Overall, it can be used as Industrial application other than food.

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