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Quality Alterations in Fresh and Reheated Edible Oils: A Comparative Assessment Across Bagmati Province, Nepal

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Abstract

The purpose of this study was to assess the qualitative and physicochemical properties of fresh, packaged, and reheated mustard oil samples collected from various locations in Bagmati Province, Nepal, to evaluate the impact of repeated heating and commercialization on oil quality.Six oil samples, including pure mustard oil (Brassica juncea), commercially packaged oils, and oils repeatedly heated in households and food shops, were analyzed. Standard methods from the Association of Official Analytical Chemists (AOAC) and the American Oil Chemists' Society (AOCS) were used to measure acid value (AV), peroxide value (PV), saponification value (SV), ester value (EV), free fatty acid content (FFA%), and totox value (TV).The pure mustard oil sample closely matched standard quality values, while commercial and reheated oils exhibited elevated AV, PV, and TV, indicating oxidative and hydrolytic degradation. SV and EV decreased with repeated heating. The most deteriorated sample, collected from a doughnut shop, had the highest acid and peroxide values. These results highlight public health risks associated with adulterated and repeatedly heated oils, emphasizing the need for stricter regulatory oversight and increased consumer awareness.

Keywords: Mustard Oil, Acid value, Peroxide value, Saponification value, reheat

Introduction

An inevitable part of our diet is edible oil. There is no any confusion from this line. In daily diet consumption basis intake of edible oil is mandatory edible oil provides

energy, essential fatty acids and carriers of different fat-soluble vitamins which are A,D,E and K (Voon et al., 2024). Edible oils are responsible for growth as they provide linoleic and linolenic acids (Ojha et al., 2024).

Among the cooking oil, mustard oil is widely and most frequently used especially in southeastAsia. Mustard oil is generally produced from *Brassica nigra, Brassica juncea* seeds and *Brassica campestris seeds* (Sharma et al., 2024). The composition of Mustard oil suggests that it contains about 60% monosaturated fatty acids (42% erusic acids and 12% oleic acids),21% polyunsaturated fats (6% omega-3 alpha linoleic acids and 15% omega -6 linolenic acids),12% saturated fatty acids(Ojha et al., 2024). According to the United States Department of Agriculture USDA (2010) 100 grams of mustard oil contains 3699 KJ (or 884 kcal) of energy, 100.0 gm of total lipid/fat, 0.0 gm of carbohydrate, 0.0 gm of fibers and 0.0 gm of protein. Mostly inside Southeast Asia, mustard oil has been in a dietary consumption from very past generations. It is helpful for lowering the cost of diabetic patients suffering from co-morbid anxiety disorders (Devi et al., 2021). Mustard oil is good for heart as it contains a good amount of unsaturated fatty acids and lower amount of saturated fatty acids (Ojha et al., 2024). The glucosinolate present in the mustard oil uplifts its antibacterial, antifungal and anticarcinogenic properties (Voon et al., 2024).

Although mustard oil is considered as health toner in Nepal, it is totally banned for internal purposes (for cooking purposes) in the countries like Canada, USA. In its pure state too it has few health hazardious chemicals. Availabily of high level of Erucic acid (42%) is a matter to think about our health linking with the mustard oil. A study done on laboratory among animals in early 1970s(Poddar, 2022), Erucic acid have toxic effects on heart at high doses. Although no negative effects of any exposure to Erucic acid have been reported in humans, these types of studies led the governments of some countries to ban the oils with high level of Erucic acids. Studies done on mustard oil is conflicting. One found mustard oil had no protective effect on heart while other is just opposite which means mustard oil has protective effects on heart (Poddar, 2022).

This controversial mustard oil is again used by reheating it multiple times. In every house of Nepal, the oil left after using for certain purpose is reused for another purpose (cooking purpose). Oil isreused twice, thrice or more than that which is a blunder in our health. Increased viscocity and darkening in the colour are some of the physical changes which can alter the fatty acid composition of the cooking oil on repeated use. Oxidation,

hydrolysis and thermal polymerisation are the chemical reactions which occur after repeated heating (Nayak et al., 2015).Heating of oil means changing the components of pure oil into other compounds. During heating/frying of oil it takes oxygen from the atmosphere and releases carbon dioxide (CO_2), carbon monoxide (CO), aldehydes, ketones, alcohols, dimers, trimers, hydrocarbons, epoxides, volatile FFA_S and water (Sánchez-Muniz et al., 2007). The presence of these harmful chemicals is measured by various qualitative methods. Some of them are acid value, free fatty acid value, peroxide value, saponification value, totox value, ester value, glycerol percentage etc (AOAC, 1980).

Mustard oil's compositional integrity and thermal stability are of significant public health and analytical interest due to its widespread use as a major edible oil in Nepal. Frequent thermal exposure during home and commercial cooking processes can cause hydrolytic reactions, polymerization, and oxidative degradation, which can change the oil's physicochemical and qualitative properties in ways that are not desirable. Additionally, processing conditions and adulteration techniques can affect the quality of locally produced and packaged mustard oils. In this regard, the current study intends to conduct a comparative assessment of the physicochemical and qualitative characteristics of commercially available mustard oil in their reheated and fresh conditions for which the samples were gathered from various regions of Bagmati Province. The outcomes of this work are expected to provide a better understanding of the effect of reheating and market variation on oil quality, thereby contributing to the assessment of consumer safety and product authenticity.

Materials and Methods

Materials: Edible mustard oil of different brands were collected from markets of Kathmandu valley (sample B and sample C). Then some used oils of various shops around the valley such as doughnut shop (sample E), hotels (sample D) were collected. Also, sample A oil which was used two times to fry potatoes in the house (sample F). Pure mustard oil of *Brassica juncea* was collected from Kavre, the nearby district of Kathmandu (sample A). All chemicals used in this study were of analytical grade and used without further purification.

Determination of chemical properties:

Acid value (AV): AV was determined by Association of Official Analytical Chemists (AOAC, 1980).

Peroxide value (PV) : PV was determined by Association of Official Analytical Chemists (AOAC, 1980).

Saponification value (SV): AV was determined by protocol of American Oil Chemists' Society (AOCS, 2017).

Ester value (EV) determination: Ester value is directly determined without any process by differentiating acid value by saponification value (AOAC, 1980).

Totox value (TV) determination: Directly totox value was determined by the addition of acid value to two times of peroxide value (Wai et al., 2009).

PH value (PhV) determination: The sample oil was placed in a PH meter and respective PH was observed as indicated by the indicator.

Results and discussion

The physico- chemical tests such as acid value, FFA percentage, saponification value peroxide value, ester value and totox value of the samples of mustard oil collected were analyzed and presented on Table 1 and Table 2.

Table 1: Standard Physico-chemical properties of edible mustard seed oil

Parameters	**Standard values**
Acid values	< 6.0
Peroxide values	<15
Saponification values	168-184

(Source: FASSAI, 2017)

Table 2. Obtained physico-chemical properties of mustard seeds oil

Samples	Acid value (mgKOH/g)	Peroxide value (mgEQ/O_2kg)	Totox value	FFA%	SV	EV
A	0.89	2.8	6.49	0.44	166.1	165.2
B	4.04	6.2	16.44	2.02	161.6	157.5
C	5.1	8.6	22.3	2.55	157.1	151.9
D	6.11	7	20.11	3.05	148.1	141.9
E	13.07	17.8	48.62	6.53	98.74	85.67
F	6.9	15.8	38.5	3.04	121.2	114.3

During the survey, the fate of various oil samples found is represented in following pie-chart (**Figure 1**):

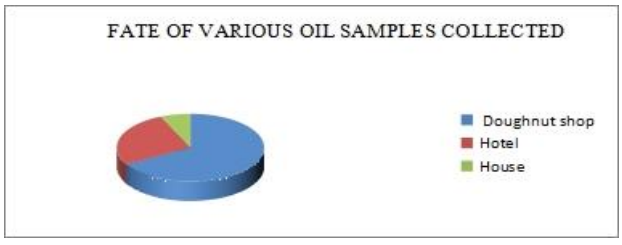

Figure 1: *Pie-chart showing oil samples (source: Field Survey, 2020)*

Doughnut shop (>15 times heated): Throwaway conditions.
Hotels (7/8 times heated): Give it to soap industries.
House (2 times heated): At least fresh oil can be added to it.

All the experiments performed above led to a common result. That is, when the oil was impure, the physico-chemical properties of oil vary differently according to the adulterants present and repeat use of the same oil. Acid value, FFA% and peroxide value of pure sample oil was found to be nearer to standard value. But both the properties showed an increment in their value when the quality of oil became poor. Sample-B was a bit good quality packaged oil than sample –C. But sample – A on repeated use for two times showed increment in acid value and FFA%. This data was very similar to the fact provided by Jinfeng (2011) where the acid value and FFA % increased by the effect of temperature on edible oil. There was a large deviation of value of sample – E and F for both the properties. Sample – E was of the most degraded quality of oil. This sample was collected from the local doughnut shop. This sample was reused unlimited times according to these experiments.In the experiments done to find saponification value, the results obtained were just opposite of above results. The more degraded oil the less value was obtained. Minimum SV was of sample – E and maximum of sample- A which was a pure oil sample.

Conclusion

The study clearly showed that the quality of mustard oil deteriorates with adulteration and repeated heating. Fresh pure oil maintained acid value, FFA%, and peroxide value close to standard levels, while these indicators increased in oils of lower quality, reflecting chemical degradation. Packaged oil (Sample-B) was of slightly better quality than Sample-C, whereas repeated use of fresh oil (Sample-A) caused moderate rises in acid value and FFA%. The most degraded sample (Sample-E), collected from a local doughnut shop and reused multiple times, exhibited the highest levels of acid and peroxide values. Conversely, saponification value decreased as the oil quality declined, being lowest in Sample-E and highest in pure oil. These findings emphasize that continuous reuse and poor-quality oils compromise safety and nutritional quality.

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