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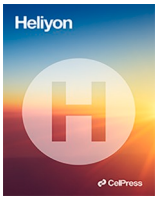

Research article

The influences of street food vendor frying equipment on the quality of frying oil

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ABSTRACT

This study was initiated to determine the quality of fresh and used oil for street vendor fried food products in Harar City, Ethiopia. Using a purposive sample technique, 12 respondents were selected for the study. The study obtained a total of 12 oil samples, categorized as fresh, in-use, and discarded, from two distinct groups of respondents. Specifically, six samples were collected from vendors utilizing an electric fryer constructed from stainless steel, while the remaining six samples were acquired from vendors employing a pan heated by wood or charcoal.The moisture content of fresh, in-use, and discarded oil samples, among other physical characteristics of the samples obtained from two types of vendors, was examined and found to vary between 0.14 and 0.44%, 0.19 and 0.52%, and 0.25 and 0.75%, respectively. Comparably, the refractive indices of oil samples that were fresh, in use, and discarded were 1.4595–1.4686, 1.4670–1.4885, and 1.4810–1.4960, in that order. Furthermore, the ranges of viscosities for fresh oil, oil samples in use, and oil samples that were discarded were 57.15–76.94, 100–196.50, and 210.22–288.50 mPa, respectively. Chemical properties, including % free fatty acid for similar samples, range from 0.22 to 1.30, 1.12 2.54, and 1.38–3.66%, respectively. Peroxide values of fresh, in-use, and discarded oil samples, have a maximum value of 11.19 meq/kg, 42.90, and 57.60 meq/kg, respectively. The iodine value showed the highest value for the fresh oil sample, while the minimum was obtained under discarded oil sample. The result indicated that they used low-quality oil. The values obtained after frying for samples collected from vendors who used a pan fryer heated with charcoal or wood fire deviated significantly from the requirements, indicating that the palm oil used by those street vendors was unsafe to consume because it could endanger the consumers' health.

1. Introduction

A street food vendor is an individual who sells food items to the public without the use of a permanent structure [1]. Street food vendors are popular in both developing and industrialized countries with significant expansion in developing countries [2]. In African economies, street food is extremely important from a socioeconomic standpoint, especially when it comes to employment opportunities. It's notable that while street food vendors come from diverse backgrounds, a significant proportion are female heads of households [3].

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The majority of street food vendors use frying oil that is solid at room temperature, which they melt with heat or sunlight before beginning the frying process, allowing the oxidation reaction to proceed more quickly. The use of oil for frying operations remains one of the most popular methods for preparing food globally. This is particularly evident with the rise in the number of fast-food restaurants and fried food vendors [4].

Fried foods are regarded as cultural foods in Harar City. The majority of people are Muslims, and people of all ages consume fried food. The increased consumption of street-fried foods in Harar city, Ethiopia, has raised concerns about the practices of fried food vendors, particularly regarding the reuse of frying oil. It's common for vendors to repeatedly use the same frying oil to save costs, discarding it only when it starts emitting smoke or when its color becomes too dark. However, this practice of recycling oil can have detrimental effects on both the quality of the oil and the nutritional value of the fried products [5].

Additionally, some street food vendors in Harar city use stainless steel electric fryers, the majority use locally made frying pans that are heated with charcoal or wood fire. There is no temperature control system on this instrument. The physicochemical reaction that occurs during the frying of food products at a higher temperature causes the frying oil to decompose, affecting the consistency of the final product [6]. Furthermore, the fryer left open during frying, exposes the oil to external moisture and light, this could causes hydrolysis and oxidation reaction.

Rancidity refers to the hydrolysis and/or autoxidation of fats, resulting in the formation of short-chain aldehydes and ketones, which impart an unpleasant taste and odor to food products [7].Oxidative and hydrolytic rancidity are the two main types of rancidity, occurring due to degradation by oxygen in the air and excessive exposure, leading to the formation of peroxides and the release of free fatty acids from triglycerides, respectively [8].

The presence of free radicals in rancid oils can have detrimental effects on health. Free radicals can damage DNA cells, contribute to arterial damage, and act as carcinogens, substances known to cause cancer [9]. Moreover, frequent consumption of rancid oils can lead to accelerated aging, elevated cholesterol levels, obesity, and abnormal weight gain. Over time, these effects can increase the risk of degenerative and chronic diseases such as cancer, atherosclerosis, neurological disorders, and heart diseases [8,9].

In Ethiopia, no official body is in charge of monitoring or regularly inspecting the oil used by vendors on the streets selling traditional or fast-fried food. Therefore, need to assess effect of frying equpmnet, types of oil used and frequency of oil re use on the quality of oil and products. The main objective of this research was to evaluate infulene of processing equipment on the quality of oil.

2. Materials and methods

2.1. Sample collection methods

The samples selected for analysis were sourced from individuals utilizing the most widely used brand of oil, which in this case was palm oil. Total of twelve samples (12 fresh,12 inuse and 12 discarded) were obtained from two types of vendors. Six samples were obtained from vendors who used a stainless steel electric fryer and six samples were obtained from vendors who used a pan heated with a charcoal/wood fire. In each case approximately 50 g of the oil samples were collected and stored in small bottles. These bottles were then placed in a refrigerator set at 4 °C to maintain the integrity of the samples until they were ready for analysis.

2.2. Physical analysis of oil samples

2.2.1. Moisture content

The moisture content was determined using the method outlined in Ref. [10], following the official method 925.09. Here are the steps involved:A crucible was dried in an oven at 105 °C for 30 min and then placed in a desiccator to cool. The weight of the crucible (W1) was determined. The sample was weighed in a dry crucible (W2) and then dried at 105 °C until a constant weight was achieved. After drying, the crucible with the sample was cooled in a desiccator to room temperature and then weighed again (W3). The moisture content was determined as follows;

$$\text{Moisture content } \% = \frac{W2 - W3}{W2 - W1} \times 100 \quad (1)$$

2.2.2. Viscosity

The viscosity measurement was conducted according to the method described by Ref. [10] using a viscometer (DRAWELL NDJ-5S) with spindle number 3 properly fixed to the holder. The procedure involved carefully placing the container containing the oil below the rotor holding the spindle. The spindle was then immersed deeply into the oil. Subsequently, the meter was turned on and adjusted to a speed of 60 rpm. The spindle was allowed to rotate in the oil for 2–3 min until a stable reading was displayed, at which point the viscosity was recorded.

2.2.3. Refractive index

According to Ref. [10], the refractive index was measured using an automatic digital refractometer (HRD-300 N). The procedure involved cleaning and calibrating the prisms of the refractometer using distilled water before taking any readings.

Once the prisms were prepared, a few drops of the oil sample were placed on the prism, and the refractive index values were recorded. This measurement provides valuable information about the optical properties of the oil sample, which can be useful for various analytical purposes.

2.3. Chemical analysis of oil samples

2.3.1. Free fatty acid (% of oleic acid)

The free fatty acid content was determined following the method outlined in Ref. [11]. In detail, 5 g of the oil sample was dissolved in a conical flask containing a mixture of ethanol (150 mL; 97% v/v). Next, 3–4 drops of phenolphthalein indicator were added to the solution to serve as an indicator. The resulting solution was then titrated with 0.1 N potassium hydroxide (KOH) solution while being shaken constantly. The titration was continued until the solution changed to a pink color, indicating the endpoint of the reaction.

The free fatty acid was calculated as follows:

$$\text{Free fatty acid } (\%) = \frac{282\text{NV}}{W} \tag{2}$$

Where:

V = volume in ml of standard potassium hydroxide or sodium hydroxide.

N = Normality of the potassium hydroxide solution or sodium hydroxide solution.

W = Weight of sample in grams.

2.3.2. Peroxide value

The peroxide value was determined according to the methods described in Ref. [10]. Initially, approximately 5 g of the oil sample was placed in a 250 mL Erlenmeyer flask. Then, 30 mL of a glacial acetic acid-chloroform solution (in a ratio of 3:2) and 0.5 mL of saturated potassium iodide (KI) solution were added to the flask. The mixture was left to stand for 1 min in the dark at ambient temperature.

Following this, 30 mL of distilled water was added to stop the reaction, and then 2 mL of saturated starch solution was introduced as an indicator. The resulting mixture displayed a color ranging from dark purple to dark brown. It was then titrated with standardized 0.01 N sodium thiosulfate solution until the color of the mixture changed from ivory to white.

The peroxide value was expressed as the milliequivalent of oxygen per kilogram of oil, as illustrated in equation (3).

$$\text{Peroxide value (mill equivalent of oxygen / Kg of oil)} = \frac{V * M * 1000}{m} \tag{3}$$

Where;

V = Volume of $Na_2S_2O_3$ (blank corrected) and M = Molarity of $Na_2S_2O_3$

2.3.3. Iodine value

The iodine value was determined according to Ref. [10]. Approximately 0.5 g of the oil sample was weighed into a 250 mL conical flask. Subsequently, 10 mL of chloroform and 30 mL of Hanus iodine solution (prepared by dissolving 18.2 g of iodine in 1 L of glacial acetic acid, followed by adding 3 mL of bromine water to increase the halogen content) were added to the flask. The solution was then left to stand in the dark for 30 min with occasional shaking.

Afterward, potassium iodide (10 mL) (15%) was added to the solution and shaken thoroughly. This was followed by the addition of 100 mL of distilled water to rinse down any iodine on the stopper. The solution was then titrated with 0.01 N thiosulfate solution using starch as an indicator (1 mL) until a yellow color appeared. At this point, 2–3 drops of the starch solution were added, resulting in a blue color. The titration was continued until the blue color disappeared. The volume (mL) of $Na_2S_2O_3$ used in the titration was recorded and represented as (S).

The same procedure was repeated without adding an oil sample, and the volume (mL) of $Na_2S_2O_3$ at the endpoint was represented as (B). Then, the iodine value was calculated using equation (4) as shown below:

$$\text{Iodine Value} = \frac{(B - s) \times N \times 0.127}{WS} \times 100 \tag{4}$$

Where: B = volume in ml of standard sodium thiosulphate solution required for the blank.

S = volume in ml of standard sodium thiosulphate solution required for the sample.

N = normality of the standard sodium thiosulphate solution.

WS = is the weight of the oil sample.

2.4. Statistical analysis

All analyses were conducted in triplicate, and the obtained data were subjected to analysis of variance (ANOVA) using Statistical Analysis System (SAS 9.1) version for Windows (SAS Institute Inc., Cary, NC, USA). A significance test was considered acceptable at a probability value of $P < 0.05$. This rigorous statistical analysis helps ensure the reliability and validity of the results obtained from the experimental procedures.

3. Results and DISCUSSIONS

3.1. Physical properties of fresh, in use and discarded oil samples

3.1.1. Moisture content

Temperature, frying time, and oil composition can all have an impact on moisture content [12]. Rancidity will occur more quickly in frying oil with a higher water concentration [13]. The results of the current investigation, as illustrated in Fig. 1(a) and (b), indicate that the moisture levels of the fresh oil that were gathered from vendors who used an electric fryer made of stainless steel and a pan heated by a wood or charcoal fire ranged from 0.14 to 0.27% and 0.18–0.44%, respectively.

It has been noted that the water content of the fresh oil collected from both categories of vendors exceeded the standard set by the Compulsory Ethiopian Standard first edition (CES 245:2019), which specifies a maximum allowable moisture content of 0.2%. Only five out of the fresh samples analyzed were within this standard limit. This finding contrasts with the results reported by Ref. [4], who observed moisture content ranging from 0.13% to 0.20% in all fresh oils obtained from local fried food vendors. Elevated moisture content not only impacts storage conditions but also influences the taste, flavor, and texture of the fried products [14].

Similarly, the moisture content of in-use oil samples indicated in Fig. 1 (a) and (b) the moisture contents of the in-use oil collected from vendors who used stainless steel electric fryer and a pan heated with Charcoal/wood fire ranged from 0.19 to 0.34% and 0.24–0.52% respectively. The values were above the standard criterion.

The moisture content of oil that was collected from the vendors who used the stainless steel electric fryers was lower than that of oil that was collected from charcoal/wood fire pans. Since the vendors who used a pan with a wood fire/charcoal fryer were leaving their fryer equipment uncovered during frying, subsequently, the oil gets exposed to the surrounding humidity, leading to a further increase in the moisture content of oil.

Further investigation was conducted to understand the moisture content of the discarded oil, depicted in Fig. 1 (a) and (b) that the moisture content of the discarded oil samples ranged from 0.25 to 0.42% and 0.33–0.75% for oils that were collected from the vendors using the stainless steel electric fryers and the charcoal/wood fire pans respectively. Regarding the national standard guideline, the observed result of the moisture content has much deviated from it. The possible reason for the increase of water content after repeated use can be migrate of moisture from food to oil, thus increasing the level of hydrolysis hence, making the oil more prone to break down.

The mitigation of moisture in oil is affected by temperature. When the oil has a high temperature, it can help to evaporate and remove moisture from the oil. Higher temperatures can accelerate the evaporation of the moisture, helping to maintain the quality of the oil. However, if the temperature is too high, it can also lead to the oxidation and degradation of the oil, which can negatively impact its quality and taste [12].

3.1.2. Refractive index

The refractive index (RI) was used in this investigation to assess the rancidity of edible oils and fats that were fresh, in-use, and discarded. Accordingly, Fig. 2 (a) and (b) show that the refractive index value of fresh oil samples ranged from 1.4595 to 1.4686 and 1.4647–1.4679 for oil samples collected from vendors who used a stainless steel electric fryer and a pan heated with Charcoal/wood fire respectively. The achieved result was higher than the Compulsory Ethiopian Standard first edition (CES 245:2019) (1.4589–1.4592) for fresh palm oil. It indicates that the samples probably contained highly unsaturated or long-chain fatty acids in their triglycerides.

Similarly, Fig. 2 (a) and (b) shows that the refractive index values of in-use oil samples ranged from 1.4670 to 1.4795 and 1.4740–1.4885 for oil samples collected from vendors who used the stainless steel electric fryer and a pan-heated with Charcoal/wood fire respectively. In this regard, in-use oils collected from vendors who used a pan heated with charcoal or wood fire showed a higher

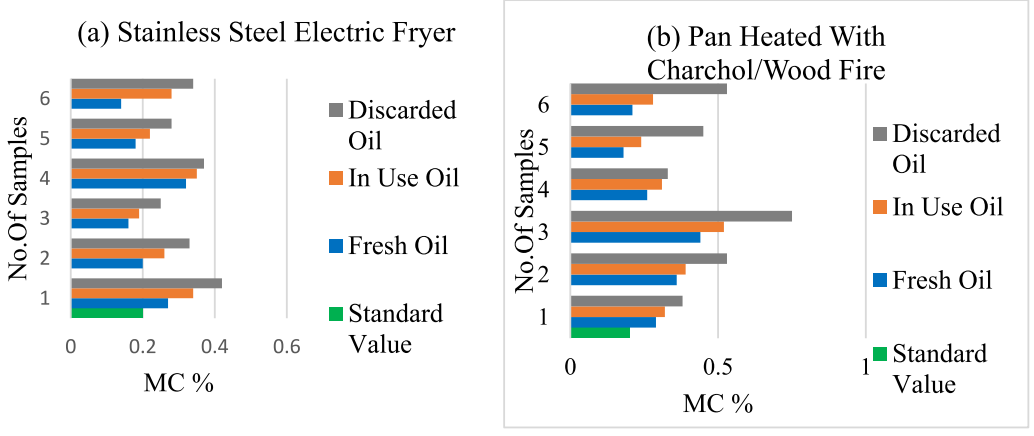

Fig. 1. Moisture content (%) of oil samples collected from vendors who used stainless steel electric fryer (a) and a pan heated with charcoal/wood fire (b).

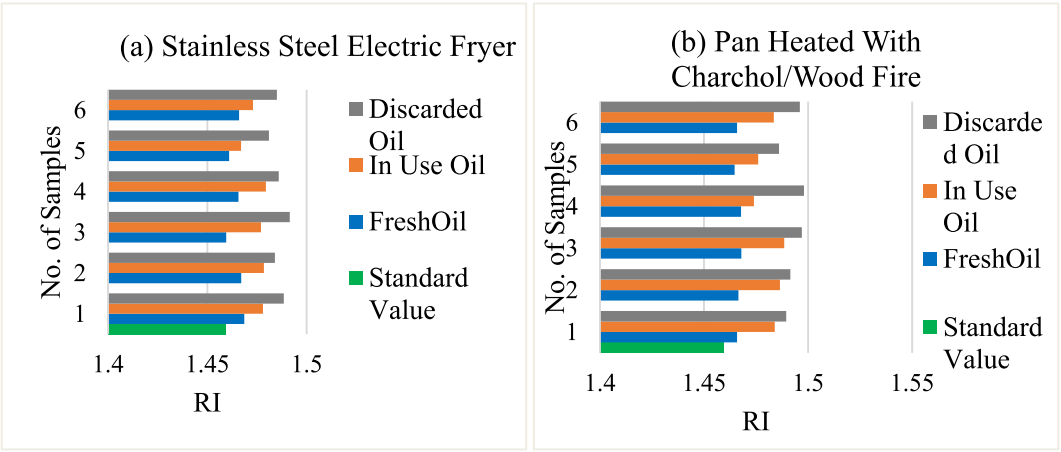

Fig. 2. Refractive index of oil samples collected from vendors who used stainless steel electric fryer (a) and a pan heated with charcoal/wood fire (b).

refractive index than samples collected from those who used a stainless steel electric fryer. Since the vendors left their frying equipment uncovered during the frying process, this could leads to oxidizing the oil, which in turn, becomes rancid, and causes the refractive index to rise.

Similarly, the refractive index of the discarded oil samples was evaluated and as indicated in, Fig. 2 (a) and (b) that the refractive index of the discarded oil samples collected from vendors who used a stainless steel electric fryer and a pan-heated with Charcoal/wood fire ranged from 1.4810 to 1.4915 and 1.4860–1.4980 respectively. The result showed that the oil samples were highly degraded.

3.1.3. Viscosity

One important measurement used to evaluate the physical changes in edible oil caused by temperature, degree of unsaturation, density, molecular weight, and melting point is viscosity [15]. The viscosity of fresh oil samples was evaluated in the current study, and the results showed that samples from vendors using stainless steel electric fryers ranged from 63.76 to 74.53 mPa, whereas samples from vendors using pans heated by charcoal or wood fire had a range of 57.15–76.94 mPa. Fig. 3(a) and (b) illustrate these findings and highlight the variations in viscosity between the two cooking techniques. Such investigations help determine the quality and usability of oils for culinary applications by offering insightful information about the physical characteristics of oils under various cooking circumstances. Similarly, the viscosity of in-use oil samples ranged from 100 to 183 mPa s and 122–196.50 mPa s for oil samples collected from vendors who used the stainless steel electric fryer and a pan heated with Charcoal/wood fire respectively (see in Fig. 3 (a) and (b)). The samples collected from vendors who used a pan heated with Charcoal/wood fire were at a higher viscosity than the samples collected from a stainless steel electric fryer. The increase in viscosity was related to the accumulation of the degraded products in oil, especially, the polymerization reaction of substances with higher molecular weight [16]. As the heat accelerates the oxidation progresses increase, and the viscosity increases gradually [17].

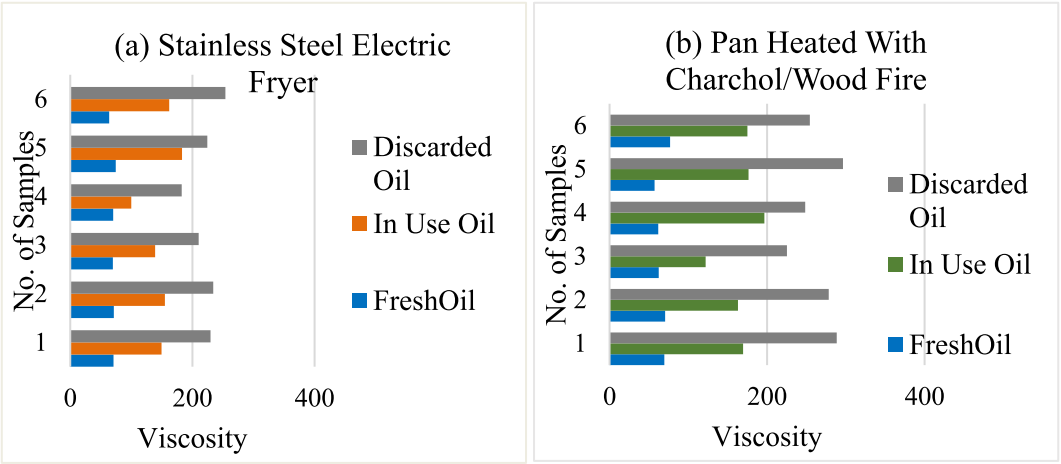

Fig. 3. Viscosity of oil samples collected from vendors who used stainless steel electric fryer (a) and a pan heated with charcoal/wood fire (b).

The viscosity of discarded oil samples exhibited a range of 210.22–254.11 mPa s for samples obtained from vendors using stainless steel electric fryers, and 225.22–288.50 mPa s for samples obtained from vendors utilizing pans heated with charcoal/wood fire (Fig. 3 (a) and (b)). The observed increase in viscosity of discarded oils may be attributed to polymerization reactions, leading to the formation of higher molecular weight compounds. These findings suggest that viscosity is significantly influenced by exposure to higher temperatures, air, and an increase in the number of frying cycles, which promote the formation of oxidative and polymeric compounds, consequently enhancing the oil's tendency to foam during frying. Additionally, an increase in moisture content can also contribute to elevated viscosity levels in the oil.

This is because water in the oil can disrupt the normal flow of the oil molecules, leading to an overall increase in viscosity. Additionally, water can also interact with other components in the oil,causing changes in their behavior and ultimately increasing the viscosity of the oil [18].

3.2. Chemical properties of fresh, in use and discarded oil samples

3.2.1. Free fatty acid as (%) oleic acid

Fatty acids make up the majority of oils, and their degree of unsaturation is the primary element influencing the oxidative stability of frying oils. This is why free fatty acids (FFA) are frequently used to evaluate the quality of frying oils [19]. The free fatty acid values of fresh oil samples obtained from vendors using electric fryers made of stainless steel and a pan heated using a charcoal or wood fire, respectively, varied from 0.22 to 0.82% and 0.25–0.45%, as shown in Fig. 4(a) and (b). The results indicated that, with the exception of three samples with values of 0.22, 0.25, and 0.29 percent (less than 0.3%), the majority of fresh oils do not fall within the suggested range of FFA levels for fresh oil.

The average FFA levels for in-use oil samples ranged from 0.78 to 1.82% and 1.24–2.54%, for samples collected from vendors who used stainless steel electric fryers and a pan heated with Charcoal/wood fire as shown in Fig. 4 (a) and (b) respectively. This result agreed with the work of [4,18] who reported that the free fatty acid value of in-use oil ranged widely from 0.25 to 3.99% and 0.56–6.9% respectively. The FFA content is vital for the resolve of fat hydrolysis and the extent of oil deterioration [12].The result revealed that the majority of in-use oil samples collected from vendors who were using a pan heated with Charcoal/wood fire have a higher FFA value than stainless steel electric fryers. This indicates that hydrolysis of triglycerides and decompositions of hydroperoxides at high temperatures in the presence of moisture results in the formation of FFA.

Fig. 4 (a) and (b) show that the FFA content of the discarded oil samples ranged from 1.38 to 2.54 % and 1.74–3.66% for samples collected from vendors who used stainless steel electric fryer and a pan heated with Charcoal/wood fire respectively. The study supported by the work of [20], reported that the FFA content of discarded oil samples ranged from 0.68 to 3.98%. The variation observed in the FFA content of discarded oil samples indicates the degree of variations to which the oils were used by different food vendors All of the in-use and discarded oil samples had higher than allowed amounts of free fatty acids (FFA), which raises the probability that part of the oil was refilled during the frying process before being discarded.

The elevated FFA levels suggest that users are not discarding their oil and are instead utilizing low-quality oil, posing significant health risks. This situation is particularly concerning as it can contribute to elevated cholesterol levels, coronary heart diseases, and liver disease. In addition to the desired characteristics, frying induces various chemical reactions such as oxidation, polymerization, and hydrolysis, which result in the degradation of unsaturated fatty acids and the generation of FFAs [20].

3.2.2. Peroxide value

The peroxide (PV) value provides the initial evidence for rancidity in unsaturated fats and oils. It gives a measure of the degree to

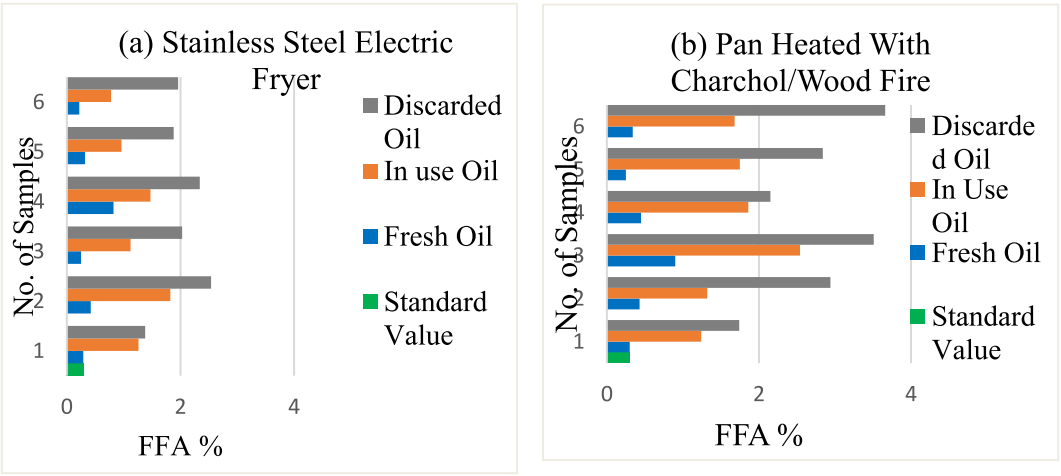

Fig. 4. Free Fatty Acid (%) of oil samples collected from vendors who used stainless steel electric fryer (a) and a pan heated with charcoal/wood fire (b).

which primary oxidation has occurred in the oil sample, especially during storage [21]. Fig. 5 (a) and (b) show that the peroxide value of fresh oil samples ranged from 1.95 to 9.33 meq/kg and 2.65–11.19 meq/kg for samples collected from vendors who used stainless steel electric fryer and a pan-heated with Charcoal/wood fire respectively. The work of [22] stated that the level of peroxide lay within the range of 3.976–11. 94 meq/g for fresh oil. Freshly refined oils usually have a PV value of less than 10 meq/kg as per the Ethiopian Standard first edition (CES 245:2019). Only a single fresh sample of oil was elevated from the aforementioned standard, this might be due to exposure of the fresh oil to sunlight and also improper packaging. Turek and Stintzing [23] reported that exposure to sunlight and heat accelerates the rate of oil degradation.

Similarly, the PV value of in-use oil samples ranged from 12.96 to 31.80 meq/kg and 18.60–42.90 meq/kg for samples collected from vendors who used stainless steel electric fryer and a pan heated with Charcoal/wood fire (see Fig. 5 (a) and (b)). This result was in agreement with the work of [13,24] reported that the PV of in-use samples was ranging from 14.70 to 25.25 and 11.4–14.9 meq/kg respectively.

The peroxide value of the oil samples which were collected from vendors using a pan with wood fire/charcoal has a higher peroxide value than the stainless steel electric fryers. In connection with this, most of the vendors were using cast iron frying equipment, which leads to the formation of oxidation in the oil. This was confirmed by Ref. [25], which stated that copper or iron-made fryers accelerate the oxidation of frying oil, which in turn, leads to an increase in the peroxide value.

Also, Fig. 5 (a) and (b) show that the PV of the discarded oils samples ranged from 18.33 to 46.00 meq/kg and 28.50–51.40 meq/kg for samples collected from vendors who used stainless steel electric fryer and a pan-heated with Charcoal/wood fire respectively, which was higher than the recommended value. The Peroxide Value (PV) of the two discarded oil samples exhibited lower values, which could be attributed to the potential replacement of the frying oil with fresh oil before it undergoes extensive frying. It is plausible that some of the previously used oil may have mixed with the fresh frying oil during this process. Conversely, higher oxidative degradation and the repeated reuse of oil are likely the primary factors contributing to the higher PV values observed in other samples.

3.2.3. Iodine value

The iodine value (IV) serves as a crucial indicator of oil quality as it measures the average level of unsaturation and provides an index for the number of double bonds present in the oil. These double bonds are capable of reacting with halogens, making IV a valuable metric for assessing the oil's chemical composition and properties [17]. Fig. 6 (a) and (b) show that the IV of the fresh oil samples ranged from 38.50 to 58.07 g I_2/100 g of oil and 35.61–57.21 g I_2/100 g of oil for samples collected from vendors who used stainless steel electric fryer and a pan heated with Charcoal/wood fire respectively. However, only four samples (56.67 I_2/100 g of oil, 58.07 I_2/100 g of oil,57.63 I_2/100 g of oil, and 57.21 I_2/100 g of oil) were within the recommended value of the Compulsory Ethiopian Standard first edition (CES 245:2019) which is 56–60 I_2/100 g of oil. In this regard [12],reported that the iodine value of fresh oil samples ranged from 50 to 55 g I_2/100 g of oil.

Comparably, the iodine value of in-use oil samples exceeded the suggested range of 24.06–36.18 g I2/100 g of oil and 20.78–40.18 g I2/100 g of oil, respectively, as indicated in Fig. 6(a) and (b) for samples obtained from vendors using an electric fryer made of stainless steel and a pan heated by charcoal or wood fire. The findings corroborated those of [4], whose research showed that the IV of in-use oil varied from 33.69 to 16.22 g I2/100 g.

The iodine value of discarded oil samples ranged from 10.46 to 25.75 g I_2/100 g oil and 8.67–20.89 g I_2/100 g oil as shown in Fig. 6 (a) and (b) for samples collected from vendors who used stainless steel electric fryer and a pan heated with Charcoal/wood fire respectively. The result showed a high level of rancidity, deterioration, which suggests a high level of unsaturation, and susceptibility to oxidative. In line with this [12], reported that the decrease in the value of iodine is an indicator that vegetable oil is being degraded. Ayub et al. [14] highlighted that a low Iodine Value (IV) was commonly observed in Malaysian palm, canola, and sesame oil. This indicates that the oxidation resulting from the prolonged use of oil for frying has led to a reduction in the number of double bonds present in the oil.

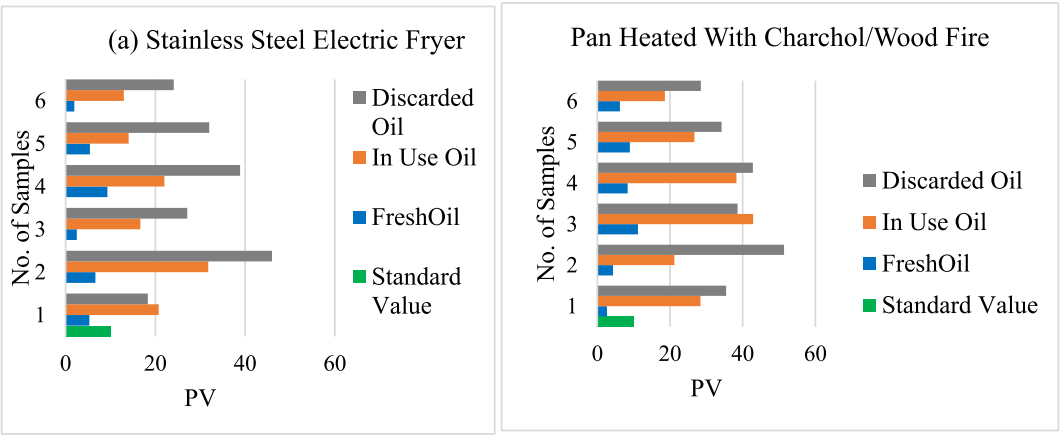

Fig. 5. Peroxide Value of oil samples collected from vendors who used stainless steel electric fryer (a) and a pan heated with charcoal/wood fire (b).

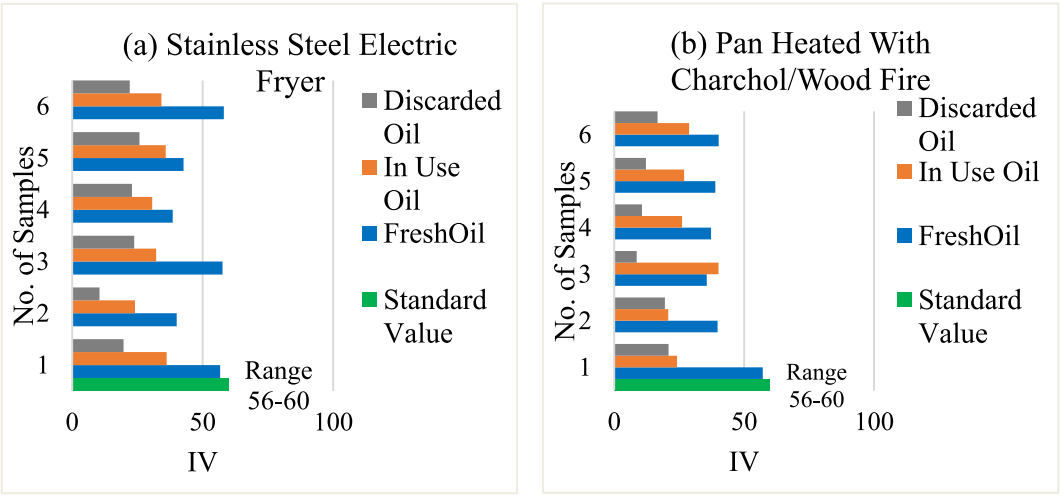

Fig. 6. Iodine Value of oil samples collected from vendors who used stainless steel electric fryer (a) and a pan heated with charcoal/wood fire (b).

4. Conclusions

The study was designed to investigate the quality of fresh, used, and discarded oil collected from street food vendors in Ethiopia, Harar city who used a stainless steel electric fryer and a pan heated with charcoal or wood fire. The result indicated that they used low quality oil. The values obtained after frying for samples collected from vendors who used a pan fryer heated with Charcoal or wood fire deviated significantly from the requirements, indicating that the palm oil used by those street vendors was unsafe to consume because it could endanger the consumers' health. The results obtained were compared with the Compulsory Ethiopian Standard first edition (CES 245:2019) not in line. The majority of fresh oil samples and all in-use and discarded samples collected from who used steel electric fryer and a pan heated with charcoal or wood fire did not meet the requirements. Further investigation into the fatty acid composition and antioxidant properties of frying oils is required. Thus, it is imperative that stakeholders and health professionals provide vendors with appropriate training. Their skill may be further improved by the training. Optimisation of the frying time, temperature, kind of oil, and rate of oil reuse is also necessary.

5. Limitation of the study

During the sample gathering process, one of the biggest issues was some vendors' accessibility. A few of them are not frequently encountered on the street, and they are unwilling to have the temperature of the oil measured. Another constraint was the expense of certain techniques used to characterise the oil, like nuclear magnetic resonance, elemental analysis, and fatty acid analyses.

Availability of data

All data generated or analyzed during this study are available on request.

CRediT authorship contribution statement

Dagmawit Fekadu: Writing – original draft, Methodology, Investigation. **Solomon Abera:** Writing – review & editing, Supervision. **Helen Weldemichael:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2024.e28293.

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