International Journal of Chemical Science
www.chemicaljournals.com
Online ISSN: 2523-2843, Print ISSN: 2523-6075
Received: 25-08-2022, Accepted: 12-09-2022, Published: 27-09-2022
Volume 6, Issue 2, 2022, Page No. 29-35

Study on the physicochemical properties of common edible oils available in the local market of different districts of Meghalaya

Wadamika Lyngdoh[1*], Lisha Brahamy N Sangma[2], Jackno Merry T Sangma[2]
[1] Department of Microbiology, State Food Testing Laboratory, Shillong, Meghalaya, India
[2] Technical Assistant, Department of Chemical Unit, The State Food Testing Laboratory, Shillong, Meghalaya, India

Abstract
Aims: Edible vegetable oils are prone to quality deterioration through oxidation and microbial degradation resulting in nutritional loss and off-flavours. Deterioration in oil quality may contribute to the formation of reactive and toxic post oxidation products, which ultimately pose health risks including cancer and inflammation. The aim of this study is the qualitative evaluation of the edible oils that are used for cooking purpose in Meghalaya.
Study design: This study was designed for selecting good quality edible oil among various edible oils available in the local market of Meghalaya.
Place and Duration of study: Different 12 brands of oil samples were purchased from local market of Shillong city of Meghalaya. The research was carried out at State Food Testing Laboratory, Chemical Department, Shillong, Meghalaya in the month of April-August.
Methodology: In this paper an attempt has been made to evaluate the physicochemical properties such as Moisture Content, Acid Value, Iodine value, saponification value, and Presence of Argemone Oil and Mineral oil of some available edible oils in Meghalaya using standard methods.
Results: In this study oils from different brand were investigated to determine the physicochemical properties like moisture content, acid value, free fatty acids, saponification value (SV), iodine value (IV). The moisture content observed is observed in between 0.03-1.35%. On the other hand, the highest and lowest saponification value was obtained from scooter rice bran oil (194.54 mg KOH/g) and Kissan mustard oil (174.93 mg KOH/g) respectively. It was observed that acid value is highest in refined rice bran oils (1.29 mg KOH/g). On contrary highest iodine value was observed in Teer refined soyabean oil (141.83 mg I_2/g).
Conclusion: The results will help us in selecting good quality edible oil.

Keywords: edible oils, physicochemical parameters, adulterations, rancidity

Introduction

Oils and fats are important parts of human diet and more than 90% of the world production from vegetable, animal and marine sources is used as food or as an ingredient in food products. Vegetable oils and fats are probably more valuable as food so they have been used in frying, salad dressing, shortening in pastry, ice-cream manufacture, etc., or for other edible purposes (B. Tesfaye., *et al* 2016) [1]. Oils are a rich source of dietary and contain more than twice the caloric value of equivalent amount of sugar. They contain polyunsaturated fatty acids (PUFA) and monounsaturated fatty acids (MUFA) which play an important role in nutrition and are also carriers of fat-soluble vitamins (Saini R.D.,2017) [14]. Some of the common vegetable oils available are sunflower oil, soybean oil, mustard oil, rice bran oil, etc. These vegetable oils are known to have numerous health benefits. They are the primary source of energy and carriers of essential nutrients which are vital for metabolic activities reducing risk of heart diseases. Mustard oil contains balanced ratio of mono-unsaturated and poly-unsaturated fatty acids having the least amount of saturated fatty acids which makes it safe for heart patients.

Due to high usage of edible oils at current era and wide range of applications in various industries (cosmetic, food, pharmaceutical, lubricants, medical characteristics, etc.) the consumer satisfaction on available oil is not up to the mark in terms of their texture and stability of food products. The competition between various brands to meet the consumer standards has led them to produce adulterated products. In the Indian subcontinent, the majority of cooking oil used is mustard oil, which is known to be adulterated with Argemone oil (Dr. N.B. Nath., 2019) [3]. In current analytical studies, the common adulterants found are Argemone oil, mineral oil, karanja oil and cyanide respectively (Pal A.D, *et al*., 2018) [12]. Different physical and chemical parameters of edible oils were used to monitor the compositional quality of oils. Physicochemical parameters like moisture content, acid

value, free fatty acids, iodine value, saponification value and adulterants which is used to assess the quality and functionality of oils (Okparanta S, *et al*., 2018) [10]. These quality parameters determine the quality and value of edible oils. Moisture content is the determining factor of the overall storage stability and quality as the presence of sufficient moisture content in oil enhances the rate of hydrolytic reactions. The main factor for the increased water content in oils is temperature. The quality and edibility of oil can be determined by the acid value as the value indicates the free fatty acid present in them. The higher the acid values, the lower the possibility of the oils to be used as cooking purpose. Also, free fatty acids are known to play important role in cell division and growth. They are the fundamental component of cell membranes, hormones, neurotransmitters etc. Increased intake of saturated fatty acids has been direct influence on human health (William Stillwell, 2016) [15]. Thus, it is recommended to have diets which are low in unsaturated fatty acid. The stability of oil is affected by degree of unsaturation which leads to appearance of degradation effect during storage. Hence, to measure this degree of unsaturation, iodine value determination is conducted. Saponification value provides the information of average chain length and molecular weight of the fatty acids in oil. It also indicates the deterioration of oils. The factors such as temperature, moisture, sunlight, soil fertility, nutrients and refining process also significantly affect the characteristics of edible oils (Ichu C.B. *et al*., 2019) [5]. It is possible to determine by different analytical techniques how to assess the quality of oil and to avoid possible adulteration. The estimation of physicochemical properties of edible oils is essential in design process and important factors that determines the overall quality and stability of a food system. Therefore, edible oils with a proved range of physic-chemical parameters (acid value, iodine value, saponification value, etc.,) would consider a good type of oil which is used for cooking purposes. The purpose of this study is to assess the quality of edible oils for public consumption in Comparison with FSSAI Food Safety & Standard Act 2006, Regulation 2011 and other literature values.

Material and Methods

1. Sample Collection

Different oil samples of 12 brands which are used for cooking purposes were purchased from local markets of different Districts of Meghalaya.

2. Chemicals and Reagents

Hydrochloric acid (HCl), Sodium hydroxide (NaOH), Potassium hydroxide (KOH), potassium iodide (KI), sodium thiosulphate ($Na_2S_2O_3$), Ethyl alcohol, Carbon tetrachloride, Iodine monochloride, Glacial acetic acid, Potassium iodide, Starch, Ferric chloride, Alkali blue indicator, Phenolphthalein indicator, Distilled water.

3. Reference Methods

The experiments were conducted following the standard analytical methods prescribed under FSSAI manual of methods of analysis of foods,

4. Moisture Content

Moisture content of oils and fats is the loss in mass of the sample on heating at 105° C under operating conditions specified.

5g of oil sample, which has been thoroughly mixed by stirring, has weighed in a previously dried and tared dish. Loosen the lid of the dish and heat, in an oven at 105^{O}C for 1 hr. After 1 hr it has removed from the oven, closed the lid, cooled in a desiccator containing phosphorus pentoxide or equivalent desiccant and weighed. Again, heat in an oven for another 1 hr, cooled and weighed. Repeated the process until change in weight between two successive observations does not exceed 1 mg.

$$\text{Moisture content} = \frac{W_1 \text{ x } 100}{W}$$

W_1 = Loss in weight (g) of the oil on drying
W = Weight in g of the oil sample taken for test.

5. Saponification Value

The saponification value is the indication of the mean molecular weight of the fatty acids of glycerides.

The Saponification value is determined by taking 1.5 g of oil sample which has been mixed thoroughly and filter through a filter paper in order to remove any impurities and the traces of moisture, in a conical flask to which is added 25 ml alcoholic KOH solution heated under a reserved condenser for 1 hour on the water bath, gently and steadily boiling until saponification is completed. It is indicated by absence of any oily matter and the appearance of a clear solution. After cooling the sample, phenolphthalein was added and titrated with 0.5 N HCl until a pink end point was reached. A blank determination was conducted following the same conditions.

$$\text{Saponification value} = \frac{56.1 \times (B\text{-}S) \times N}{W}$$

B = Volume in ml of HCl required by blank
S = Volume in ml of HCl required by oil sample
N = Normality of HCl
W = Weight of oil in g taken for test.

6. Acid Value

Acid value is a relative measure of rancidity as free fatty acids are normally formed during decomposition of glycerides. The value is also expressed as per cent of free acids calculated as oleic acid, lauric acid, ricinoleic and palmitic acids.

The acid value of oils was determined by taking about 0.1- 20g (depending on the oil) of oils in 250 ml conical flask. Then 50 ml of freshly neutral ethyl alcohol was added to it and then boiled on water bath (75-80º C). Phenolphthalein indicator solution (1-2 drop) was added. In case of Rice bran oil or RBO based blends, about 1 ml of alkali blue indicator was added then the mixture while hot was titrated against with standard potassium hydroxide solution with shaking. The end point was noted to the first pink colour which persists for 30 seconds. And end point using alkali blue indicator was noted when the disappearance of blue colour which developed during addition of indicator. Acid value was calculated as mg of KOH per gm of Oil.

$$\text{Acid value} = \frac{56.1 \times V \times N}{W}$$

For Free Fatty Acids (as oleic acid) = 28.2 VN / W per cent by weight

Hence, *Acid Value* = Percent fatty acid (as oleic acid) × 1.99

V= Volume of standard KOH solution in ml
N = Normality of standard KOH solution.
W = Weight of oil sample in grams.

7. Iodine Value

The iodine value is a measure of the amount of unsaturation (no.of double bonds) in a fat.

About 0.25 g oil sample was taken in a 500 ml glass stoppered conical flask and dissolved in 25 ml Ccl4 mixed it well. Then 25 ml of Wij's solution was added and the mixture was allowed to stand for 30 min in dark with occasional shaking. 15 ml 10% KI solution and 100 ml distilled water were added and washed down any free iodine on the stopper. The liberated iodine was titrated against previously standardized 0.1 N $Na_2S_2O_3$ solution gradually with constant shaking until yellow solution turned almost colorless. Few drops of starch indicator were added and titration was continued until blue color entirely disappeared. The flask was shaken violently so that any iodine remaining in solution in the CCl4 might be taken up by the KI solution. The volume of Na2S2O3 solution consumed in the titration was noted. A blank determination was also conducted. Percentage of weight of iodine absorbed by the oil sample was calculated by the following formula:

1 ml 1N $Na_2S_2O_2$ = 0.1269 g I_2

$$\text{Iodine value} = \frac{12.69 \times (B\text{-}S) \times N}{W}$$

B = Volume in ml of 0.1N $Na_2S_2O_3$ required by blank
S = Volume in ml of 0.1N $Na_2S_2O_3$ required by oil sample
N = Normality of Na2S2O3
W = Weight of oil in g of the sample

8. Test for Argemone Oil

Ferric Chloride Test: For this test, 5 ml of oil sample was taken in a test tube and to this 2 ml of conc. Hcl were added. It was shaken for one minute. The test tube was then kept gently in a boiling water bath for 2 minutes. The acid and oil layers were separated clearly. Held the test tube in a slanting position and slowly added 1 ml of the ferric chloride reagent allowing it to just tickle down the side of the tube gently between the palms. Then the test tube was placed in the same water bath for 12 minutes. Then the test tube was examined. Reddish brown, needle shaped crystalline precipitate indicates the presence of argemone oil in the sample (IS 15642 (Part 1): 2006; Dr. N.B. Nath.,2019).

9. Test for Mineral Oil

The presence of mineral oil is indicated by the development of turbidity when hot distilled water is added to a freshly prepared alcoholic solution of the soap formed by the oil. The percentage of mineral oil present is indicated by the intensity of turbidity.

Presence of mineral oil was determined by dissolving 1ml of oil sample in a 25 ml of alcoholic KOH solution in a conical flask. The mixture was boiled on the water bath using air or water-cooled condenser till the solution become clear and no oily drops are found on the sides of the flask. Then the flask was taken out from the water bath, transferred to wide mouth warm test tube. 25 ml of boiling distilled water was added along the sides of the test tube, shaking the tube lightly from side to side during addition. Occurrence of turbidity indicates the presence of mineral oil.

Results

The Physicochemical properties of edible oil samples were screened in order to assess its quality. The parameters such as moisture content, acid value, Free fatty acid as oleic acid, saponification value and iodine value were determined. The results of these determinations are given in Table below (Table 1).

Table 1: Physicochemical properties of some edible oils in Meghalaya

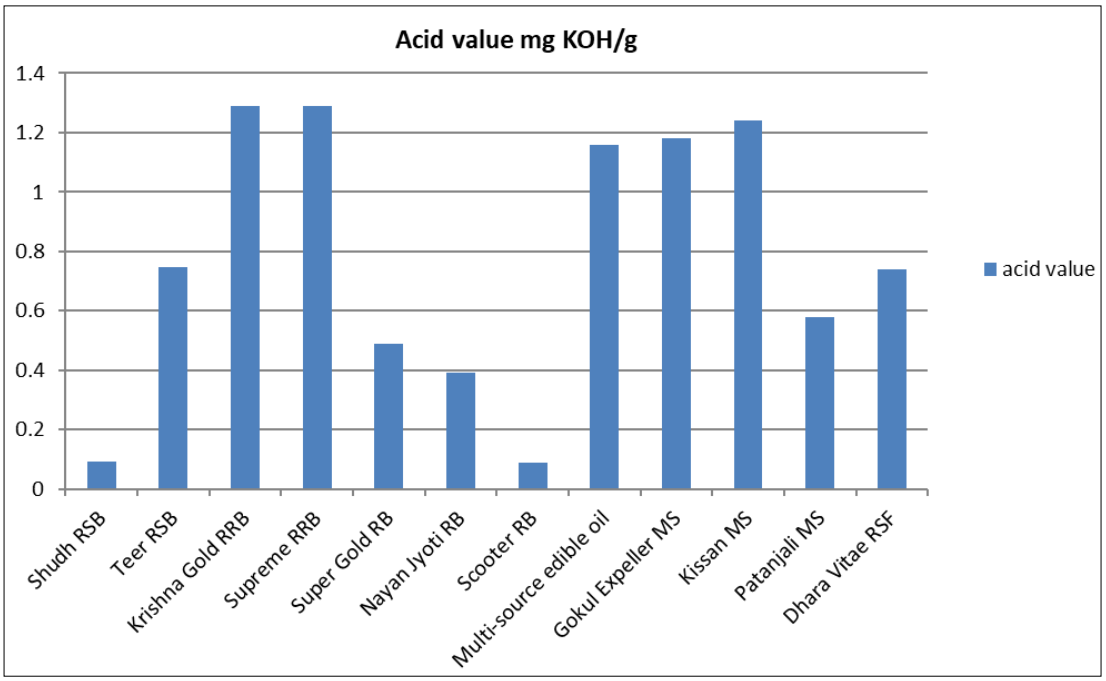
Name of the oils	Moisture content (%)	Acid Value (mg KOH/g)	FFA as oleic acid (%)	Saponification value	Name of the oils
Shudh refined soyabean oil	0.16	0.092	0.046	192.66	121.71
Teer refined soyabean oil	0.05	0.747	0.375	189.89	141.83
Krishna gold refined rice bran oil	0.20	1.29	0.648	184.65	94.46
Supreme refined rice bran oil	0.24	1.29	0.648	187.03	98.22
Super gold rice bran oil	0.12	0.49	0.246	189.78	100.34
Nayan Jyoti rice bran oil	0.03	0.39	0.195	187.09	98.52
Scooter rice bran oil	0.20	0.09	0.045	194.54	126.14
Multi-sourced edible oil	0.27	1.16	0.582	191.47	135.96
Gokul mustard expeller oil	0.07	1.18	0.592	176.64	105.38
Kissan mustard oil	1.35	1.24	0.623	174.93	103.68
Patanjali mustard oil	0.38	0.58	0.291	179.7	105.87
Dhara Vitae sunflower refined oil	0.051	0.74	0.371	191.14	125.41

1. Moisture content

The moisture content of Kissan mustard oil (1.35%) was found to be highest and the lowest moisture content is of Nayan Jyoti rice bran oil (0.03%). The high moisture content of edible oils indicates higher chances of undergoing rancidity. According to WHO/FAO guidelines, the maximum limits of moisture content allowed for edible oils is 0.2% (Negash *et al*. BMC Res Notes., 2019) [16]. Out of the 12 samples collected, 9 (66.66%) samples are falling under the prescribed limits of WHO/FAO. Furthermore, moisture content is found to affect the overall quality parameters. (B.A. Orhevba, *et al*.,2013) [11]. The main reason for the increase of water content in oil is temperature (Kumar R, 2018)

2. Acid value

Acid value is the amount of mg KOH/g required to counteract the free fatty acid content in 1g of oil or fat. From Figure 1. it has been observed that refined rice bran oils have higher acid value (1.29 mg KOH/g) compared to other oil samples. The lowest is observed in Scooter rice bran oil (0.09 mg KOH/g) and Shudh refined soyabean oil (0.092 mg KOH/g). High acid value indicates the conversion of triglycerides to fatty acids and glycerol which plays a role in causing rancidity of edible oils, whereas, low acid value indicates stability against decomposition owing to its longer shelf life and better quality (Hasan, *et al*., 2016, Ichu C.B *et al*., 2019) [7, 5],



Abbr: RSB=Refined soyabean oil, RRB=Refined rice bran oil, RB=Rice bran oil, MS=Mustard oil, RSF=Refined Sunflower oil

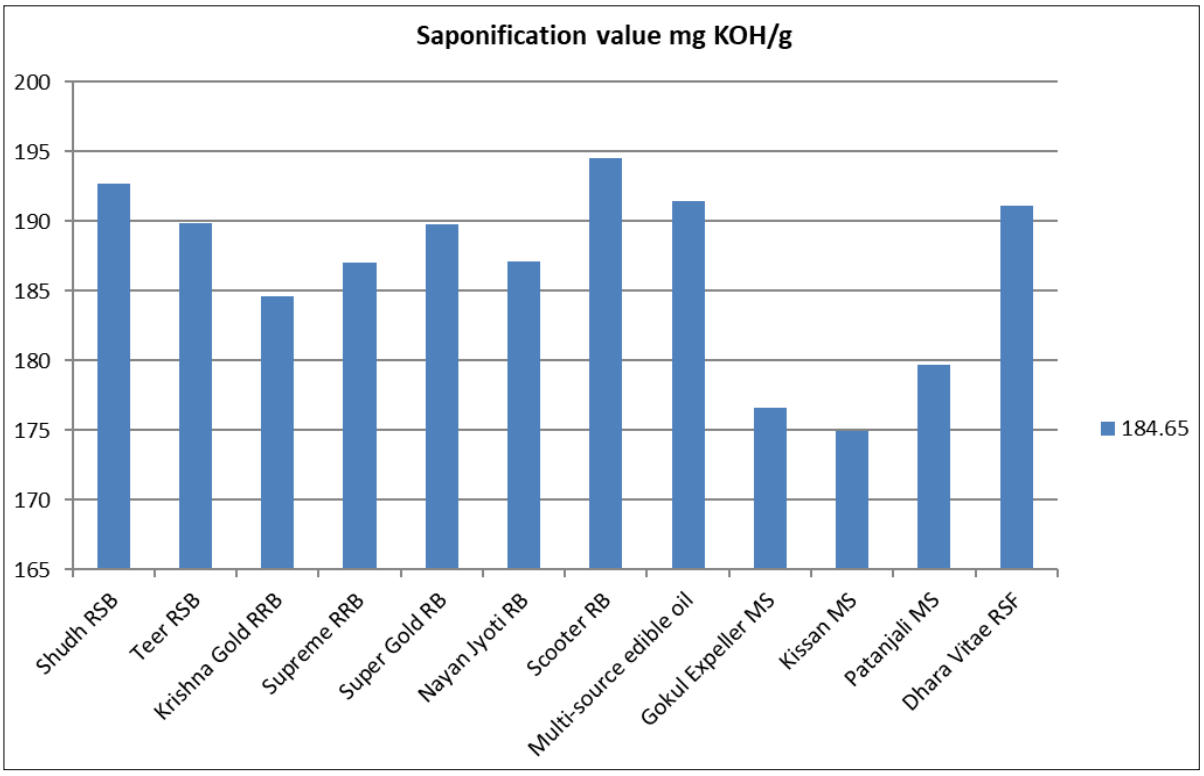
Fig 1: Acid value of edible oils

3. Free fatty acid value

Free fatty acids are obtained from triacylglycerol and are determined to assess the overall purity of edible oils. From the analysis the highest FFA was determined from refined rice bran oils (0.648% oleic) and lowest in Shudh refined soyabean oil (0.046% oleic). High value of FFA indicates lower value of oxidative stability of the product and high susceptibility to rancidity. FFA depends on acid value, i.e., higher the value of acid, higher is the FFA.

4. Saponification value

Saponification value is determined to analyze the total amount of KOH consumed to neutralize the Ester linkages of edible oils (Hasan, *et al*.,2016) [7]. In the chart given below it has been observed that saponification values of mustard oils are comparatively lower than other oil samples ranging between 174.93 – 179.7 mg KOH/g while the highest value is determined from Scooter rice bran oil (194.54 mg KOH/g). Normally, the saponification value of edible oils are below 195 mg KOH/g (Ichu C.B, *et al*.,2019) [5]. The values of all the samples are found to be falling under the specified limits for edible oils (FSSAI regulation 2021).

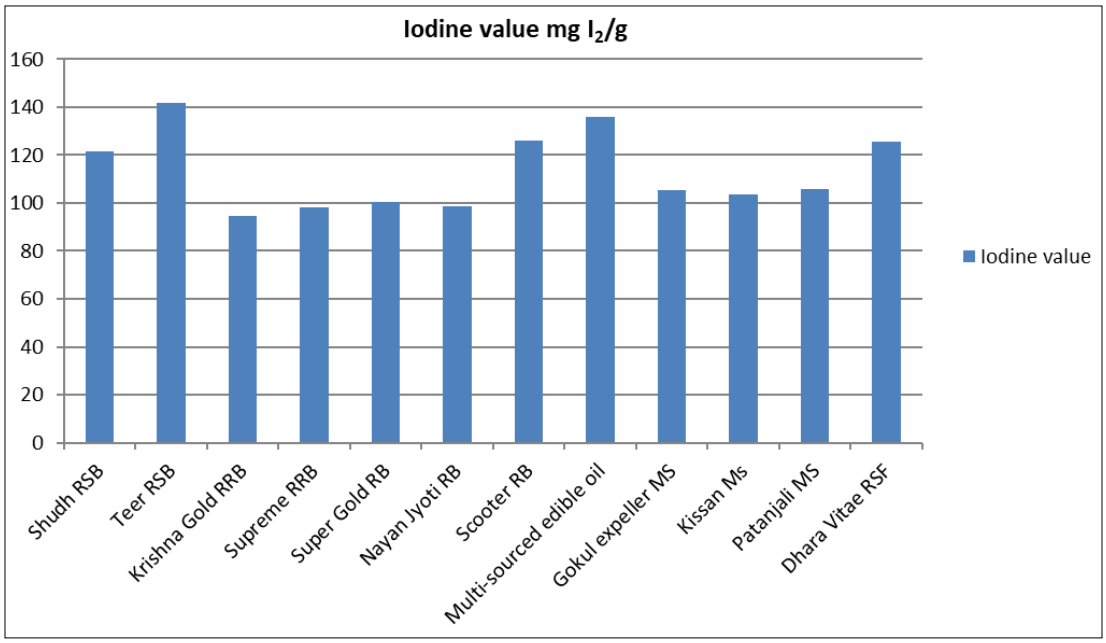


Abbr: RSB=Refined soyabean oil, RRB=Refined rice bran oil, RB=Rice bran oil, MS=Mustard oil, RSF=Refined Sunflower oil

Fig 2: Saponification value of edible oils

5. Iodine value

Iodine value is determined to analyze the saturation of edible oil samples. The Iodine value of refined rice bran oils were observed to be lowest compared to other oil samples with values ranging from 94.46 -98.22 mg I_2/g and the value of Teer refined soyabean oil was found to be highest among the oil samples, i.e., 141.83 mg I_2/g. The Iodine values of all the edible oil samples are found to be within the specified limits for oils and fats. The low value of refined rice bran oils shows higher oxidative storage stability.



Abbr: RSB=Refined soyabean oil, RRB=Refined rice bran oil, RB=Rice bran oil, MS=Mustard oil, RSF=Refined Sunflower oil

Fig 3: Iodine value of edible oil

6. Adulterants

As per India Food Standard and Safety Act, 2006, adulterant is any material that is mixed into the food causing change in its quality and safety. The collected edible oil samples were tested for adulterant such as Argemone oil and mineral oil as per IS 15642 (Part 1) quick determination methods. The results were negative indicating that these oil samples are unadulterated and is consumer safe. In Indian Subcontinent, Argemone oil is found to be incorporated into edible oils, mostly mustard oils, to increase its bulk as its cost is cheap (Pooja. B, *et al*., 2021) [13].

Discussion

From the physicochemical analyses it has been found that moisture content vary with different brands of oil samples. Previous studies have shown that edible oils with moisture content beyond 0.2% are more likely to undergo rancidity due to its susceptibility to bacterial growth. However, those with moisture content ranging from 0.05 to 0.3 could also undergo rancidity (BMC Research notes). In some oil samples high moisture content could be because of poor moisture refining process as some of the companies use low technology for the production of oil or the duration and condition of storage (Mengistie *et al*., 2018) [9].

As per codex standard (CODEX-STAN210-1999), the acceptable acid value for good quality oil is 0.6 mg KOH/g. The Acid value of refined rice bran oils is found to be highest (1.29 mg KOH/g). High acid value indicates high amount of free fatty acid which makes the oil susceptible to rancidification degrading its quality as these oils have low oxidative stability. Acid value is also found to be inversely proportional to the saponification value, i.e., lower the value higher is the saponification ability of oils. Oils with high saponification value are significantly suitable for industrially manufacturing of soaps and cosmetics.

Iodine value index signifies the saturation of edible oils. Lower value shows greater oxidative storage stability and less susceptible to oxidative rancidity. Besides, it also indicates that food prepared by this oils have higher stability against oxidative rancidity (Md. Kamrul Hasan *et al* 2019) [8]. Multi-sourced edible oil, sunflower refined oil and soyabean refined oils have been observed to have higher Iodine value which indicates that these oils have higher molecular mass of unsaturated fatty acids. Edible oils with unsaturated fatty acids are recommended over oils with high saturation. Furthermore, the quality and safety of edible oils also depends on how they are adulterant free. Adulterated edible oils are detrimental to health.

Conclusion

The edible oil samples available in Meghalaya are found to have met the safety standards specified in Food Safety and Standard Act 2006, Regulations 2011. However, some of the oil samples were above the maximum limits set by Codex Standards 210-1999. In order to choose good edible oils for domestic and industrial use, the physicochemical properties are needed to be considered. Highly saturated and adulterated oils not only deteriorate its overall nutritive value but also tend to be detrimental to general health. This analysis was conducted in order to determine the quality of edible oils in the State. However, it is to be noted that room temperature, storage condition and duration could play a significant role in the overall quality and edibility of edible oils and a routine assessment should follow in order to ensure that these oils are meeting the standards to be consumed by Public in general.

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