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Modification of refined palm oil by blending with Akashmoni seed oil (*Acacia auriculiformis*) to improve its nutritional value and study of its frying properties

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Abstract
This study explores the nutritional and frying performance improvements achieved by blending refined palm oil with akashmoni seed oil (*Acacia auriculiformis*). Refined palm oil, rich in saturated fatty acids, offers oxidative stability, while akashmoni oil contributes polyunsaturated fatty acids for enhanced nutritional value. Blended oils were analyzed for fatty acid composition and subjected to frying tests, including periodic assessments of oxidative stability indicators. The study reveals that the blended oil exhibited lower peroxide and anisidine values and maintained a balanced fatty acid profile, demonstrating its potential as a healthier alternative for culinary use.

Keywords: Blended oil, refined palm oil, Akashmoni seed oil, fatty acid composition, frying stability

1. Introduction
Oils and fats are crucial components of food preparation, influencing flavour, texture, and nutritional value. However, individual oils often fall short of meeting all functional and nutritional requirements. Palm oil, widely used for its affordability, stability, and balanced composition, is rich in saturated fats and beneficial compounds like carotenoids and tocopherols. Yet, its high saturated fat content raises health concerns, particularly for cardiovascular health[1-2]. Blending palm oil with other oils can improve its nutritional profile while retaining its oxidative stability.
Akashmoni seed oil, derived from *Acacia auriculiformis*, is an underutilized edible oil rich in polyunsaturated fatty acids (PUFAs). It offers numerous health benefits, including potential cardioprotective and antioxidant effects. Its low saturated fat content and absence of toxic non-glyceride components make it a promising candidate for blending[3]. Blending oils like akashmoni and palm oil can optimize fatty acid composition and micronutrient content, aligning with dietary recommendations.
This study aims to prepare and evaluate a blend of refined palm oil and akashmoni oil in a 1:1 ratio. The blend's fatty acid composition and frying properties are analyzed, focusing on nutritional enhancement and stability. Results could present a viable, healthier alternative for culinary use, bridging functionality and health benefits.

2. Materials and Methods
Akashmoni seeds were procured from the local market of Kolkata. Refined palm oil was collected from Budge Budge Refinery Ltd. West Bengal, India. Non-stick pan was used for carrying out the frying operations. Potatoes were purchased from the local market.
All the reagents and chemicals used were of analytical grade and procured from E-Merck India Ltd.

2.1. Extraction of Akashmoni oil
Oil is extracted from akashmoni seeds by Soxhlet extraction using food grade hexane and refined in the laboratory.

2.2. Preparation of oil blend
Blended oil was prepared by mixing refined palm oil and akashmoni seed oil in 1:1 proportion.
All the oils were tested for their acid value, iodine value, peroxide value, p-anisidine value, conjugated diene, and conjugated triene by adopting standard methodologies[4].

2.3. Analysis of the fatty acid composition of extracted lipid by Gas-Liquid Chromatography

The fatty acid composition of the extracted oil from the akashmoni seeds, refined palm oil and blended oil were determined using Gas-Liquid Chromatography (Hewlett Packard 6890) according to the AOCS 7th edition 2017, Official method Ce 1-07 Capillary GLC method, and one at a time. After preparation of the fatty acid methyl esters using boron trifluoride in methanol, it (0.1-1µg) was injected from a Hamilton syringe into the inlet of the machine. The gas chromatograph (Agilent 6890N) was fitted with a DB-Wax capillary column (30m X 0.32mm X 0.25□m) and a flame ionization detector. N_2, H_2, and airflow rate were maintained at 1, 30, and 300 ml/min, respectively. Inlet and detector temperatures were kept at 250ºC and the oven temperature was programmed to increase from 150ºC to 190ºC at a rate of 15ºC/min, then to hold for 5 min, and then to increase to 230ºC at a rate 4ºC /min, and then to hold for 10 min.

2.4. Frying of potato chips

The locally purchased potato was peeled, washed by water, and sliced of equal dimension (0.5 cm) (200 g) were fried 1L of refined palm oil and blended oil separately at 180-190ºC. Oil samples were pooled once at the beginning (0 h), second after 2 h, third after 4 h, and at the end of 6 h. The temperature maintained during the whole experiment, including the frying operation, was within the range of 180ºC -190ºC. The heating of the oil was carried out in a non-stick frying pan to prevent the leaching of metals from utensils. This is also to mention that neither salt nor any other spices were added during the frying of the potato chips.

2.5. Oil samples

Oil samples were collected every 2 h and kept in refrigeration. Fresh oil was never added to the frying vessel for replenishment.

2.6. Oil analysis

The oil quality parameters *viz* acid value, iodine value, peroxide value, p-anisidine value, trans fatty acid, conjugated diene, and conjugated triene were determined for fresh oil as well as for the heated oil samples collected every 2 h of heating.

For determination of acid value, iodine value, peroxide value, and p-anisidine value, AOCS official method Te1a-64, AOCS official method Cd 1b-87, AOCS official method Ja 8-87, and AOCS official method Cd 18-90 were followed respectively[5].

For determining conjugated diene and conjugated triene, a sample weighing between 0.0001 to 0.001g was taken in a test tube and 10 ml of iso-octane was added to it. Absorbance was measured at 233 nm for determining conjugated diene and at 268 nm for determining conjugated triene[5] by using a spectrophotometer (UV-VIS Shimadzu 1700).

2.7. Statistical analysis

All experiments were done in triplicate and the results were expressed as the mean value ± S.D.

3. Results and Discussion

3.1. Analysis of the fatty acid composition of extracted lipid by Gas-Liquid Chromatography

Oil is extracted from Akashmoni seeds with n-hexane. Refined Palm oil is collected from market. The fatty acid composition of Akashmoni oil, refined Palm oil and Blended oil (50:50) are represented in Tables 1– 2. It is observed from those tables that akashmoni oil is rich in polyunsaturated fatty acids whereas, refined palm oil is rich in saturated fatty acids. Upon mixing in 1:1 proportion, the blend oil shows comparatively high levels of PUFA and moderate levels of SAFA and MUFA and represented in Table 3. The blended oil is found to contain no trans-fat.

3.2. Analysis of quality parameters

FFA contents (Acid value; AV) of oils and fats were measured by AOCS (1998) Official Method[4]. AV is defined as the mg of potassium hydroxide required to neutralize the free carboxyl groups in 1g of the sample, can be used to assess the qualitative degradation of oil. Table 4 shows that refined Palm oil showed a higher acid value, lower peroxide value, than fresh akashmoni oil.

The oil sample collected after 2 h of heating showed an increase in acid value. Refined Palm oil showed the least changes in acid value. An increase in free fatty acid has been known to result from hydrolysis of triglycerides, triggered by infusion of moisture from the food into the oil and by its oxidation. However, determination of amount of free fatty acids gives about the idea of degradation but it is difficult to ensure that the increase in free fatty acids is due to oxidation or hydrolysis.

The iodine value, represented in Table 4, gives an indication about the extent of the unsaturation present in the oil molecule. During heat treatment, a progressive decrease in unsaturation was observed in all oils. This decrease in unsaturation can be attributed to the destruction of double bonds by oxidation, scission and polymerization.

In order to assess the oxidative changes in different oils during heating, peroxide value was determined and presented in Table 4. Detection of peroxides gives the initial evidence of development of rancidity in unsaturated fats and oils. Significant differences were observed in peroxide value at different time intervals. The refined palm oil showed a greater change in peroxide value than the blended oil. With time, higher rate of increase in acid value for refined palm oil was observed indicating higher level of degradation.

3.3. Frying study of oil samples

Frying study was carried out by taking a blend of easily available refined palm oil (rich in saturated fatty acids) and akashmoni oil (rich in PUFA content). During the frying, samples were collected at different time intervals and were analyzed for fatty acid composition including trans fatty acids, free fatty acids, peroxide value, p-anisidine value, iodine value, diene and triene content, represented in Table 5.

3.4. Evaluation of Conjugated diene, triene and p-Anisidine values after frying

For determining conjugated diene and conjugated triene, sample weighing 0.0001g to 0.001g was taken in a test tube and 10ml of iso-octane was added to it. Absorbance was measured at 233 nm for determining conjugated diene and at 268 nm for determining conjugated triene [AOCS official method Ti 1a-64] by using spectrophotometer (UV-VIS Shimadzu 1900). Data is represented in Table 6.

Fatty acid composition of heated oil in different intervals were also studied (Table 7

Table 1: Fatty acid profile of refined palm oil

Saturated Fatty Acid	%	SAFA (%)
C14:0	1.11	46.65± 1.74
C16:0	41.88	
C18:0	3.66	
Mono unsaturated fatty Acid	%	MUFA (%)
C18:1	42.12	42.12± 1.86
Poly unsaturated fatty Acid	%	PUFA (%)
C18:2	11.25	11.25± 0.58

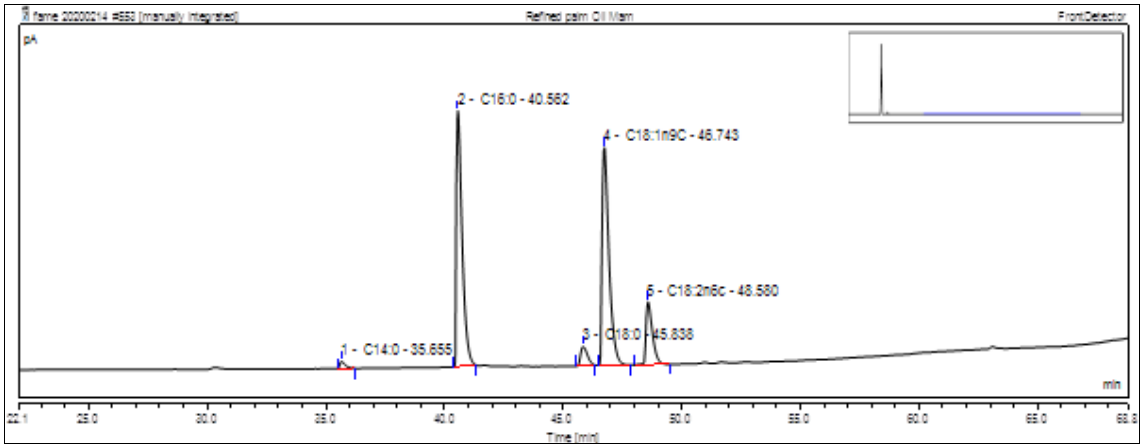

Fig 1: Chromatogram of Refined palm Oil

Table 2: Fatty acid profile of akashmoni oil

Saturated Fatty Acid	%	SAFA (%)
C16:0	6.7	13.3± 1.54
C18:0	0.5	
C20:0	6.1	
Mono unsaturated fatty Acid	%	MUFA (%)
C18:1	13.0	13.0± 1.36
Poly unsaturated fatty Acid	%	PUFA (%)
C18:2	73.7	73.7± 1.89

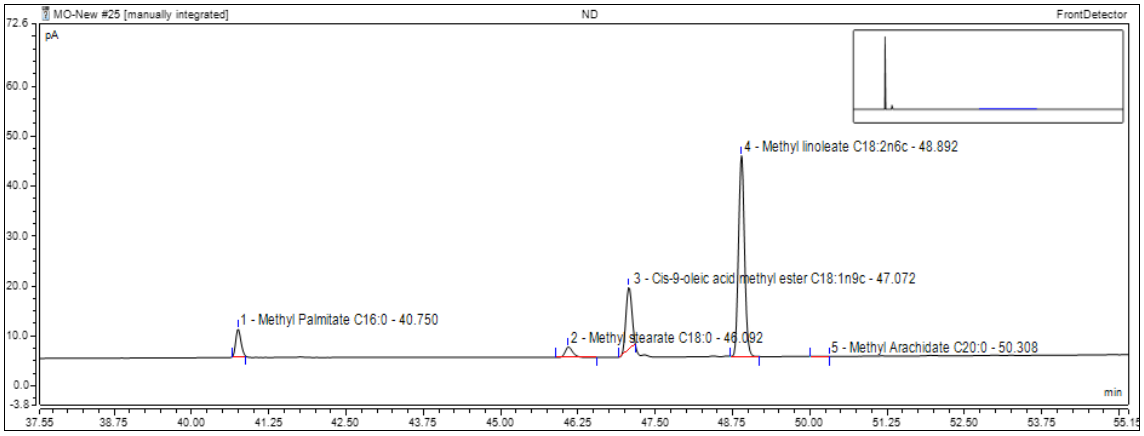

Fig 2: Chromatogram of Akashmoni Oil

Table 3: Fatty acid profile of fresh blended oil

Saturated Fatty Acid	%	SAFA (%)
C16:0	24.3	29.34 ± 1.72
C18:0	2.14	
C20:0	2.90	
Mono unsaturated fatty Acid	%	MUFA (%)
C18:1	22.8	22.80± 0.98
Poly unsaturated fatty Acid	%	PUFA (%)
C18:2	47.86	47.86± 1.49

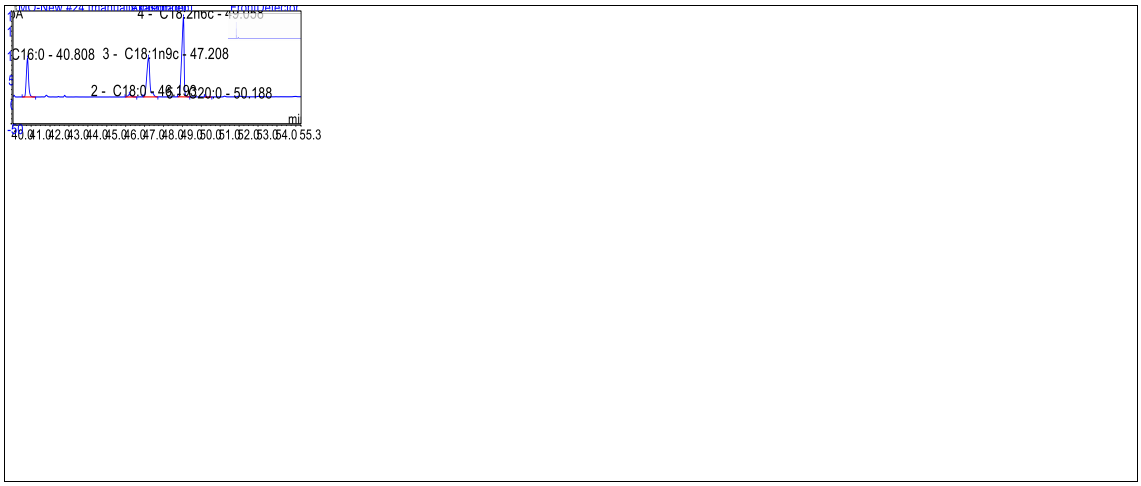

Fig 3: Chromatogram of Fresh Blended Oil

Table 4: Physical and chemical characteristics of various fresh oils

Name of the Cooking oil	Fresh (before experiment)					
	AV	PV (meq/kg)	IV	M (%)	SV	Unsap (%)
Refined Palm oil	0.62 ± 0.04	2.06 ± 0.5	54.59 ± 0.83	0.06 ± 0.02	197.23 ± 2.44	0.60 ± 0.17
Akashmoni oil	0.54 ± 0.84	4.17 ± 0.23	109.39 ± 2.52	0.03 ± 0.01	168.62 ± 2.08	1.01 ± 1.34
Blended oil	0.59 ± 0.08	3.27± 0.21	79.75± 1.34	0.04± 0.02	182.07 ± 2.84	0.82 ± 0.21

values are Mean ± S.D
Blended oil is composed of Akashmoni oil: Palm oil –50:50
AV: Acid value, PV: Peroxide Value, M: Moisture, SV: Saponification Value;
Unsap: Unsaponifiable matter;

Table 5: Analysis of frying oils after total 6 h of frying

Name of the Cooking oil	Acid Value (AV)				Peroxide Value (PV) (meq/kg)				Iodine Value (IV)			
	0 h	2h	4h	6h	0h	2h	4h	6h	0 h	2h	4h	6h
Refined Palm oil	0.62 ± 0.12	0.76 ± 0.08	0.82 ± 0.08	0.89 ± 0.11	2.06 ± 0.08	2.97 ± 0.11	3.66 ± 0.09	5.16 ± 0.11	54.59 ± 0.89	50.79 ± 1.12	46.13 ± 0.87	41.32 ± 0.95
Blended oil	0.59 ± 0.04	0.64 ± 0.06	0.75 ± 0.05	0.81 ± 0.09	3.27 ± 0.07	3.88 ± 0.11	4.23 ± 0.24	5.96 ± 0.35	79.75 ± 0.34	69.43 ± 0.82	62.57 ± 0.89	51.51 ± 0.90

Values are Mean± S.D

Table 6: Evaluation of conjugated diene, triene and p-Anisidine values after frying

Parameters	Blended Oil				Refined Palm Oil			
	0 h	2 h	4 h	6 h	0 h	2 h	4 h	6 h
Conjugated diene (%)	0.106 ± 0.01	0.122 ± 0.02	0.129 ± 0.02	0.141 ± 0.01	0.052 ± 0.01	0.067 ± 0.01	0.072 ± 0.02	0.081 ± 0.02
Conjugated triene (%)	0.129 ± 0.02	0.147 ± 0.01	0.162 ± 0.01	0.191± 0.04	0.076 ± 0.02	0.082 ± 0.01	0.094 ± 0.02	0.101 ± 0.01
p-Anisidine Value	0.93 ± 0.11	1.76 ± 0.17	2.41 ± 0.09	3.63 ± 0.18	1.87 ± 0.07	2.76 ± 0.11	4.12 ± 0.14	6.92 ± 0.07

Values are Mean± S.D

Table 7 (A): Fatty acid composition (%w/w) of refined palm oil and blended oil at 0 h (initial)

Variety of oil	Saturated fatty acids	0 h	
Refined Palm Oil	C14:0	1.11	46.65±1.24
	C16:0	41.88	
	C18:0	3.66	
	Monounsaturated fatty acids	0 h	
	C18:1	42.12	42.11 ± 0.76
	Polyunsaturated fatty acids	0 h	
	C18:2	11.25	11.25 ± 0.36
Blended Oil	Saturated fatty acids	0 h	
	C16:0	24.30	29.34 ±1.72
	C18:0	2.14	
	C20:0	2.90	
	Monounsaturated fatty acids	0 h	
	C18:1	22.80	22.80 ±0.98
	Polyunsaturated fatty acids	0 h	
	C18:2	47.86	47.86 ± 1.49

Values are Mean ± S.D

Table 7 (B): Fatty acid composition (%w/w) of refined palm oil and blended oil at 2 h of frying

Variety of oil	Saturated fatty acids	2 h	
Refined Palm Oil	C14:0	1.15	47.52±1.75
	C16:0	42.68	
	C18:0	3.69	
	Monounsaturated fatty acids	2 h	
	C18:1	43.18	43.18±1.26
	Polyunsaturated fatty acids	2 h	
	C18:2	9.30	9.30± 0.39
Blended Oil	Saturated fatty acids	2 h	
	C16:0	24.86	31.17±1.72
	C18:0	2.44	
	C20:0	3.87	
	Monounsaturated fatty acids	2 h	
	C18:1	23.43	23.43±0.98
	Polyunsaturated fatty acids	2 h	
	C18:2	45.40	45.40 ± 1.49

Values are Mean ± S.D

Table 7 (C): Fatty acid composition (%w/w) of refined palm oil and blended oil at 4 h of frying

Variety of oil	Saturated fatty acids	4 h	
Refined Palm Oil	C14:0	1.32	48.38± 1.14
	C16:0	43.09	
	C18:0	3.97	
	Monounsaturated fatty acids	4 h	
	C18:1	43.97	43.97± 0.86
	Polyunsaturated fatty acids	4 h	
	C18:2	7.65	7.65± 0.17
Blended Oil	Saturated fatty acids	4 h	
	C16:0	25.32	32.24 ±1.65
	C18:0	2.94	
	C20:0	3.98	
	Monounsaturated fatty acids	4 h	
	C18:1	23.89	23.89 ±0.79
	Polyunsaturated fatty acids	4 h	
	C18:2	43.87	43.87 ± 1.74

Values are Mean ± S.D

Table 7 (D): Fatty acid composition (% w/w) of refined palm oil and blended oil at 6 h of frying

Variety of oil	Saturated fatty acids	6 h	
Refined Palm Oil	C14:0	1.57	49.49±1.81
	C16:0	43.78	
	C18:0	4.14	
	Monounsaturated fatty acids	6 h	
	C18:1	44.68	44.68± 0.97
	Polyunsaturated fatty acids	6 h	
	C18:2	5.83	5.83± 0.21
Blended Oil	Saturated fatty acids	6 h	
	C16:0	25.69	33.13 ±1.22
	C18:0	3.12	
	C20:0	4.32	
	Monounsaturated fatty acids	6 h	
	C18:1	24.25	24.25 ±1.42
	Polyunsaturated fatty acids	6 h	
	C18:2	42.62	42.62 ± 1.64

Values are Mean ± S.D

5. Conclusion

This study demonstrates the potential of akashmoni seed oil (*Acacia auriculiformis*) as a viable alternative oil source. Rich in polyunsaturated fatty acids (PUFAs) and low in saturated fatty acids (SAFAs), akashmoni oil contributes significantly to nutritional improvement. By blending it with refined palm oil, which is rich in SAFAs, a 1:1 mixture was created to achieve an improved fatty acid balance from a dietary perspective.

The frying study confirmed that the blended oil performed satisfactorily, maintaining its oxidative stability and nutritional integrity during high-temperature frying. The combination of akashmoni oil and palm oil optimizes both health benefits and functional properties.

Thus, the study concludes that the blended oil exhibits promising potential for use in cooking, offering a healthier and functional alternative to standalone oils. Further exploration and commercialization could expand its application in the culinary and food processing industries.

6. References

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