

Assessment of Saponification, Acid, Peroxide, and Iodine Values by Physicochemical Analysis of Reused Cooking Oil

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ABSTRACT

This study examines the deterioration of frying oils utilised in local food enterprises by analysing essential quality indicators. Oil samples, obtained after extended frying of typical food items like samosas, Manchurian, chicken, medu vada, jalebi, and momos for durations of 8 to 9 hours, were analysed. Palm and vegetable oils were evaluated for acid value, saponification value, peroxide value, and iodine value utilising standard titrimetric methods. Acid-base titration techniques were employed to determine acid, peroxide, and saponification levels, whereas iodometric titration was utilised for assessing iodine value. The comparative analysis underscores the chemical alterations in reused oils, stressing the importance of consistent monitoring to guarantee safety and appropriateness for ongoing usage in food preparation.

Keywords: Acid value, Saponification Value, Titrimetric Analysis, Used frying oil.

INTRODUCTION

The continual utilisation of frying oil results in chemical deterioration by hydrolysis, oxidation, and polymerisation, yielding detrimental substances like free fatty acids, peroxides, and polymerised triglycerides. These alterations adversely impact oil quality and present possible health hazards, including gastrointestinal discomfort and chronic toxicity. Oil quality is evaluated by analysing critical characteristics like acid value, peroxide value, saponification

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value, and iodine value. The acid value indicates the degree of hydrolysis, signifying the generation of free fatty acids. The peroxide value quantifies primary oxidation products, whereas the saponification value reflects the average molecular weight of fatty acids. The iodine value measures the degree of unsaturation in the oil. This study assesses utilised frying oils obtained from local vendors following 8–9 hours of frying samosas, Manchurian, medu vada, jalebi, and momos [1]. Titrimetric methods were utilised to ascertain these characteristics, with the objective of evaluating oil quality and emphasising the necessity of regular monitoring for the safe reutilization of oil in culinary applications. Sample Acquisition Oil samples utilised for frying several food items were obtained from numerous local food outlets in Chinchpokli [2]. The oil for Medu Vada was procured from a local eatery, but the oil for Samosa was acquired from Maharashtra Farsan Mart, also situated in Chinchpokli. Further oil samples, encompassing those utilised for Manchurian, fried chicken, and Chinese dishes, were gathered from multiple stalls in Chinchpokli [3]. The Jalebi oil was sourced from Siddhivinayak Sweet Shop, while the oil utilised for momos was acquired from a vendor in Lalbaug. The samples were chosen to assess the chemical properties of oils frequently utilised in the preparation of popular street dishes in the area .

RESEARCH ELABORATIONS

Standardisation of Alcoholic KOH: 1. Ten cubic centimetres of 0.5N succinic acid was transferred into a clean conical flask. Succinic acid was titrated with 1N alcoholic KOH from the burette, employing phenolphthalein as an indicator. The ending was identified by a colour transition from colourless to pink. The precise normality of the provided alcoholic KOH was determined and expressed as ('A' N). Standardisation of HCl: 1. 25 cm³ of roughly 0.1 N HCl was transferred into a clean conical flask using a pipette. The titration was conducted using standardised alcoholic KOH from the burette, with phenolphthalein serving as the indicator. The endpoint was indicated by a transition from colourless to pink. The precise normality of the provided HCl was determined and designated as ('B' N). Empty In the titration process, 25 cm³ of the standardised alcoholic KOH solution was transferred into a 250 cm³ volumetric flask. The solution was diluted to the specified volume with distilled water. 25 cm³ of the diluted alcoholic KOH solution was transferred into a clean conical flask, and several drops of

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phenolphthalein were introduced as an indicator. The solution was titrated with the standardised HCl ('B' N) from the burette. The endpoint was indicated by a colour transition from pink to colourless, and the volume of HCl utilised in the blank titration was documented as 'C' cm.

A volume of 10-15 cm³ of the oil sample solution was transferred into a clean round-bottom flask. 25 cm³ of the standardised alcoholic potassium hydroxide was introduced into the round-bottom flask. A few exquisite porcelain pieces were incorporated, and a reflux condenser was affixed to the round-bottom flask. The mixture was refluxed in a boiling water bath for about one hour. Subsequent to refluxing, the contents of the round-bottom flask were chilled and quantitatively transferred to a 250 cm³ volumetric flask. The RB flask was rinsed with distilled water, and the washings were gathered into the identical standard flask. The contents were diluted to 250 cm³ using distilled water. 25 cm³ of the diluted refluxed solution was transferred into a clean conical flask, and several drops of phenolphthalein were introduced. The solution was titrated using the standardised HCl ('B' N) from the burette. The terminus was signified by a transition from pink to colourless. The volume of HCl utilised in the titration estimation was documented as 'D' cm³. Conclusive Computation: The volumes of NaOH utilised in the blank titration ('C' cm³) and the estimation titration ('D' cm³) were documented. The disparity between these two volumes (D – C) was employed to compute the saponification value of the oil sample utilising the subsequent formula: Saponification Value = $[(D - C) \times N \times 56.1] / W$ Where D represents the volume of NaOH utilised in the estimating titration (in cm³), C denotes the volume of NaOH employed in the blank titration (in cm³), N signifies the normality of NaOH (0.1 N), 56.1 indicates the molecular weight of KOH in g/mol, and W refers to the weight of the oil sample (10 g). The saponification values for several oil samples were compiled and analysed for comparison.

Standardisation of NaOH: 10 cm³ of 0.1 N succinic acid was transferred into a 150 cm³ conical flask. The solution was subsequently titrated with the provided 0.1 N NaOH solution, utilising phenolphthalein as an indicator, with the endpoint signalled by a faint pink hue. The precise normality of the provided NaOH was subsequently determined. Preparation of Samples: Ten grammes of an oil sample were measured and placed in a 150 cm³ conical flask. Subsequently, 50 cm³ of ethanol was incorporated, accompanied by several drops of phenolphthalein indicator, and the resultant liquid was agitated. The solution was titrated

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dropwise with 0.1 N NaOH until a pale pink hue was attained. The neutralised solution was thereafter put into the conical flask containing the oil sample. The mixture was heated until the oil was completely dissolved in the ethanol. The primary titration involved the addition of phenolphthalein indicator to the heated mixture of oil and ethanol. The solution was titrated using the standardised NaOH solution, with the endpoint indicated by a colour transition from colourless to pink. The volume of 0.1 N NaOH utilised in the titration ('V' cm³) was documented for each oil sample. The acid value was subsequently computed via the formula: Acid value = (Molecular weight × Normality × Volume) / Weight Location: • Mw = Molecular weight of sodium hydroxide (NaOH) • N = Normality of the sodium hydroxide solution (NaOH) • V = Volume of NaOH utilised (burette measurement) • W = Weight of the oil specimen (in grammes) This calculation yielded the acid value, signifying the quantity of free fatty acids in the oil sample.

Table 1. Acid Value

SR. NO.	OIL SAMPLES	ACID VALUE (mg KOH/g oil)
1	MEDU VADA	0.73
2	SAMOSA	1.12
3	MANCHURIAN	1.04
4	FRIED CHICKEN	0.85
5	CHINESE	1.15
6	JALEBI	1.01
7	MOMOS	0.92

A volume of 10 cm³ of standard 0.1 N potassium dichromate solution was transferred into a clean conical flask for the standardisation of sodium thiosulphate. Subsequently, 5 cm³ of strong hydrochloric acid and 10 cm³ of a 10% potassium iodide solution were incorporated. The resultant mixture was titrated using the provided sodium thiosulphate solution, utilising newly made starch solution as an indicator. The ending was identified by a colour transition from pale yellow to blue and ultimately to colourless. The precise normality of the provided sodium thiosulphate (Na₂S₂O₃) was subsequently determined. Approximately 10–12 g of the oil sample was precisely measured and transferred to an Erlenmeyer flask. A 30 cm³ volume of an acetic acid–chloroform mixture was introduced to the oil sample, and the mixture was

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agitated thoroughly. Thereafter, 1 cm³ of saturated potassium iodide (KI) solution was included and agitated for 1 minute to achieve uniformity. Subsequently, 30 cm³ of distilled water was included, and the mixture was agitated for an additional minute. Subsequently, 0.5 cm³ of 1% starch indicator was added, and the solution was titrated with 0.01 N standardised sodium thiosulphate. The titration proceeded until the dark hue entirely vanished, signifying the endpoint through a colour transition from black to white. Conclusive Computation: The peroxide value of the oil sample was determined using the formula: Peroxide Value (meq. O₂/kg) = (V × N × 1000) / W Location: • V = Volume (in cm³) of sodium thiosulphate utilised in the titration • N = Normality of sodium thiosulphate • W = Weight (in grammes) of the oil sample designated for analysis This formula was employed to ascertain the peroxide value, reflecting the degree of lipid peroxidation in the analysed oil sample.

Table 2: Peroxide Value

SR. NO.	OIL SAMPLES	PEROXIDE VALUE (meq. O ₂ /kg)
1	MEDU VADA	1.93
2	SAMOSA	3.38
3	MANCHURIAN	2.24
4	FRIED CHICKEN	2.41
5	CHINESE	3.27
6	JALEBI	1.58
7	MOMOS	2.15

Standardisation of Sodium Thiosulphate (Na₂S₂O₃): A 10 cm³ sample of standard 0.1N potassium dichromate solution was transferred into a conical flask. Five cubic centimetres of strong hydrochloric acid (HCl) and ten cubic centimetres of a 10% potassium iodide (KI) solution were added to the flask. The resultant mixture was titrated using a freshly made sodium thiosulphate (Na₂S₂O₃) solution, employing starch solution as an indicator. The titration endpoint was identified by a colour transition from pale yellow to blue, thereafter shifting to vivid green. Assessment of Oil Sample: A sample of oil weighing between 0.3 and 0.5 grammes was precisely measured and placed in a stoppered bottle. 2. Ten cubic centimetres of chloroform were added to the sample for dissolution. 25 cm³ of Wij's solution was transferred into the stopper vial containing the dissolved oil sample. The bottle was gently twisted to ensure

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complete mixing. The bottle was securely sealed and positioned in a dark environment for 30 minutes. 6. Following the incubation period, 10 cm³ of 10% KI and 100 cm³ of distilled water were introduced into the bottle. The solution was titrated using a standardised sodium thiosulphate (Na₂S₂O₃) solution, accompanied by vigorous agitation, and a freshly made starch solution served as the indicator. The terminus was noted as a transition in colour from pale yellow to blue and ultimately to vivid green. A blank titration was conducted under the same conditions, utilising distilled water instead of the oil sample, to control for any background influence in the titration process. Conclusive Computation: Iodine Value = ((S - B) × N × 12.69) / W Location: • S = Volume of sodium thiosulphate (Na₂S₂O₃) solution necessary for the sample (in mL) • B = Volume of sodium thiosulphate (Na₂S₂O₃) solution utilised in the blank titration (in mL) • N = Normality of the sodium thiosulphate (Na₂S₂O₃) solution (in N) • W = Weight of the oil specimen (in grammes) • 12.69 = A constant that translates the volume of reacted iodine into iodine value units (grammes of iodine per 100 grammes of oil) The formula was employed to ascertain the iodine value of oil samples, indicating the degree of unsaturation, specifically the number of double bonds present in an oil or fat sample.

Table 3: Iodine Value.

Sr. No.	OIL SAMPLES	IODINE VALUE
1	MEDU VADA	4.38
2	SAMOSA	8.27
3	MANCHURIAN	5.37
4	FRIED CHICKEN	4.56
5	CHINESE	8.35
6	JALEBI	6.37
7	MOMOS	5.65

RESULTS AND DISCUSSIONS

Table 4 Comprehensive Overview of Saponification, Acid, Peroxide, and Iodine Values

OIL SAMPLE	SAPONIFICATION VALUE	ACID VALUE	PEROXIDE VALUE	IDODINE VALU
MEDU VADA	83.47	0.73	1.93	4.38
SAMOSA	75.46	1.12	3.38	8.27
MANCHURIAN	79.82	1.04	2.24	5.37

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FRIED CHICKEN	80.81	0.85	2.41	4.56
CHINESE	77.52	1.15	3.27	8.35
JALEBI	80.77	1.01	1.58	6.37
MOMOS	83.08	0.92	2.15	5.65

This study assessed the quality of frying oils utilised in diverse food preparations by measuring their saponification value, acid value, peroxide value, and iodine value. The results demonstrate considerable discrepancies in oil quality metrics among various meal samples. The oils utilised for Chinese cuisine and samosas demonstrated elevated acid values (1.15 and 1.12) and peroxide values (3.27 and 3.38), indicating significant hydrolytic and oxidative deterioration. The increased iodine values in these samples indicate a greater level of unsaturation, rendering them more susceptible to oxidative rancidity upon repeated heating. Conversely, the oils utilised for Medu Vada had the greatest Saponification Value (83.47) alongside considerably lower Acid (0.73) and Peroxide (1.93) values, signifying generally fresh and stable oil with minimal degradation. The research highlights the necessity of consistent assessment of frying oil quality to avert the development of detrimental degradation byproducts and to guarantee food safety. This analysis underscores the necessity for stringent regulations for the reuse of frying oils, appropriate frying methodologies, and regular quality evaluations in both commercial and street food environments. Implementing these strategies would enhance food safety standards and promote superior public health results.

CONCLUSIONS

The study assessed the quality of frying oil across various food preparations, revealing notable discrepancies; oils utilised for Chinese cuisine and samosas exhibited considerable degradation, but the oil for medu vada remained comparatively fresh. The study underscores the imperative of consistent oversight and stringent regulations regarding the reuse of frying oils to guarantee food safety and enhance public health results. The complete analysis is available for your review.

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