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Compendium on Phisicochemical Analysis of Different Marketed Preprations Of Musturd Oil

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ABSTRACT

Mustard oil, a staple in Indian cuisine, is extracted from Brassica campestral seeds using mechanical pressing, prized for its unique flavor and health benefits. Rich in linoleic acid and essential fatty acids, it boasts anti-inflammatory properties and aids in digestive health, often utilized in traditional remedies for arthritis and muscle strains. This study assessed three mustard oil brands by analyzing their physicochemical properties including specific gravity (SG), refractive index (RI), saponification value (SV), iodine value (IV), peroxide value (PV), acid value (AV), and ester value (EV). Following AOAC (Association of Official Analytical Chemists) and IS (Indian Standard) 548 procedures, the experimental results obtain that SG lies between 0.871-0.922, RI:1.464 -1.465, SV:169.88-150.33mg/KOH/g, IV:9-51-7.72gms, PV:7.32- 4.44MeqO2/Kg, AV: 7-3.94mgKOH/gm, EV: 165.94-143.52mg/KOH/g acceptable ranges, affirming the oils' quality. Among the brands, Fortune oil exhibited superior quality, deemed suitable for both culinary and health purposes. Conversely, Gagan oil demonstrated lower usability. Rancidity, indicative of fat or oil deterioration, was not observed in any of the oils, ensuring pleasant odor and flavor in foods. Overall, this analysis underscores the importance of evaluating mustard oil's compositional quality, with Fortune oil emerging as a preferred choice for cooking and health benefits.

KEY WORDS: Mustard Oil, Iodine Value, Saponification Value, Peroxide Value, Acid Value, Ester value

INTRODUCTION

India stands as a significant player in the global edible oil industry, ranking as the largest importer and third-largest user of edible oil worldwide. With substantial shares in oil meal production, export, import, and consumption, India's presence in the global vegetable oil landscape is undeniable. The Indian vegetable oil economy emerges as a formidable player on the global stage, holding the prestigious position of the world’s fourth largest. This highlights the need for comprehensive research to ensure the quality, safety, and sustainability of this essential dietary component [1,2].

India's dominance in the global edible oil industry underscores the importance of ensuring the quality, safety, and sustainability of this essential dietary component. With substantial shares in production, export, import, and consumption, India's vegetable oil economy plays a pivotal role on the global stage. Mustard oil, a versatile ingredient in Indian cuisine, is extracted through mechanical pressing and distillation, offering both stability and

aromatic qualities. Its widespread use in cooking and beyond highlights its significance in the culinary landscape of the region [3].

Mustard oil offers various health benefits, including its role in digestion and body temperature regulation due to linoleic acid content. It contains phytonutrients like glucosinolate, which exhibit antibiotic, fungicidal, and anti-carcinogenic properties, reducing the risk of colorectal and gastrointestinal cancers [4]. With antibacterial and antifungal qualities, mustard oil aids in treating skin diseases and internal organ infections. Its composition aligns with the body's requirements, featuring less than 7% saturated fat and substantial amounts of monounsaturated and polyunsaturated fatty acids, strengthening the immune system and improving metabolic processes [5,6]. Additionally, mustard oil is rich in anti-inflammatory antioxidants, lowering the risk of major illnesses such as cancer and heart disease [7,8]. Studies suggest that avoiding trans fats, prevalent in mustard oil, can reduce the risk of diabetes, asthma, and allergies in children, making it a favorable choice for preventing skin diseases [9,10,11].

Mustard oil is commonly used in cooking and seasoning due to its nutritional richness and high tolerance for high temperatures. Its lack of trans-fatty acids and minimal saturated fatty acids make it healthier than olive oil, serving as an excellent source of omega-3 and omega-6 fatty acids [12,13]. Moreover, mustard oil's vitamin E content acts as a natural preservative, inhibiting fungal growth and maintaining the freshness of pickles and canned vegetables [14].

LITERATURE REVIEW

Research indicated that vegetable oils were prone to oxidation when exposed to high temperatures. To mitigate this oxidation and preserve the quality of vegetable oils, it was essential to incorporate antioxidants such as vitamin E. Antioxidants like vitamin E effectively slowed down the oxidation process in vegetable oils, thereby extending their shelf life. By including antioxidants, vegetable oils could maintain their quality for longer durations, ensuring their suitability for culinary and nutritional purposes. Overall, the incorporation of antioxidants like vitamin E was crucial for enhancing the stability and preserving the quality of vegetable oils [15].

The ultrasonic method was highly reliable for analyzing the physicochemical properties of edible mustard oil. It offered dependable results and accuracy in assessing various parameters, ensuring quality control and compliance with industry standards. Ultrasonic devices were widely used not only in the food industry but also in medical fields, particularly in imaging technologies like ultrasound scans. Their versatility made them indispensable tools for non-destructive testing and analysis, facilitating rapid and efficient evaluation of edible oils and other substances [16].

The study findings suggested that the health benefits of mustard oil diminished with repeated heating. Specifically, heating mustard oil to its boiling point led to the formation of secondary oxidized products. This phenomenon underscored the importance of monitoring cooking practices involving mustard oil, as repeated heating could lead to the deterioration of its health-protective properties [17].

MATERIALS AND METHOD

Sample collection: The three samples (sample 1, sample 2, sample 3) of mustard oil were procured from local market of Kharar, Mohali, Punjab.

Table 1: Name and type of mustard oil

Name of the sample oil	Manufacture company	Manufactured date	Date of expiry
1. Premium kachi Ghani pure mustard oil (Pkgpmo)	Fortune	16/11/2023	15/11/2024
2. Kachi Ghani mustard oil (Kgmo)	Dalda	23/07/2023	22/07/2024
3. Active kachi Ghani mustard oil (Akgmo)	Gagan	24/10/2023	23/10/2024

Determination of Specific gravity:

A specific gravity bottle was used to measure the density of the oil sample. The process involved cleaning and drying the pycnometer, weighing it, and then filling it with water at 20°C to determine the weight of the water. After emptying and drying the pycnometer again, it was filled with the oil sample and weighed. The specific gravity of the oil sample was calculated by dividing the weight of the oil by the weight of an equal volume of water at 20°C.

$$\mathrm{SG} = \frac{\text{weight of oil}}{\text{weight of water}}$$

Determination of Refractive index:

In accordance with the IS 548 standard (2015a), the Abbe refractometer was calibrated using distilled water. The cover of the prism assembly was opened, and the prism surfaces were cleaned with a soft cloth. A few drops of distilled water were placed on the prism, and the cover was closed gently. The calibration dial was adjusted until the crosshairs intersected exactly at the boundary between the water and air. Samples were prepared following standard guidelines, ensuring cleanliness, absence of bubbles, and appropriate temperature. The cover of the prism assembly was opened again, and the prism surfaces were cleaned. A small drop of the sample was placed on the prism surface, covering the entire area. The cover was closed gently. Adjustments were made by looking through the eyepiece until the boundary between the sample and air was sharp and well-defined. The adjustment knobs were used for this purpose, making small adjustments until the boundary was clear. Once the boundary was sharp, the refractive index value was read directly from the scale on the refractometer, ensuring accuracy. After measurement, the prism surfaces were thoroughly cleaned with distilled water and dried with a soft cloth to prevent contamination [18].

Determination of Saponification value:

A 4% ethanolic potassium hydroxide solution was prepared by dissolving 1.67 grams of potassium hydroxide pellets and 1 gram of aluminum foil in 200 ml of absolute ethanol. Then, 6 grams of potassium hydroxide pellets were dissolved in 150 ml of the 4% ethanolic potassium hydroxide solution. A 0.5 normal hydrochloric acid solution was made by diluting 4.1 ml of concentrated hydrochloric acid with distilled water to 100 ml. Phenolphthalein indicator solution was made by dissolving 2 grams of phenolphthalein powder in 100 ml of ethanol. For sample preparation, approximately 5 grams of oil or fat sample were weighed into a 250 ml flask, and 50 ml of the 4% ethanolic potassium hydroxide solution was added. Saponification involved heating the sample flask for 30 minutes, checking for oil separation, then repeating if necessary. Titration followed, using phenolphthalein indicator and 0.5 normal hydrochloric acid solution to determine acidity, with the blank flask undergoing the same process as the sample. The saponification value was determined using the provided equation:

$$SV = \frac{(Vs - Vb) \times 1000 \times 28.05}{Ws}$$

Where Vs is the volume (in ml) of 0.5 N hydrochloric acid solution, Vb is the volume (in ml) used for the blank titration. Ws is the weight (in grams) of the oil or fat sample [19].

Determination of Iodine value:

The solution preparation involved dissolving 0.5 grams of starch in 50 ml of boiling water, filtering to obtain a clear filtrate. Simultaneously, 2.5 grams of sodium thiosulfate crystals were dissolved in 80 mL of distilled water, cooled, and diluted to 100 ml to prepare a 0.1 N sodium thiosulfate solution. Sample preparation included measuring 3 grams of the oil sample in a flask with 25 ml of glacial acetic acid. A blank flask was prepared similarly without adding the sample. To both, 25 ml of Wijs solution was added, and the flasks were capped and incubated for 30 minutes in the dark. Afterward, 100 ml of distilled water was added to the sample flask, followed by 1 ml of starch indicator solution. Sodium thiosulfate solution was then added until a faint yellow color appeared. The volume used was recorded, and the same procedure was repeated for the blank flask. The (IV) of sample was determined by following equation:

$$IV = \frac{(B - S) \times N \times 12.69}{Ws}$$

where B represents the volume (in m) of Na_2SO_4 used in the blank, S denotes the volume (in ml) of Na_2SO_4 used for the sample, N is the normality of the Na_2SO_4, Ws indicates the weight of the sample in grams [20].

Determination of Peroxide value:

An acetic acid-chloroform mixture was prepared by combining 90 ml of concentrated acetic acid with 60 ml of chloroform. A 1% starch solution was made by dissolving 0.5 grams of soluble starch in 50 ml of boiling distilled water. For the 0.1 N sodium thiosulfate solution, 0.25 grams of sodium thiosulfate crystals were dissolved in 80 ml of distilled water, then cooled and diluted to a final volume of 100 ml. Sample preparation involved adding 10 grams

of the oil sample to an Erlenmeyer flask, followed by the addition of 30 ml of the acetic acid-chloroform mixture. After shaking, 1 ml of saturated potassium iodide solution was added, and the flask was rotated for one minute. Then, 30 ml of distilled water were added and shaken for another minute. In the titration, 0.01 N sodium thiosulfate solution was gradually added until the solution turned white, and the volume used was determined by the difference in burette readings. It can be calculated by following equation:

$$PV = \frac{V \times N \times 1000}{Ws}$$

where V stands for volume of Na_2SO_4, N for normality, and Ws is weight of sample grams [21].

Determination of Acid value:

A phenolphthalein indicator solution was prepared by dissolving 2 grams of phenolphthalein powder in 100 ml of ethanol. Then, 4 grams of sodium hydroxide pellets were dissolved in 900 ml of distilled water to make a 0.1 N sodium hydroxide solution. Sample preparation involved taking 10 grams of oil sample and 50 ml of 99% ethanol in separate conical flasks. Phenolphthalein indicator solution was added to the ethanol, which was then neutralized by 0.1 N sodium hydroxide. The neutralized ethanol was combined with the oil sample and heated until the sample dissolved completely. Titration was performed using 0.1 N sodium hydroxide, with phenolphthalein indicator added to the solution in the conical flask. The titration was stopped when the solution turned light pink, and the final burette reading was recorded. AV can be calculated by following equation:

$$AV = \frac{V \times N \times \text{Mol. wt.of NAOH}}{Ws}$$

Where V is the volume of NaOH solution, N is the normality of NaOH and Ws is the weight of the sample [22].

Determination of Ester value:

The ester value represents the amount of potassium hydroxide (KOH) needed to react with the glycerol or glycerin produced from 1 gram of oil sample after saponification.

Ester Value = Saponification Value (SV) – Acid Value (AV) [19,22].

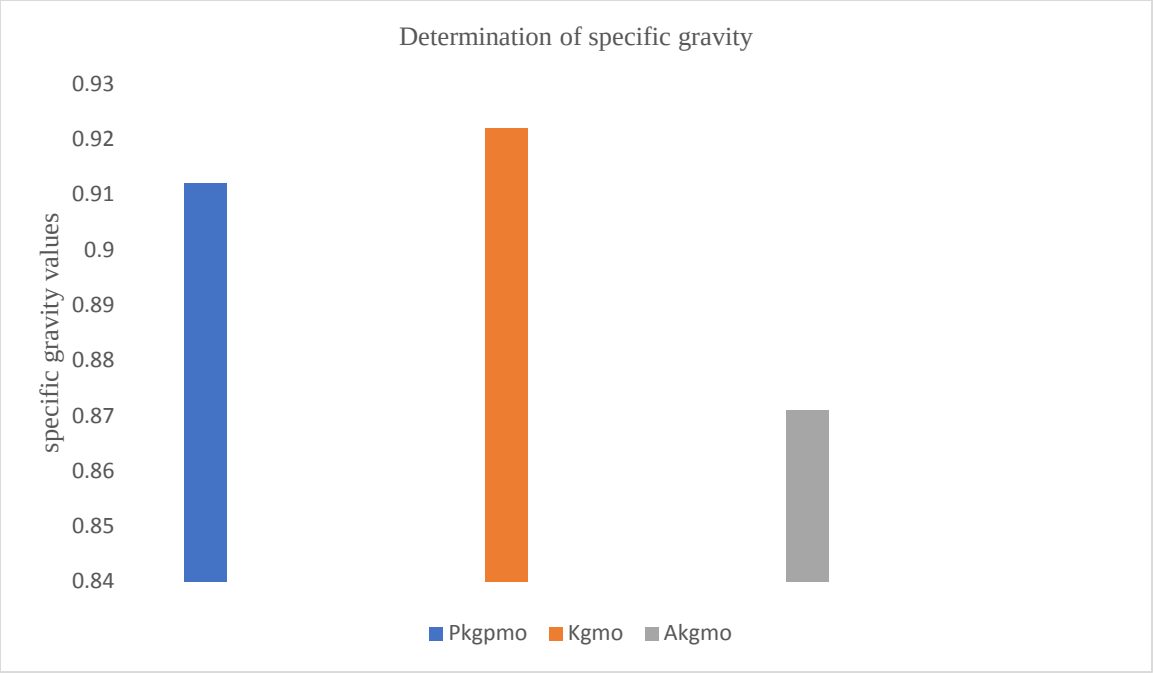
RESULT AND DISCUSSIONS

Specific gravity:

Table 2: Determination of specific gravity

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading	Codex 2015
Pkgpmo	0.969	0.879	0.890	0.912	0.899-0.920
Kgmo	0.896	0.894	0.978	0.922	
Akgmo	0.859	0.895	0.860	0.871	

Specific gravity is a unit used to compare the density of a substance to that of water at a particular temperature. It is a crucial parameter for mustard oils, helping to identify them based on their unique densities. Edible oils have distinct specific gravities, which aid in their characterization and differentiation. From the above table, it was clearly noticeable that the specific gravity fell in the range between 0.912-0.871. Akgmo did not match with the CODEX-2015 standards.

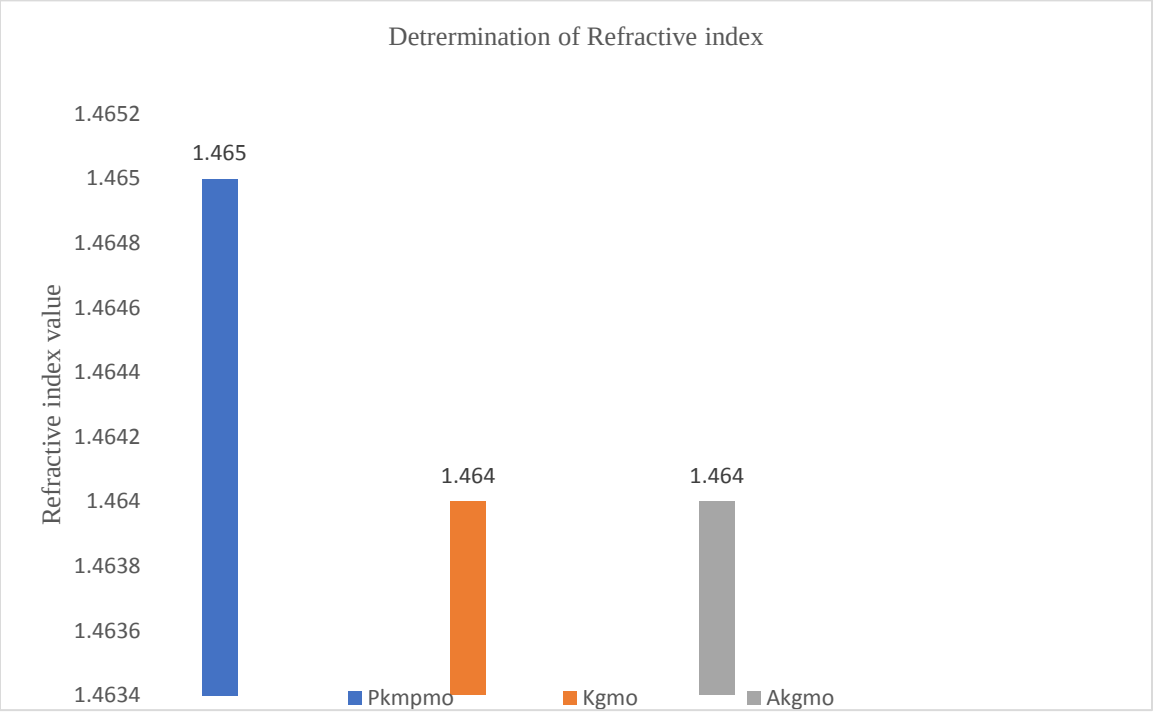


Refractive index:

Table 3: Determination of Refractive index

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading	CODEX 2015
Pkgpmo	1.467	1.465	1.464	1.465	1.461- 1.469
Kgmo	1.460	1.469	1.463	1.464	
Akgmo	1.470	1.461	1.462	1.464	

The refractive index readings for all three sample brands of mustard oil (1.465, 1.464, and 1.464) are within the expected range for mustard oil (1.461 - 1.469 at 20°C) according to CODEX 2015.

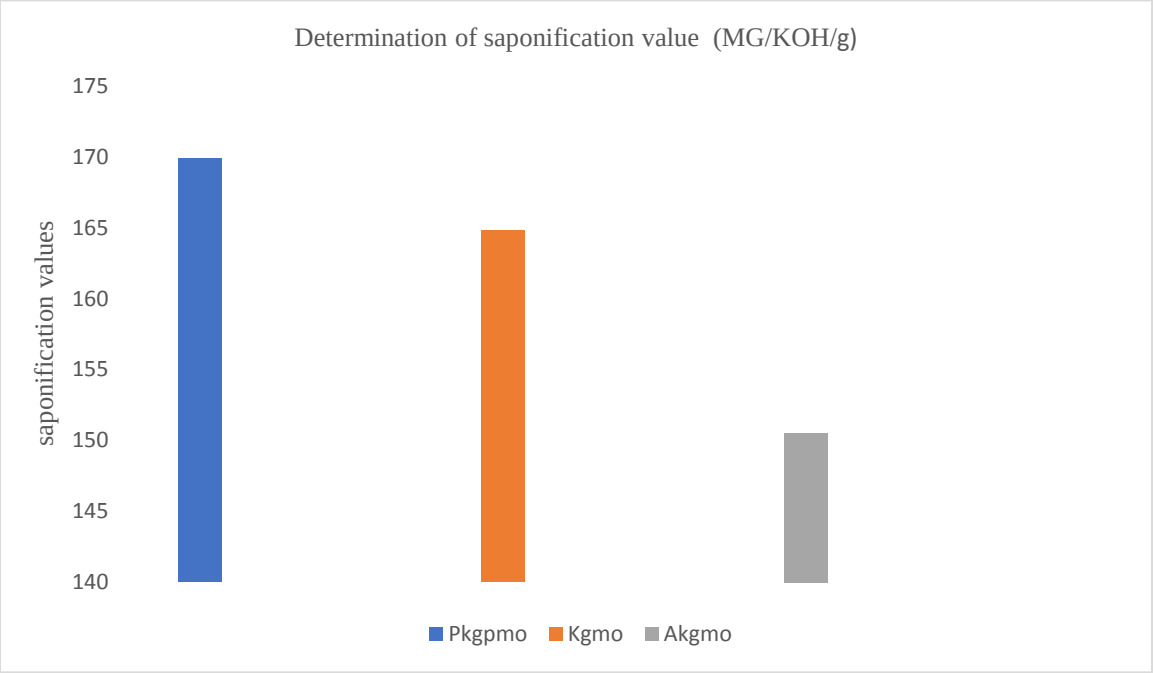


Saponification value:

Table 4: Determination of saponification value

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading	CODEX-2015
Pkgpmo	169.42	170.54	169.70	169.88	168-184 mg/KOH/g
Kgmo	162.12	162.69	161.56	164.79	
Akgmo	151.47	149.22	150.90	150.53	

The saponification values of the three mustard oil brands were analyzed to assess their fatty acid profiles. Pkgpmo and Kgmo exhibited saponification values within the typical range for mustard oil, indicating a predominance of shorter to medium-chain fatty acids, as expected. However, Akgmo showed a lower saponification value, suggesting a higher proportion of longer-chain fatty acids in its triglycerides. This deviation may stem from differences in processing or composition, potentially impacting the oil's properties and suitability for various applications. Notably, Pkgpmo demonstrated the highest saponification value among the samples, while Akgmo exhibited the lowest.

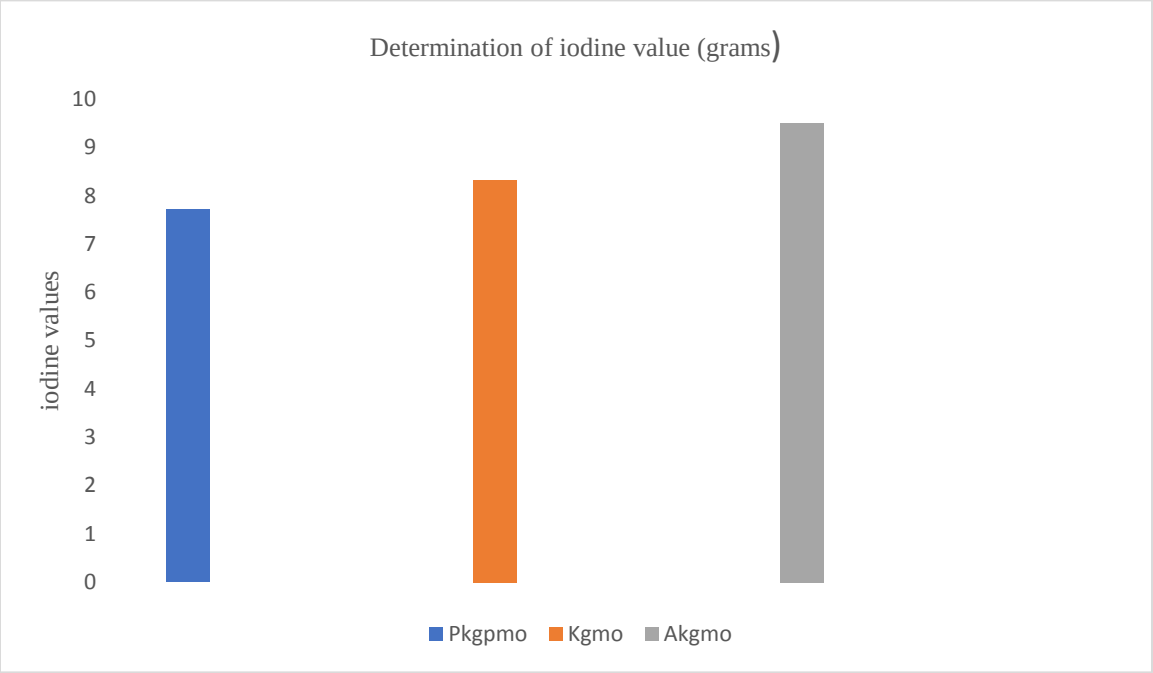


Iodine value:

Table 5: Determination of iodine value

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading
Pkgpmo	7.80	7.71	7.67	7.72
Kgmo	8.20	8.44	8.37	8.33
Akgmo	9.60	9.34	9.60	9.51

A lower iodine value indicates that the oil contains fewer unsaturated bonds, which makes it less prone to oxidation and rancidity. Based on the data provided in the table, Iodine value ranges between 9.51-7.72 and it is evident that Pkgpmo exhibits a lower iodine value compared to Akgmo, which has the highest iodine value among the samples.

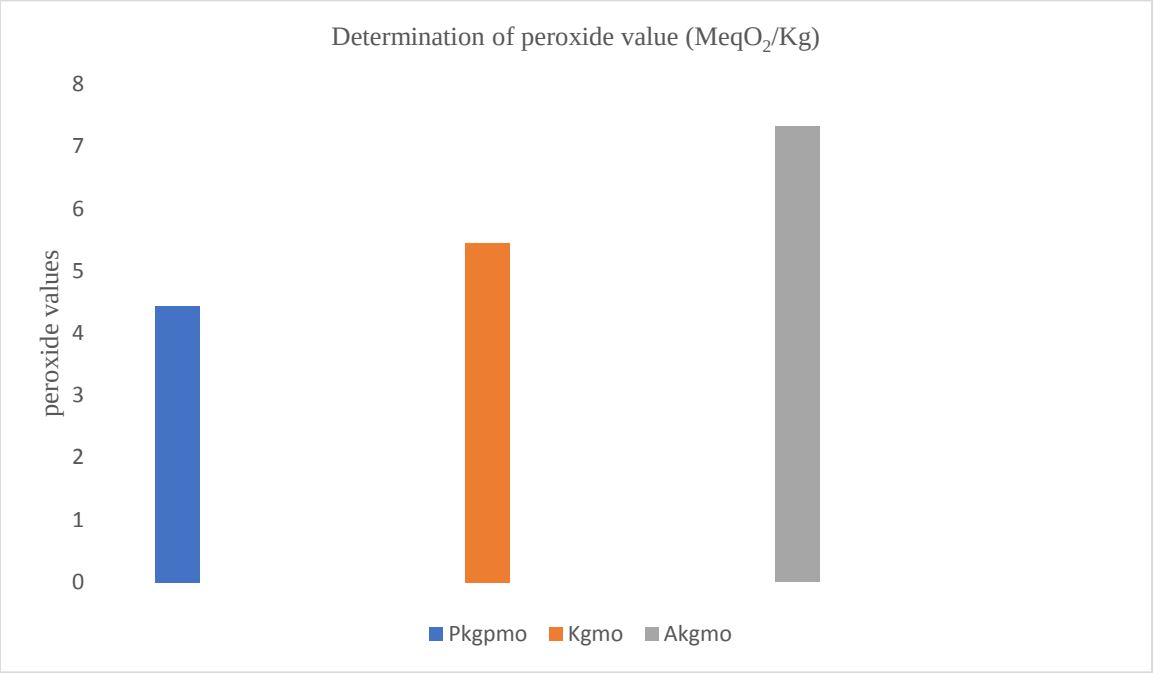


Peroxide value:

Table 6: Determination of peroxide value

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading	CODEX 2015
Pkgpmo	4.41	4.33	4.58	4.44	1-10 MeqO2/Kg
Kgmo	5.47	5.37	5.51	5.45	
Akgmo	7.35	7.29	7.32	7.32	

The peroxide values of the three mustard oil brands were evaluated based on the CODEX 2015 standards, which stipulate a maximum permissible level of 10 milli equivalents of oxygen per kilogram of oil. Pkgpmo exhibited the lowest peroxide value, indicating a fresher oil with minimal oxidation and high quality. Kgmo had a slightly higher peroxide value but still fell within an acceptable range for mustard oil, suggesting a slightly lower level of freshness compared to Brand 1. However, Akgmo showed the highest peroxide value, signaling a significantly higher level of oxidation and potentially lower quality or freshness. Therefore, Akgmo may raise concerns regarding its suitability for consumption.

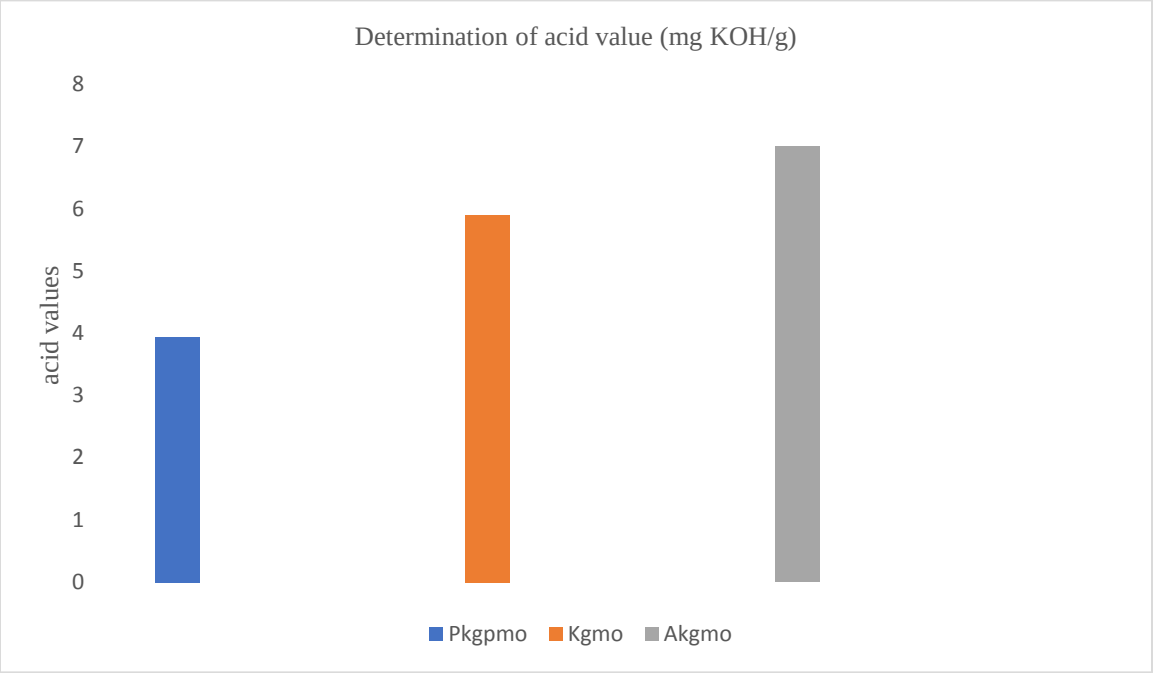


Acid value:

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading	CODEX 2015
Pkgpmo	3.90	3.96	3.98	3.94	0.6-5.0 mg KOH/g
Kgmo	5.88	5.90	5.94	5.90	
Akgmo	7.00	7.03	6.98	7.00	

Table 7: Determination of acid value

The acid values of the three brands of oil were assessed against industry standards and CODEX 2015 standards, which dictate a maximum acceptable level of free fatty acids. Pkgpmo demonstrated an acid value within the acceptable range, indicative of low free fatty acid content and high-quality oil. Kgmo, although still within the range, approached the upper limit, implying slightly higher free fatty acids and potentially reduced quality or older oil. Conversely, Brand 3 surpassed the recommended upper limit, signaling significantly elevated free fatty acids and potential quality concerns such as aging, improper processing, or exposure to unfavorable conditions like heat or light. Therefore, Brand 3 may raise concerns regarding its overall quality and suitability for use.

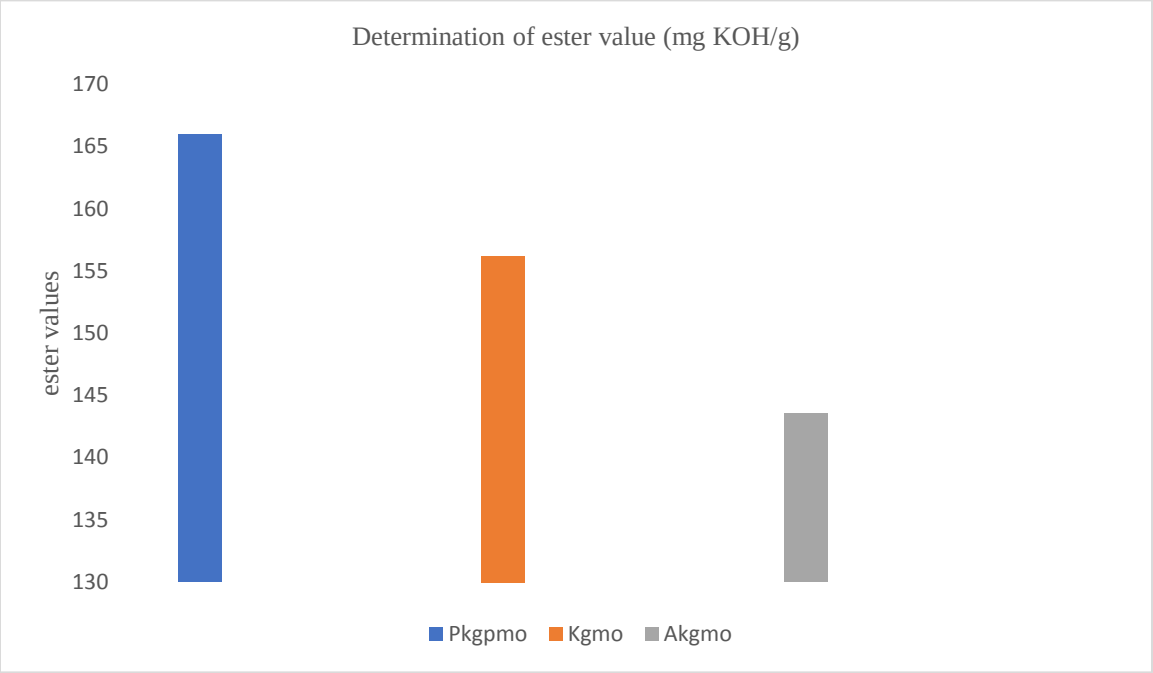


Ester value:

Table 8: Determination of ester value

Name of the sample	Reading 1	Reading 2	Reading 3	Mean reading
Pkgpmo	165.52	166.58	165.72	165.94
Kgmo	156.24	156.79	155.62	156.21
Akgmo	144.47	142.19	143.92	143.52

The ester values of the three brands of oil were evaluated, providing insights into their triglyceride content and potential freshness. Pkgpmo exhibited the highest ester value, suggestive of ample triglycerides and possibly fresher oil. However, the reason behind Kgmo lower ester value remains unclear. In contrast, Akgmo demonstrated the lowest ester value, hinting at either reduced triglycerides or elevated free fatty acids, although this could not be definitively concluded. Overall, ester values serve as indicators of oil freshness and triglyceride breakdown, with Pkgpmo potentially boasting higher quality due to its higher ester value.



Name of the sample	Specific gravity	Refractive index	Saponification value	Iodine value	Peroxide value	Acid value	Ester value
Pkgpmo	0.912	1.465	169.88	7.72	4.44	3.94	165.94
Kgmo	0.922	1.464	164.79	8.33	5.45	5.90	156.21
Akgmo	0.871	1.464	150.53	9.51	7.32	7.00	143.52

Table 9: Measured physicochemical parameters of different mustard oil samples

CONCLUSION

In the present study various physicochemical characteristics (specific gravity, refractive index saponification value, iodine value, peroxide value, acid value, ester value) have been studied and may be used for quality control of the different brand of mustard oil sample. The measurement of the mentioned physicochemical characteristics indicate that Fortune oil has better properties as compared to other oils.

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