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Recycling and Reuse of Fried Waste Oil through Cornstarch Treatment

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FATTY acid composition (FAC) of the oil might affect the processes of autoxidation and hydrolytic alteration, which causes oils to deteriorate during frying. However, natural biopolymers, like corn starch, may be able to recycle fried frying oil to be used again. The goal of this search is to treat sunflower and soybean blend oil as waste-cooking oil (WCO) with starch. The findings show that starch treatment keeps the acid value within allowable bounds and aids in preserving a lower peroxide value, which improves the oxidative stability of fried oils. Furthermore, it not only increases the stability of unsaturated fatty acids but also reduces the quantities of saturated slightly at ½ h (from 20.09 to 19.11) and 90 min (from 25.84% to 19.11%), and trans fatty acids was 0.70 % and 0.63% with 10% and 30% starch after half an hour of frying, which may result in healthier frying results. The findings presented highlight the possibility of using starch as a useful ingredient to recycle WCO and maybe increase its shelf life. Further study in this field may yield important insights into how to best fry food for better oil quality and health advantages. In-depth knowledge of how starch preserves oil quality could be gained from future research on the molecular pathways involved, which would help with frying technique optimization.

Keywords: Fatty acids, Oil quality, Recycling fried cooking oil.

Introduction

Lipids play a crucial role in the diet by supplying essential fatty acids such as linoleic acid (n-6) and alpha-linolenic acid (n-3) necessary for providing the energy required for the body (Kaur et al., 2014). One of the principal ways of utilizing fats in cooking is by frying. Indeed, frying is a complex process involving heat, mass, and momentum transfers that modify food's physical and chemical state (Xu et al., 2020). Frying is a frequently used, efficient, and uncomplicated cooking method (Borjian Borojeni et al., 2016). Although the calorie, cholesterol, and saturated fat content of fried foods is frequently a source of concern, this cooking method is praised for improving the taste, texture, and look of food (Ghidurus et al., 2010), all of which can have a favorable impact on the food's nutritional value. There are two main methods for frying: deep frying and shallow frying. Deep frying is the method that is used more frequently. This process dramatically improves the finished goods' quality, flavor, and taste by immersing food in heated oil at temperatures between 150 and 190 °C (Choe & Min, 2007).

WCO is derived from different types of edible vegetable oils that are utilized for frying food in the food industry or by individuals (Omojola et al., 2021). The oxidation of lipids is affected by numerous elements, including the type of oil used, the temperature at which the food is fried, its duration, the type of food, the cooking method, and the presence of antioxidants, all affect the overall quality of fried food (Choe & Min, 2007; Serjouie et al., 2010). Used cooking oils may contain chemicals from an interaction between food ingredients and oil, oxidative compounds, and products of thermal degradation,

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among other dangerous substances that are produced while heating. First, peroxides and hydroperoxides are produced, and then peroxide polymers build up (Lupea et al., 2004; Popa et al., 2017). There have been reports of an increase in free fatty acids (FFAs) and peroxide value (PV) following the heating of cooking oils at various temperatures and intervals. The quality measurements under investigation rise in tandem with the heating duration, which causes the oil to degrade (Ahmad et al., 2018). The consumption of degraded oils can have detrimental impacts on the health of both humans and animals (Johnston et al., 2018), However, improper disposal of deteriorated oils might pollute the environment (Syahir et al., 2017). Oil quality is determined by its chemical (peroxide, iodine, acidity, and saponification values) and physical (color, viscosity, solidification temperature, consistency, and texture) characteristics (Perumalla Venkata & Subramanyam, 2016). When exposed to air, heat, or light, unsaturated fatty acids oxidize, causing this deterioration (Bhoyar, 2024).

The burgeoning demand for fried foods has resulted in a significant accumulation of WCO, presenting environmental challenges and potential health risks associated with improper disposal (Chong, et al., 2023). Using recycled cooking oil has garnered attention due to its economic and environmental benefits. However, harmful compounds formed during frying, such as polar compounds and free fatty acids, necessitate effective treatment methods to enhance their quality for reuse (De Feo et al., 2023). A major problem is turning WCO recycling into alternative, highly recyclable, and reasonably priced products. However, using biosorbents improves economic sustainability while providing an environmentally beneficial alternative (Chong et al., 2023).

Starch, a natural biopolymer, has emerged as a promising treatment agent for recycled oil due to its ability to adsorb impurities and stabilize oil emulsions. Several studies have investigated the efficacy of starch-based treatments in reducing polar compounds and enhancing the stability of recycled oil. For instance, research by Wang et al. (2021) demonstrated that starch treatment significantly reduced the total polar compound content in recycled oil, thereby improving its oxidative stability and sensory properties. Additionally, studies by Hu et al. (2013) have highlighted the potential of starch-based treatments in mitigating the formation of harmful compounds in recycled oil. Despite these advancements, further research is needed to optimize starch treatment protocols and assess their impact on recycled cooking oil›s overall quality and safety.

Objective

The study aims to examine how adsorbents, like cornstarch, can help prevent the degeneration of cooking oil and make it possible to reuse it. The study's specific goal is to inspect how the fatty acid profile of fried oil changes before and after cornstarch treatment to shed light on how this procedure affects the composition and quality of the oil.

Methodology

Materials

Cornstarch, black eggplant, and (sunflower oil mix soyabean oil; 1:1 volume), an edible frying oil blend bought from the local market in Cairo, Egypt, were used in the study. Each sample was supplied in the same way and stored in the dark at a comfortable temperature before testing. The oil samples were purchased in 3-liter containers. To ensure uniformity, the four kilograms of eggplant were carefully peeled and chopped by hand. The eggplant slides were then thoroughly cleaned with absorbent paper after being rinsed with water. The temperature was kept at 180 °C during the frying cycles. Following each frying cycle, the frying pan was homogenized by moving, and 200 milliliters of oil were obtained for analysis. To get 10% and 30%, the starch sample (5g and 15g) was dissolved in 50ml of tap water. The treatments given to the fresh or fried oils under examination are compiled in Table 1.

The treated oil undergoes quality assessment tests to evaluate its chemical properties, including fatty acid content, acid value, and peroxide value. The clarified and treated oil is stored in clean, airtight containers away from direct sunlight and heat to prevent oxidation and degradation until further use for analysis (Konuskan et al., 2019).

Chemical analysis of oil

- *Peroxide value (PV):* The method described by ISO 3960 (2017) was used for analysis. According to this method, after thoroughly dissolving the oil sample (2.5 ± 0.1 g) in 10 mL of chloroform, 15 mL of acetic acid and 1 mL of saturated potassium iodide solution were added. After a minute of stirring, the sample was allowed to stand for five minutes.

Following the addition of 75 mL of distilled water, the released iodine was titrated with a 0.01 M sodium thiosulfate solution while starch was present and constantly stirred. The findings are based on three iterations of the sample analysis.

- *Acid value (AV):* The technique outlined by AOAC 969.17(1995) was used for analysis. According to this method, 50 mL of solvent was used to dissolve a 5.0±0.01 g vegetable oil sample while stirring (ether: 95% alcohol). In the presence of phenolphthalein, the resultant mixture was titrated with 0.1 M KOH solution until the pink turning point was reached. The findings are represented as mg KOH/g, and the samples were analyzed three times.
- *Fatty acid profile:* The detailed method by ISO, 12966-4 (2015) was followed in the preparation of fatty acid methyl esters (FAMEs). Ten milliliters of 0.2 mol/L H_2SO_4 made in anhydrous methanol were used to dissolve 0.2 grams of oil. In tightly sealed Pyrex tubes, esterification was carried out by refluxing for 30 minutes at 100 C. 10 mL of petroleum ether (40–60) and 10 mL of deionized water were added when the mixture had cooled to room temperature. It was then gently stirred and left to settle until the top layer of petroleum ether turned clear. In a sealed vial, the distinct top layer of petroleum ether's methyl esters was meticulously isolated and used for analysis. The GC's data processor unit (Agilent GC-MS-MS 8890, TQ7010B system) recorded peaks for the corresponding retention periods and regions after injecting 2 µL of the petroleum ether aliquots into the chromatographic column. Each methyl ester of a fatty acid was identified by comparison with genuine reference standards. Each sample was analyzed for one time. Every standard and solvent used was of analytical quality (Merck, Fluka).

Statistical analysis

For statistical analysis, researchers employed the SPSS version 21.0 package (SPSS, Chicago, USA). The mean comparison was carried out using the t-test. The alpha risk of 0.05 was selected. According to Chan (2003), a one-way analysis of variance (ANOVA) and a Percentage Change Calculator were used to determine whether the amounts of peroxide and acid values altered across different treatments.

TABLE 1. The treatments were applied to the fresh or fried blend oil samples used

Sample No.	Type of Oil	Notes
S.1	Fresh blend oil	(Sunflower + Soyabean oil 1:1) as its bought
S.2	Fried blend oil for ½ hour	Fry slides of black eggplant in oil for 30 minutes at 180°C (Dong et al., 2017).
S.3	WCO Fried blend oil +10% cornstarch	The starch-treated oil is heated to 180°C, while continuously stirring for 5 min to facilitate the interaction between starch and impurities (Yousif et al., 2012).
S. 4	WCO Fried blend oil +30% cornstarch	The starch-treated oil is heated to 180°C, while continuously stirring for 5 min to facilitate the interaction between starch and impurities (Yousif et al., 2012).
S. 5	Fried blend oil for 90 min.	Fry slides of black eggplant in oil for 90 min. (Dong et al., 2017).
S. 6	WCO Fried blend oil for 30 min. +10% cornstarch	The starch-treated oil is heated to 180°C, while continuously stirring for 5 min to facilitate the interaction between starch and impurities (Yousif et al., 2012).
S.7	WCO Fried blend oil for 90 min. + 30% starch	The starch-treated oil is heated to 180°C, while continuously stirring for 5 min to facilitate the interaction between starch and impurities (Yousif et al., 2012).

Results and Discussion

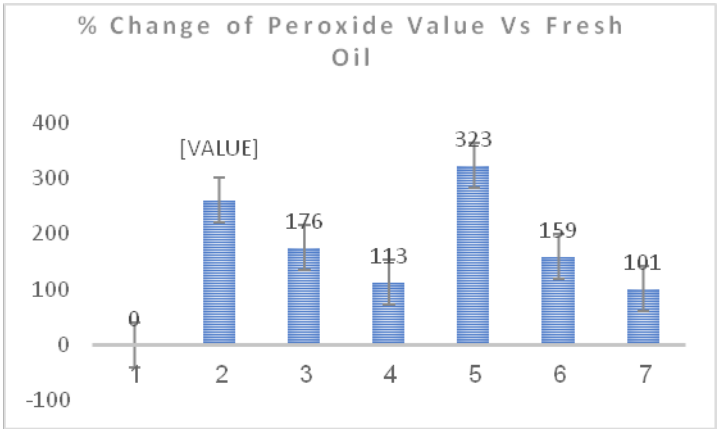
Table 2 and Figure 1 illustrate fresh and fried oil's peroxide value (PV) and percent change. The data presented in this highlight the variation in peroxide levels between the two types of oil, with fresh oil serving as the baseline. This comparison can provide valuable insights into the oxidative stability of oil under frying conditions, where the peroxide value is a common indicator of lipid oxidation. The percentage change of all treatment oils is higher than that of fresh oil, as shown in Figure 1. The 90-minute fried oil treatment had the largest percentage change (323%), whereas the 90-minute fried oil treatment with 30% starch treated had the lowest (101%). The results were better when an additional 30% of starch was applied after frying oil for 30 or 90 minutes (-41; -53%). Table 2 shows the increase in peroxide value from 4.78 meqO_2/kg in fresh blend oil to 17.25 meqO_2/kg after frying for half an hour indicating considerable lipid oxidation, suggesting degradation of oil quality. The incorporation of starch demonstrates a marked protective effect against oxidation. Fried oil treated with 10% starch shows a peroxide value of 13.21 meqO_2/kg, while the 30% starch treatment results in an even lower peroxide value of 10.2 meqO_2/kg. Moreover, the increase of peroxide values in oils fried for one hour plus ½hour (20.2meqO_2/kg), even with prolonged exposure, shows values of 12.38 and 9.59 meqO_2 /kg with 10% and 30% starch, highlighting starch's efficacy in prolonging oil stability. The data demonstrate how starch treatment influences the oxidative stability of oil during frying. The peroxide value is a key indicator of lipid oxidation, and likely varies across these treatments, reflecting the impact of frying time and starch concentrations on oil degradation. This comparison may help to evaluate the protective or worsening effects of starch addition on oil quality during extended frying. During the process of repeated frying (180 ^{0}C) of fats and oils, many volatile and non-volatile substances are formed due to the reactions that occur and which cause changes in the structure of fats and oils (Drumm amd Spanier, 1991). Lipid oxidation is a major source of quality degradation, which causes nutritional loss, reduced shelf-life, formation of off-flavors, and increased rancidity (Galano, 2015). The PV is important for monitoring the peroxides in the first stages of oxidation. The results vary depending on the process used and the temperature (Abramovic and Abram, 2005). Values of PV around 40.50 meqO_2/kg obtained from the simulation during heating at 180 ^{0}C of the sunflower oils are by other studies (Popa et al., 2017; Marinova et al., 2012). This suggests that starch may function as an absorbent, trapping free radicals and volatile compounds that contribute to oxidation (Almeida et al., 2020). The PV of oils serves as a measure of their freshness by measuring the primary oxidative damage of edible oils, namely, the conversion of hydroxyl groups of unsaturated fats in oils by molecular oxygen to hydroperoxides and peroxides (Gilbraith et al., 2021). The results of the research show that the effects of treating oil blend —WCO with corn starch are similar to those of Petrovi´c et al. (2023), with natural adsorbents showing high efficiency in reducing PV.

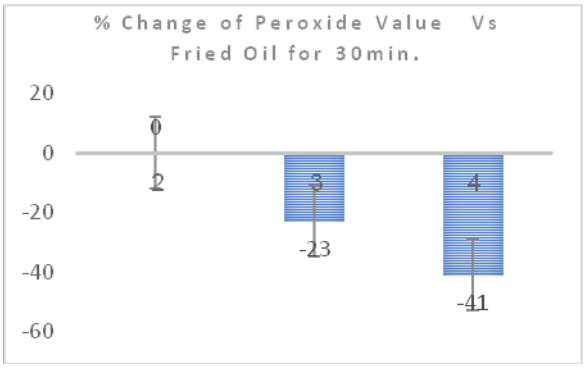
Figure 2 depicts the percent change in the acid value (AV) of fresh and fried oil with two starch treatments. The acid value is a key indicator of the level of free fatty acids in oil, which increases as the oil undergoes oxidation and hydrolysis. This figure highlights how different frying times and starch treatments influence the acid value of oil. When comparing fresh and fried oil, the statistics show that fried oil had the largest percentage change in acid value over 90 minutes (33%). After 30 or 90 minutes, the best improved fried oil was in the 30% starch-treated oil (-16; -22%). In the same table 2, the acid value across the samples remained consistent and well within the normal range of 1-1.5%. The pH levels observed in the fried oils (ranging from 0.24 to 0.32 %) suggest a relative stability in acidity, which is an important indicator of oil quality. While the pH does not exhibit significant variation with starch treatment, these levels indicate that the oils remain chemically stable in terms of acidity (Jung and Kim, 2023). The minor fluctuations in acidity values could be attributed to the starch›s interaction with the oil matrix, which may affect the release of free fatty acids during frying, although these effects appear minimal in this study. The current results show that corn starch can reduce the acidity of residual oil. Natural starch was used for the first time as an absorbent to reduce the AV and PV of WCO. The results are comparable to those in the literature (Tereshchuk et al., 2019; Putranti et al., 2018). The results of this present study closely align with those of Mishra and Sharma, (2014), who noted an acidity of 0.13% and 0.14% in a mixture of rice bran oil and sunflower oil (60:40 volume: volume) during the frying of potato chips, which had initial respective moisture contents of 0.5% and 64.77% after the sixth frying cycle. The hydrolysis process of cooking oil is expedited by the presence of water within the oil (Azzury and Yulistiani, 2024).

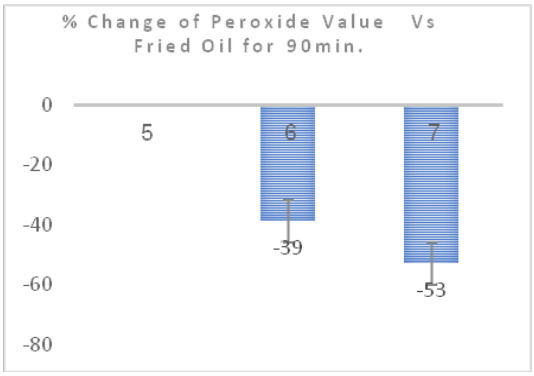
TABLE 2. Peroxide values (PV) and Acid values (AV) of fresh and fried oil with two concentration starch treatments (mean ± SE).

Parameters	Normal value	Fresh oil	Samples treatment						*P-value*
			Fried oil for 30 min and starch treatment 10;30%			Fried oil for 90 min and starch treatment 10;30%			
		S (1)	S (2)	S (3)	S (4)	S (5)	S (6)	S (7)	
Peroxide value	20 $mEqO_2$ / kg oil	4.78± 0.12	17.25± 0.26	13.21± 0.17	10.2± 0.17	20.2± 0.2	12.38± 0.15	9.59± 0.14	< 0.000
Acid Value	1.0 - 1.5%	0.24±0.011	0.31± 0.015	0.27± 0.015	0.26± 0.009	0.32± 0.009	0.28± 0.009	0.25± 0.011	0.002

S.1= fresh blend oil S.2= fried oil for ½ hour S.3=Fried oil for ½ hour + 10% starch
S.4= Fried oil for ½ hour + 30% starch S.5=Fried oil for 1 hour after ½ hour
S.6=Fried oil for 1 hour after ½ hour + 10% starch S.7= Fried oil for 1 hour after ½hour + 30% starch
Significant when P< 0.05







S.1= fresh blend oil S.2= fried oil for ½ hour S.3=Fried oil for ½ hour + 10% starch
S.4= Fried oil for ½ hour + 30% starch S.5=Fried oil for 1 hour after ½ hour
S.6=Fried oil for 1 hour after ½ hour + 10% starch S.7= Fried oil for 1 hour after ½hour + 30% starch

Fig. 1. The percent change in the peroxide value of fresh and fried oil with two concentration starch treatments.

S.1= fresh blend oil S.2= fried oil for ½ hour S.3=Fried oil for ½ hour + 10% starch
S.4= Fried oil for ½ hour + 30% starch S.5=Fried oil for 1 hour after ½ hour
S.6=Fried oil for 1 hour after ½ hour + 10% starch S.7= Fried oil for 1 hour after ½hour + 30% starch

Fig. 2. The percent change in the acid value of fresh and fried oil with two concentration starch treatments.

Table 3 detailing the fatty acid profiles in different treatment options provides valuable insights into how frying times (30 and 90min) affect the composition of WCO oils and the addition of two concentrations of starch (10 and 30%), which have important implications for oil quality and health. The same table provides a comprehensive overview of the fatty acid content across various samples, highlighting differences in saturated and unsaturated fatty acids. Notably, the total unsaturated fatty acids generally dominate, with linoleic acid being the most prevalent in most samples. The variations in palmitic and stearic acid levels suggest different lipid profiles that could be indicative of the source or processing methods of the samples. Trans-fatty acids, particularly in a sample (5, fried oil for 90 min), raise potential health concerns and warrant further investigation. Overall, this data is crucial for understanding the fatty acid composition, which can inform nutritional guidelines and food industry practices.

The data show minor fluctuations in the levels of saturated fatty acids. Myristic acid levels slightly increased after frying, peaking at 0.26 % after ½ hour of frying but after 90 min was 0.42% compared to fresh oil (0.23 %). This result was in harmony with the report by Gloria and Aguilera (1998) who said the continual or repeated use of oil at high temperatures results in several oxidative, polymerization, and thermal degradation reactions causing changes in its physical, chemical, dietary, and sensory properties. Liu et al. (2007); Ibrahim et al. (2019), reported that the extent of deep frying can result in the formation of varied amounts of trans fatty acids depending upon the frying temperature and the oil used. When adding two concentrations (10 and 30%) of starch improves the level of myristic acid at two times. However, palmitic acid remains relatively stable throughout, with values close to

18.32%. Palmitic Acid: This fatty acid increases from 12.69% in fresh oil to 18.32% after 90 min. of frying. This significant rise suggests that prolonged frying may cause the degradation of unsaturated fats, leading to a higher relative concentration of saturated fats. Interestingly, the presence of starch seems to moderate this increase slightly, particularly with the 30% starch addition (from 13.54 in fried WCO to 12.24 at 30 min and from 18.32 to 12.93 at 90 min). Stearic Acid: The levels fluctuate slightly across treatments, with a peak of 5.47 and 6.54% after two times of frying with 30% starch. This variability suggests that different therapies can influence the stability of stearic acid during cooking. The decrease in stearic acid content, especially notable after starch treatment, indicates possible interactions between starch and oil that may alter fatty acid profiles (Khan et al., 2017). The overall reduction in total saturated fatty acids after starch treatment (from 20.09 to 19.11 at ½ h and from 25.84% to 19.11% at 90 min) suggests that starch may influence lipid metabolism during frying, promoting a healthier fatty acid profile and indicating changes in these fatty acids during frying and the potential impact of cooking duration and starch additives. Peelman et al. (2013) showed that starch is recognized as one of the good biopolymers with high promise because it can biodegrade, is renewable and abundant, and is very economical.

In general, the higher the degree of unsaturation of fatty acids in vegetable oils, the more susceptible they are to oxidative deterioration (Zambiazi et al., 2000; Bradley and Min, 1992). The short-chain fatty acids are of lower melting point and are more soluble in water. Whereas, the longer chain fatty acids have higher melting points. Unsaturated fatty acids have a lower melting point compared to saturated fatty acids of similar chain length (Chayanoot and Ausa, 2010). A noteworthy increase in total unsaturated fatty acids (from 74.01% to 80.56%) is observed with the addition of starch. The highest content of total unsaturated FA was found in sample oil fried for 30 min and added 30% of starch. The most degradation was in sample oil fried for 90 min. This shift indicates that starch may protect unsaturated fatty acids from degradation during the frying process. Specifically, oleic acid levels remain stable. A higher level of oleic acid in a frying medium is demonstrated to give higher stability during the frying process (Bou et al., 2012; Romano et al., 2021). This indicates that starch could influence the oil's oxidative stability, potentially degrading oleic acid. However, the utilization and effectiveness of starch are dependent on its precise structure and composition (Pfister and Zeeman 2016; Abe et al., 2014). As a form of stored energy, many plants synthesize starch as a natural, regenerative, and biodegradable polysaccharide (Tetlow and Bertoft, 2020). The increase in linoleic acid content (from 30.29% to 37.87%) reflects potential preservation mechanisms that starch might employ to shield these sensitive compounds from oxidative damage. Research suggests that unsaturated fats are crucial for cardiovascular health, highlighting the significance of maintaining higher levels during frying (Poudyal, 2012).

Table 3 shows a clear shift in the balance of saturated and unsaturated fatty acids with different treatments. While fresh oil contains a higher proportion of unsaturated fats (80.53%), the frying process and starch additions lead to a decrease in total unsaturated fats, particularly with prolonged frying. High saturated and trans fatty acids have been linked to a higher risk of non-communicable diseases such as coronary heart disease, hypercholesterolemia, metabolic syndrome, stroke, and obesity (Hooper, 2020). Oppositely, polyunsaturated fatty acids play an important role in the prevention of chronic diseases such as hypertension, coronary artery disease, and cancer (Poudyal, 2012).

The total trans-fatty acid content decreases with starch treatment, from 0.78 % in normal oil to 0.70 % and 0.63% with 10% and 30% starch after half an hour of frying. This reduction is promising, as trans fats are linked to adverse health effects, including an increased risk of heart disease **(**Mozaffarian et al., 2010). The potential of starch to reduce the formation of trans fats during frying presents an intriguing area for further investigation, as it could inform healthier frying practices. The interest in trans fatty acids has increased in days gone by few years, because of the relation between trans fatty acid intake and the risk of cardiovascular, chronic respiratory, neural, and degenerative diseases and certain cancers (Stender and Dyerberg, 2004)

The omega-6 fatty acid content remains relatively consistent, which is beneficial since these fatty acids are essential for various physiological functions. However, a slight decrease in omega-3 content suggests that frying and starch treatment may affect the stability of these sensitive compounds. Lipids play a crucial role in the diet by supplying essential fatty acids such as linoleic acid (n-6) and alpha-linolenic acid (n-3) necessary for providing the energy required for the body (Kaur et al., 2014). Maintaining a balanced ratio of omega-6 to omega-3 is essential for optimal health, indicating a need for further studies on how starch treatments could better preserve these fatty acids during cooking.

Table 3: Fatty acid profiles in fresh blend oil and different treatment options (frying times (30 and 90 min) affect the composition) and (the addition of two starch concentrations (10 and 30%) of WCO oils.

Content of fatty acids	Fatty acids relative	Fresh oil	Samples treatment					
			Fried oil for 30 min and starch treatment 10;30%			Fried oil for 90 min and starch treatment 10;30%		
		(S1)	(S2)	(S3)	(S4)	(S5)	(S6)	(S7)
Saturated fatty acids	Lauric acid	0.05	0.04	0.05	0.04	0.04	0.05	0.03
	Myristic acid	0.23	0.26	0.24	0.23	0.42	0.39	0.24
	Pentadecanoic acid	-	-	-	-	-	-	-
	Palmitic acid	12.69	13.54	13.00	12.24	18.32	15.30	12.93
	Margaric acid	0.04	0.04	0.03	0.02	0.07	0.06	0.04
	Stearic acid	5.05	4.78	5.16	5.47	4.08	5.42	6.54
	Arachidic acid	0.20	0.28	0.20	0.16	0.72	0.52	0.16
	Behenic acid	0.95	0.98	0.85	0.82	1.38	0.98	0.92
	Lignoceric acid	0.10	0.17	0.15	0.13	0.18	0.13	0.10
Mono-unsaturated fatty acids	Myristoleic acid	-	-	-	-	-	-	-
	Palmitoleic acid	0.18	0.19	0.18	0.13	0.30	0.27	0.19
	Cis-Vaccenic acid	-	-	-	-	0.07	-	-
	Olic acid	37.38	37.87	37.69	37.35	37.63	36.25	35.29
	Trans-Vaccenic acid	0.01	0.03	0.02	0.01	0.19	0.11	0.02
	11-Eicosenoic acid	0.04	0.03	0.06	0.12	0.07	0.52	0.87
Polyunsaturated fatty acids	Linoleic acid	42.00	40.46	41.75	42.67	38.16	41.49	42.70
	Trans- Linoelaidic acid	0.77	0.79	0.68	0.62	1.32	1.19	0.94
	Linolenic acid	0.20	0.18	0.18	0.19	0.17	0.17	0.22
Total Saturated fatty acid		19.31	20.09	19.96	19.11	25.84	22.85	20.96
Total unsaturated fatty acid		80.53	78.55	80.56	81.09	77.91	78.77	79.23
Total Mono-unsaturated fatty acids		37.61	38.12	37.95	37.61	38.26	35.92	35.37
Total Polyunsaturated fatty acids		42.92	41.43	42.61	43.48	39.65	42.85	43.86
Omega 3		0.20	0.18	0.18	0.19	0.17	0.17	0.22
Omega 6		42.00	40.46	41.75	42.67	38.16	41.49	42.70
Total Trans-fatty acid		0.78	0.82	0.70	0.63	1.51	1.27	0.76

S.1= Fresh blend oil S.2= Fried oil for 30 min. S.3= Waste fried oil for 30 min. + 10% starch
S.4= Waste fried oil for 30 min.+ 30% starch S.5=Fried oil for 90 min.
S.6= Waste fried oil for 90 min.+ 10% starch S.7= Waste fried oil for 90 min. + 30% starch

Conclusions

The analysis underscores the significant impact of frying duration and the addition of starch on the fatty acid composition of oils. The quality of frying oil started deteriorating with the increase in frying cycles and would be more dangerous from the health point of view when it crossed some limits. The frying stability of blend oil under the same conditions of frying before and after treatment with starch was compared. The results underscore the effectiveness of starch as a stabilizing agent in frying oils, significantly reducing the peroxide value and maintaining acceptable acid levels. The reduction in oxidation markers suggests that starch treatment could enhance the shelf life and healthfulness of fried oils. Future investigations should explore the underlying mechanisms of starch's protective role and assess its impact on the sensory qualities of fried products.

Recommendation

While cornstarch demonstrated positive results in preserving the fatty acid profile and oxidative stability of oil, other natural biopolymers or additives could be explored for even greater benefits. Comparing the effectiveness of starch with materials may uncover more efficient methods for recycling WCO.

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