ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2025; 25(5): 26727-26745 https://doi.org/10.18697/ajfand.142.25660

Date	Submitted	Accepted	Published
	3rd January 2025	28th April 2025	7th July 2025

INFLUENCE OF SWEET POTATO PEEL EXTRACT ON OXIDATIVE STABILITY OF PALM OIL DURING FRYING

Jittrepotch N[1], Kraboun K[2], Rojsuntornkitti K[1], Thanasukarn P[1], Kongbangkerd T[1], Uthai N[3] and J Wattanakul[3]*

Nitipong Jittrepotch

*Corresponding author email: jutarat.w@mail.rmutk.ac.th

[1]Faculty of Agriculture, Department of Agro-Industry, Natural Resources and Environment, Naresuan University, Phitsanulok, 65000, Thailand

[2]Faculty of Science and Technology, Department of Food Safety Management and Technology, Rajamangala University of Technology Krungthep, Bangkok, 10120, Thailand

[3]Faculty of Home Economics Technology, Department of Food and Nutrition, Rajamangala University of Technology Krungthep, Bangkok, 10120, Thailand

ajfand Since 2001 AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ABSTRACT

Deep-frying is a widely used culinary technique valued for its rapid cooking process and the appealing flavor and texture of fried foods. However, oxidative changes during frying significantly deteriorate the nutritional quality of fats and oils, leading to health concerns and reduced oil usability. The aim of this study was to assess the influence of sweet potato peel extract (*Ipomea batatas* Cultivar Phichit 65-3) on palm oils stability during frying of potato chips. The antioxidant activities of the sweet potato peel extracts were determined in term of total phenolic content, total flavonoid content (TFC), total monomeric anthocyanin (TMA) and 2,2-diphenyl-1-picryl hydrazyl (DPPH) radical scavenging activity. It was found that the sweet potato peel extract showed antioxidant activity in the form of total phenolic content, total flavonoid content, total anthocyanin and 2,2-diphenyl-1-picryl hydrazyl (DPPH) radical scavenging activity equivalent to 157.84 mg GAE/100 g, 370.17 mg QE/100 g, 126.84 mg/100 g and 80.72%, respectively. The peroxide values (PV), 2-thiobarbituric acid values (TBA), free fatty acid (FFA), total polar compounds (TPC) of the fresh oil were 2.53 meq H_2O_2/kg oil, 1.70 mg malondialdehyde/kg oil, 0.03% and 3.78%, respectively. These values changed to 25.98, 15.12, 8.49 and 26.78, respectively for the control oil. Extracts from sweet potato peels, which are abundant in antioxidants such as phenolic compounds, serve as a natural substitute for synthetic antioxidants in frying oil, improving its stability and prolonging its shelf life. Results revealed using sweet potato peel extracts at 1,600 ppm and 2,000 ppm in palm oils were effective in reducing changes of the chemical properties of palm oil during frying at 180 ± 5°C for 35 h. Fatty acid compositions of palm oil during frying for 35 h were used to assess the extent of lipid oxidation. Using the sweet potato peel extracts in frying oil slowed down the rate of the formation of *trans* fat isomerization compared to the control. Sweet potato peel extract could be recommended and applied as a potent source of antioxidants for the stabilization of oil food systems.

Key words: Antioxidant activity, fatty acid composition, sweet potato peel extracts, oxidative stability, palm oil

Citation: **Jittrepotch N, Kraboun K, Rojsuntornkitti K, Thanasukarn P, Kongbangkerd T, Uthai N and J Wattanakul** Influence of sweet potato peel extract on oxidative stability of palm oil during frying. *Afr. J. Food Agric. Nutr. Dev.* 2025; **25(5):** 26727-26745
https://doi.org/10.18697/ajfand.142.25660

INTRODUCTION

Fats and oils consist of a mixture of monounsaturated, polyunsaturated, and saturated fatty acids. Trans fatty acids are unsaturated fatty acids characterized by the presence of at least one double bond in the trans configuration, as opposed to the typical *cis* structure [1]. Research has established a direct correlation between trans fatty acids and cardiovascular disorders, breast cancer, preeclampsia risks, obesity, and allergies [2]. Several nations, including Belgium, France, Germany, Switzerland, the Netherlands, the United States, and Chile, have implemented laws and regulations to regulate the quality of frying oil. In 2018, Thailand enacted legislation mandating that both domestic and imported foods contain less than one percent of industrially produced trans fat, so essentially prohibiting the usage of partly hydrogenated vegetable oils within the nation. Trans fats are generated during lipid oxidation. Elevated temperatures expedite the oxidation process, hence hastening the production [3].

Deep-frying is a significant culinary technique owing to its quick cooking process and the appealing flavor and textural attributes of fried dishes. During frying, multiple concurrent processes transpire in the presence of the atmosphere, air, food, water, and elevated temperatures, such as 180°C [4]. Heat transfers from oil to food, causing water evaporation and oil absorption [5]. Numerous physical and chemical transformations occur in oil due to oxidation, pyrolysis, polymerization, hydrolysis, and isomerization reactions, generating countless substances that are integrated into foods, thereby modifying their appearance, aroma, and flavor [6,7]. Furthermore, the concomitant processes elevate the viscosity of the oils, darken their hue, enhance foaming, and reduce the smoking point [6] indicated that the generation of trans fats during food frying is significantly influenced by the temperature and method of frying. Numerous plant extracts have been documented to exhibit differing levels of antioxidant activity in fats and oils [8]. Typically, the refuse from fruits and vegetables is utilized as livestock feed or as fertilizer. However, peels, pomace, and seeds are abundant in bioactive chemicals that can be isolated for dietary and medicinal use [9].

Sweet potato (*Ipomea batatas* L.) is a significant agricultural product in numerous nations globally. It is facile to cultivate, exhibits excellent adaptability to many climatic circumstances, and possesses great yield potential and substantial energy content [10]. In recent years, purple sweet potatoes have been extensively cultivated in several regions of Thailand. The two novel breeding kinds, Maejo 343 and Phichit 65-3, exhibit rapid growth and enhanced productivity. Furthermore, the Phichit 65-3 cultivar exhibits a distinct deep purple hue, rendering it more favored in Thailand. Phenolic chemicals are primarily located in the potato cortex and skin tissues [11].

There is an increased emphasis on the necessity of antioxidants to enhance antioxidant activity in frying oil, aiming to substitute synthetic antioxidants with safer alternatives and diminish the levels of saturated and trans fats in frying oil. The objectives of this study were to assess the impact of the extract derived from sweet potato peels on the regulation of thermal oxidation during frying. This investigation involved the individual addition of antioxidant extracts to palm oil, with samples being fried for 5 h daily over a span of seven consecutive days at 180°C.

MATERIALS AND METHODS

Materials

Frozen pre-fried French fries and palm oil were acquired from a nearby market. Purple sweet potato (*Ipomea batatas* Cultivar Phichit 65-3) was supplied by the Agriculture Development and Research Center in Phichit, Thailand. Fresh roots were preserved at 10°C before utilization. The samples were planted in an experimental field and harvested 4-5 months after planting. The sweet potato samples were cleansed, and the peel was manually detached from the flesh. Whole peels were desiccated in a hot air oven and the samples were preserved at -20°C until the antioxidant extraction procedure was finalized, subjected to an air oven at 50ºC for 24 h, and thereafter pulverized to a fine powder (less than 400 µm). Samples were preserved and maintained at -20°C for further analysis.

Extraction of sweet potato peels

The extraction of sweet potato peel was conducted following the methodology of Koduvayur Habeebullah *et al.* [12], with few modifications. A 10 g of sweet potato peel powder was extracted with 100 ml of 95% ethanol. The mixture was agitated the mixture in a water bath at 70 °C for 30 min. For subsequent to extraction, it was centrifuged at 9000 rpm for 10 min and filtered using Whatman No.1 paper. The extract was evaporated using an evaporator and subsequently kept at -20°C for further analysis.

Determination of total phenolics

The total phenolic content was assessed utilizing the Folin-Ciocalteu reagent as outlined by Singleton *et al.* [13], with certain adjustments implemented. In summary, 100 µl of each sweet potato peels extract was allocated to the test tube and combined with 500 µl of diluted Folin-Ciocalteu reagent (1:1 ratio in distilled water). Following a 5-min equilibration period, 1 ml of sodium carbonate (7.5% w/v) was added to the mixture in the tube and permitted to react for 30 min at ambient temperature. The absorbance was measured at 760 nm. The total phenolic content was estimated from a calibration curve established with gallic acid standard (0.01-0.1%) as a reference. The total phenolic content was quantified as mg of gallic acid equivalent (GAE) per 100 g of dry sample weight.

DPPH radical scavenging

The DPPH radical scavenging activity was evaluated according to the methodology outlined by Turkmen *et al*. [14], with several changes. A 0.1 mM DPPH solution was produced in 95% ethanol and combined with 1.0 ml of extract solution (or standard) at varying concentrations of 500, 1,000, 1,500, 2,000, and 2,500 mg/L. This was succeeded by thorough mixing and incubation in darkness for 60 min. The absorbance was quantified at 517 nm utilizing the spectrophotometer, followed by the calculation of the percentage inhibition. The determination of the percentage inhibition of antioxidant activity was conducted as follows:

$$\% \text{ Inhibition} = [(Ac - As / Ac) \times 100]$$

Where Ac is the absorbance of control and As is the absorbance in the presence of potato peel extracts.

Total flavonoid content (TFC)

The flavonoid content was assessed utilizing the colorimetric aluminum chloride method [15] with certain modifications. In summary, 1.5 mL of methanol, 0.1 mL of 10% aluminum chloride, 0.1 mL of 1 M potassium acetate, and 2.8 mL of deionized water were combined with 0.5 mL of suitably diluted sample solutions. Following a 30-min incubation at room temperature, the absorbance of the reaction mixture was measured at 437 nm. The yellow hue signifies the presence of flavonoids. The flavonoid concentration is quantified in mg of quercetin equivalent/gram of dried extract (mg QE/g).

Total monomeric anthocyanin content (TMA)

The concentration of total monomeric anthocyanins was assessed using a modified pH differential approach [16]. The absorbance values of the samples were quantified using a spectrophotometer at wavelengths of 530 and 700 nm in a buffer with pH levels of 1.0 and 4.5. The variation in absorbance between pH levels and wavelengths was computed:

$$A = (A_{530\ nm} - A_{700\ nm})\ pH1.0 - (A_{530\ nm} - A_{700\ nm})\ pH4.5$$

The concentration of monomeric anthocyanin pigment was calculated using the formula: monomeric anthocyanin pigment (mg/L) = (A × MW × DF × 1000)/ (ε × 1), where MW represents the molecular weight, DF denotes the dilution factor, ε indicates the molar absorptivity, and 1 corresponds to a standard 1-cm pathlength. The molecular weight (MW = 449.2) and molar absorptivity (ε = 26900) of cyanidin-3-glucoside were utilized. The total monomeric anthocyanins were quantified as mg of anthocyanins/100 g of fresh or dry weight (mg cyanidin-3-glucoside/100 g, dw).

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Frying Experiments

Four sets of frying experiments were performed; natural antioxidant (sweet potato peel extracts) added oil at concentrations of 800 1,200 1,600 and 2,000 ppm and the control (oil without any antioxidants). Potato slices were fried in palm oil at 180 ± 5°C in 5-L capacity restaurant style stainless steel deep fryers (Champ, Thailand). A batch of 500 g of frozen French fries was fried for 8 min in palm oils heated at 180 ± 5 °C, every 1 h interval and fried for 5 times for 7 consecutive days. At the end of each day of frying, the fryers were shut off, cooling to 60 ± 5 °C and all frying media were filtered to remove solid debris. Then, samples of oil were transferred to a screw capped bottle flushed with N_2 and closed tightly, before keeping in the dark at -20 °C. However, fresh oil was not added between the cycles.

Fatty acid determination

Gas chromatography (GC) was carried out with a GC model GC 17A (Shimadzu Corp., Kyoto, Japan) equipped with a flame-ionization detector and Zebron ZB-Wax fused silica wall-coated open tubular column (0.25 mm i.d. x 30 m, 0.25 µm in film thickness: Torrance, CA, USA). Fatty acids of total lipid were esterified to methyl esters, using a base-catalyzed transesterification, followed by a BF3 -MeOH catalyzed esterification, according to the official method of AOCS Ce 1b-89 [17], to obtain fatty acid methyl ester (FAMEs). The FAMEs were dissolved in iso-octane and injected into a gas chromatograph. The column oven and injection port temperature were held initially at 170°C for 2 min, then programmed to 240°C at a rate of 5°C/min, from 240°C to 250 °C at a rate of 1.6 °C/min, and finally held at 250 °C for 10 min. A running time of 60 min was employed for each sample solution. Nitrogen was used as a carrier gas with an inlet pressure of 2.0 kg/cm^2. The results were expressed as a percentage fraction of total fatty acids. The absolute amounts of cis and trans fats in the oil were calculated based on the peak intensity of the internal standard.

Thiobarbituric acid values (TBA)

The use of TBA as an agent for measuring fat oxidation was established through several empirical methods used to animal and vegetable lipids. The TBA values for each sample were ascertained using the standard technique Cd 19-90 of the American Oil Chemists' Society [17]. TBA was quantified at 530 nm using a spectrophotometer and expressed as mg malondialdehyde/kg sample.

Peroxide values (PV)

PV was quantified according to the methodology outlined by Buege and Aust (1978) [18] and expressed in mmol/kg of lipid. The absorbance of the reaction solutions was measured at 500 nm.

https://doi.org/10.18697/ajfand.142.25660

Free fatty acid (FFA)

The free fatty acid (FFA) content of oils was estimated using the standard technique Ca 5a-40 of the American Oil Chemists' Society [17]. The outcomes are shown in percentages (in terms of palmitic acid).

Total polar compounds (TPC)

The samples were evaluated for % TPC utilizing the Food Oil Monitor 310 (FOM 310, Ebro Inc., Germany). Prior to doing any measurements, the test mode (liquid, semiliquid, or solid) of the FOM 310 was chosen based on the oil sample's state, and the sensor was calibrated accordingly. The test strip was directly immersed in the hot oil (165-190°C) for 3 sec. This constant was transformed into the percentage of total polar compounds using the formula supplied by the manufacturer.

Fatty acid determination

Gas chromatography (GC) was carried out with a GC model GC 17A (Shimadzu Corp., Kyoto, Japan) equipped with a flame-ionization detector and Zebron ZB-Wax fused silica wall-coated open tubular column (0.25 mm i.d. x 30 m, 0.25 µm in film thickness: Torrance, CA, USA). Fatty acids of total lipid were esterified to methyl esters, using a base-catalyzed transesterification, followed by a BF3 -MeOH catalyzed esterification, according to the official method of AOCS Ce 1b-89 [17], to obtain fatty acid methyl ester (FAMEs). The FAMEs were dissolved in iso-octane and injected into a gas chromatograph. The column oven and injection port temperature were held initially at 170°C for 2 min, then programmed to 240°C at a rate of 5°C/min, from 240°C to 250 °C at a rate of 1.6 °C/min, and finally held at 250 °C for 10 min. A running time of 60 min was employed for each sample solution. Nitrogen was used as a carrier gas with an inlet pressure of 2.0 kg/cm^2. The results were expressed as a percentage fraction of total fatty acids. The absolute amounts of *cis* and trans fat in the oil were calculated based on the peak intensity of the internal standard.

Statistical analysis

All experiments were conducted in triplicate. The statistical analyses were conducted using Microsoft Excel 6.0 (Microsoft Corporation, Washington, USA) and IBM SPSS Statistic for Windows Version 27.0 (IBM Corp, Armonk, NY, USA). The data were examined utilizing one-way ANOVA, and means were compared employing Duncan's multiple range test. Differences were considered to be statistically significant at $p<0.05$.

ajfand Since 2001 AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

RESULTS AND DISCUSSION

Antioxidant activities

The antioxidant activities of the extract from sweet potato peel (*Ipomoea batatas* Cultivar Phichit 65-3) are presented in Table 1. Phenolic compounds are secondary metabolites of plants, with chlorogenic acid being the predominant phenolic acid, comprising up to 90.0% of the total phenolic compounds in potatoes [19]. The total phenolic components in sweet potato peel extract was 157.84 ± 6.10 mg GAE/100 g, consistent with the findings of Rumbaoa *et al.* [20]. Additionally, Kim *et al.* [21] documented a maximum total polyphenol concentration of 134.67 mg GAE/g extract derived from sweet potato. Flavonoids constitute the predominant category of plant phenolic chemicals, and their presence affects the flavor and color of fruits and vegetables. Table 1 indicates that the total flavonoid content, measured as quercetin equivalents from sweet potato peel extracts, exhibited elevated values of 370.17 ± 16.67 mg QE/100 g. Anthocyanin is a subclass of phenolic phytochemicals existing as a glycoside, whereas anthocyanidin is recognized as the aglycone. Anthocyanidins are classified into three categories: 3-hydroxyanthocyanidins, 3-deoxyanthocyanidins, and O-methylatedantho cyanidins, whereas anthocyanins exist as anthocyanidin glycosides and acylated anthocyanins [22]. Anthocyanins are typically present in the flowers and fruits of numerous plants. The majority of flowers exhibiting red, purple, and blue hues contained anthocyanins. The extracts from sweet potato peels exhibited elevated total anthocyanin levels of 126.84±9.31 mg cyanidin-3-glucoside/100 g.

The 2,2-diphenyl-1-picryl-hydrazyl (DPPH) radicals are the most often utilized radicals for assessing antioxidant activity [23]. The antioxidant activity, measured by DPPH, was 80.72 ± 2.98% in sweet potato peel extracts. Several researches examined the elevated antioxidant activity of potato peels, which comprise 90.0% phenolic compounds [19]. Flavonoids represent the most extensive category of low molecular weight polyphenols and are deemed accountable for the color and flavor of several fruits and vegetables [24]. The findings indicate that sweet potato peel extracts exhibit antioxidant capabilities and may serve as alternative natural antioxidants.

Peroxide value

The alteration of the peroxide value of oil samples during deep frying is seen in Figure 1. The peroxide number has been extensively utilized as an indicator of oil rancidity. A high peroxide number generally indicates a higher degree of rancidity. Upon heating the oil, an oxidative reaction transpires, yielding hydroperoxide, a volatile breakdown product, which subsequently decomposes into aldehydes,

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ketones, lipoperoxides, and free radicals These chemical compounds produced undesirable odor and flavor in the oil and its fried product.

The PV quantifies the concentration of peroxides and hydroperoxides generated during the initial phase of oil and fat oxidation [25]. The PV of all samples exhibited significant differences ($p<0.05$). The PV of the control group swiftly rose from 2.53 ± 0.10 to 25.98 ± 1.00 mmol/kg oil during the first 30 h of frying, subsequently declining to 23.43 ± 0.90 mmol/kg oil. In the oil samples containing 1,600 and 2,000 ppm potato peel extracts, the peroxide value (PV) gradually escalated from 2.53±0.10 to 16.00±0.20 mmol/kg throughout the initial day to 30 h of frying, then exhibiting a progressive decline of PV until 35 h of frying time. The effect of sweet potato peel extract intensified with concentration, and the antioxidant activity at concentrations of 1,600 and 2,000 ppm did not exhibit significant differences ($p<0.05$). The findings concurred with those of Samarin *et al.* [26], who demonstrated that the antioxidant efficacy of 1,600 ppm of potato peel extract was analogous to that of the synthetic antioxidant BHT following a 16-day storage of soybean oil at 63°C. Che Man *et al.* [27] similarly obtained analogous results.

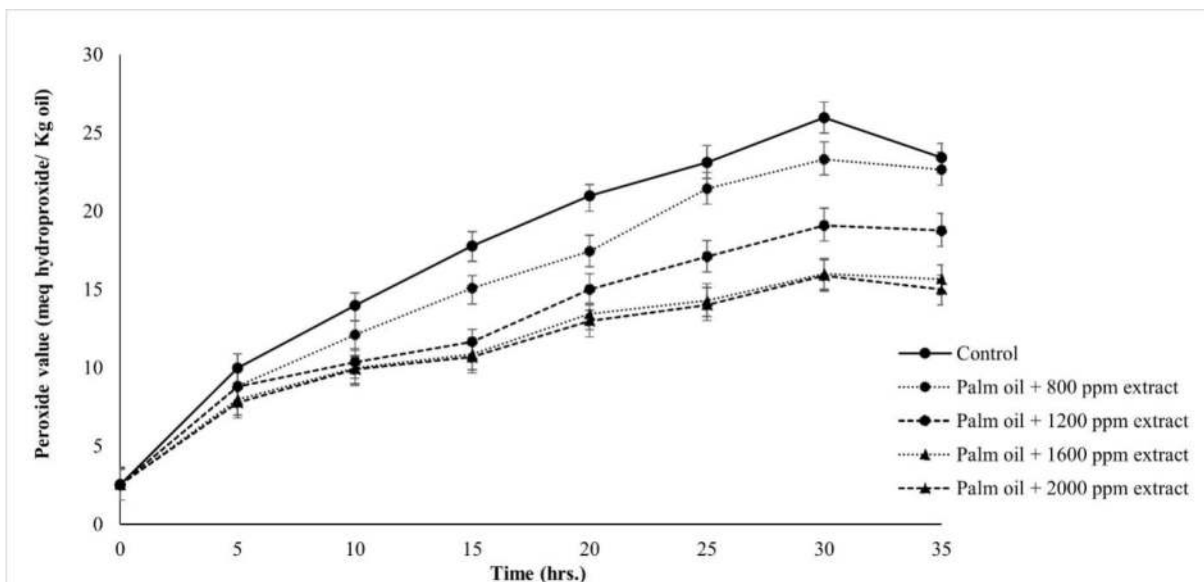

Figure 1: Change of PV of oil samples during deep frying for 35 h

Thiobarbituric acid values (TBA)

The incorporation of a natural antioxidant into palm oil influenced TBA values to varying extents during a 35-h total frying period (Figure. 2). The TBA value measurement serves as a criterion for assessing secondary oxidation products. This technique relies on quantifying the pink complex generated at an absorbance of 532 nm following the interaction of one molecule of malondialdehyde (MD) with two molecules of thiobarbituric acid [28]. A higher TBA value generally indicates a higher

CC BY NC ND

ajfand Since 2001
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

of lipid peroxidation, which is related with a rancidity of oil. During the initial phase of frying, there was no statistically significant difference ($p>0.05$) in TBA values among the various treatment groups. TBA readings varied from 1.70 to 1.80 mg malondialdehyde/kg oil; nevertheless, at the conclusion of the frying duration (35 h), the TBA value of the control exceeded that of all samples ($p<0.05$). The TBA values of all oil samples were comparable to those documented by Samarin *et al.* [26] and Habib and Shah [29], exhibiting a steady increase over the frying duration. The elevated quantity of antioxidants was demonstrated to enhance the stability of frying oil. Consequently, sweet potato extracts may inhibit the elevation of TBA values in palm oil.

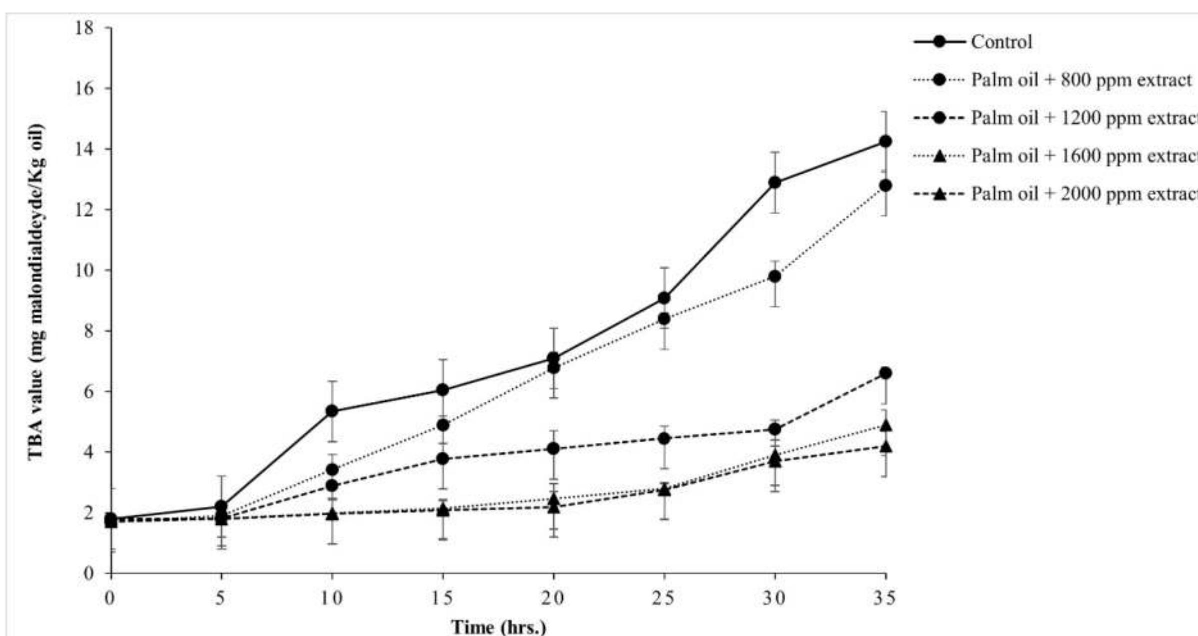

Figure 2: TBA values during frying for 35 h

Free fatty acid

Hydrolytic rancidity predominantly affects products derived from lauric oils, including palm kernel and coconut oils. The rancidity results from the release of free fatty acids from the parent oils, which therefore contain significant quantities of capric, lauric, and myristic acids [7]. The determination of these free fatty acids (FFA) is both rapid and dependable, making this a method that is commonly used by several food processors for the monitoring of free fatty acid during frying [30]. Figure 3 illustrates the variation in free fatty acid (FFA) concentration of oil samples over a frying duration of 35h. No substantial variation was seen between the initial free fatty acid (FFA) levels of the oil samples at 0 h. Fresh oil and oil supplemented with potato peel extracts exhibited high quality when the free fatty acid (FFA) content remained within a restricted range of 0.03% to 0.05% (Figure. 3). The FFA levels rose from 0.03% to 2.23% in the control, surpassing those of all experimental samples

CC BY NC ND

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

(*p*<0.05). Nevertheless, the oil samples containing 1,600 and 2,000 ppm of potato peel extracts markedly inhibited the generation of free fatty acids (FFA) (*p*<0.05). This aligns well with other prior studies Delfanian *et al*. and Kalogianni *et al.* [31-32]. The findings indicated that the natural antioxidants in the peel extracts more effectively safeguarded the oils against hydrolysis. The findings align with those of Habib and Shah [29] and Delfanian *et al.* [31], who investigated the antioxidant properties of potato peel extract and *Eriobotrya japonica* extract in soybean oil.

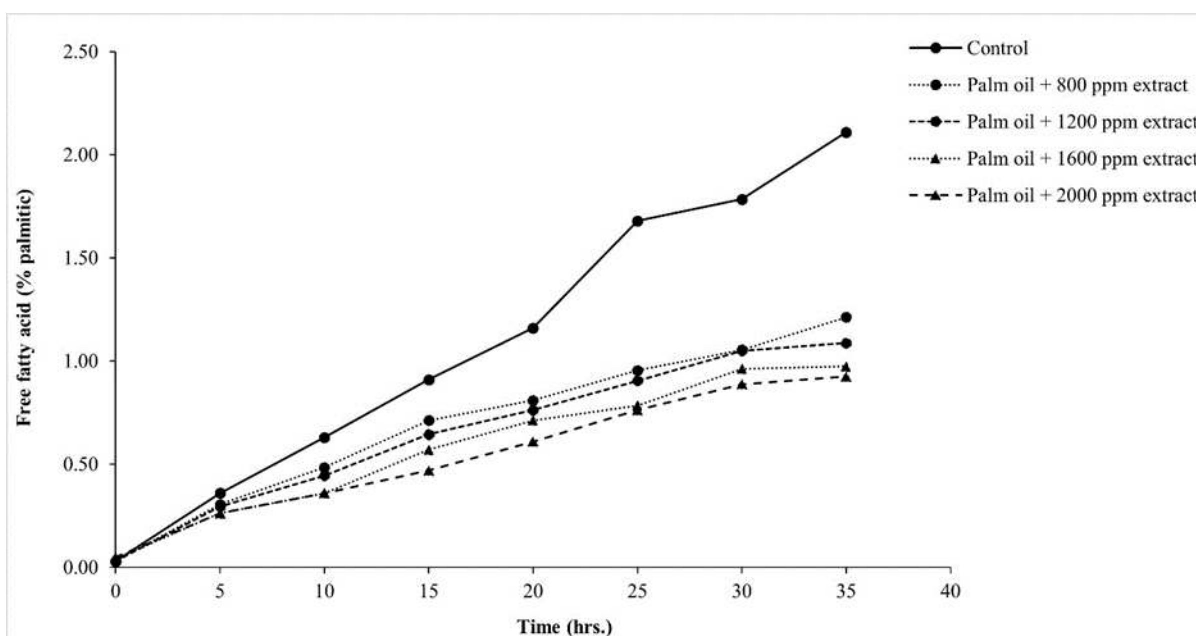

Figure 3: FFA content of oil samples during frying for 35 h

Total polar compounds

The Food and Drug Administration of Thailand found that the total polar compounds, a significant indicator of oil degradation, surpassed the limit by 25% of the used oil. The elevation of TPC in the oils indicates the synthesis of highly polar molecules, including triacylglycerols and subsequent oxidation products. The total polar compounds in unused oils typically vary from 3.78 to 3.90 mg/100 mg of oil and the total polar compounds of this new frying oil also indicated its high quality [33]. The total polar compounds in all oil samples rose with extended frying duration (*p*<0.05). During the frying process, it was noted that the fat content of the control sample increased more than that of the other oil samples, ultimately reaching the crucial threshold of 25%. At the conclusion of the frying duration, the control sample demonstrated the highest total polar compounds, succeeded by palm oil with 800, 1200, 1600, and 2000 ppm of potato peel extracts, respectively (Figure 4). Nonetheless, there is no statistically significant difference (*p*>0.05) in total polar compounds between samples containing 1,600 and 2,000 ppm of sweet potato peel extracts. The findings concurred with earlier research by Casarotti and Jorge [34],

CC BY NC ND

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

which shown that rosemary extract was more efficacious in diminishing the synthesis of polar molecules in frying oil than tert-butylhydroquinone (TBHQ), which is used as an antioxidant preservative for unsaturated oils.

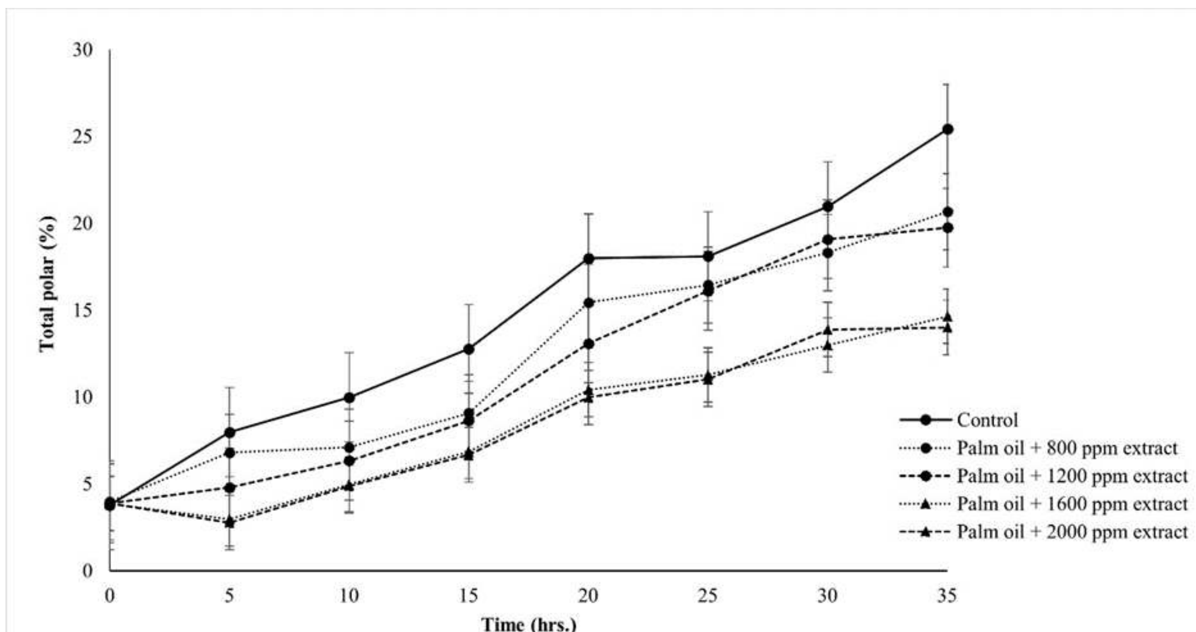

Figure 4: The total polar content of oil samples during frying for 35 h

Fatty acid composition

The content of fatty acids is frequently utilized to determine the validity of oils [35]. This information allows users to forecast the stable condition of the oil. The fatty acid contents of palm oil after 35 h of frying are presented in Table 2. Typically, palm oil contains high levels of oleic acid (C18:1) and palmitic acid (C16:0). This investigation identified oleic acid (C18:1) and palmitic acid (C16:0) as the major fatty acids in all samples. In control samples, the concentrations of lauric acid (C12:0), myristic acid (C14:0), palmitic acid (C16:0), and stearic acid (C18:0) significantly increased with prolonged frying duration. The rise in saturated fatty acids and the decline in unsaturated fatty acids in repeatedly used frying oils may be attributed to the greater oxidation of unsaturated fatty acids compared to saturated fatty acids throughout the frying process. The findings concurred with those of Che-Man *et al.* [27], who investigated the impact of natural and synthetic antioxidants on the alterations of refined, bleached, and deodorized palm olein during the deep-fat frying of potato chips.

This study primarily examines the impact of potato peel extract on trans fats consisting of 18 carbon atoms, which were the most prevalent. The initial total trans-fat levels in all samples ranged from 0.02% to 0.03% (Table 2). Individual trans fats observed included C18:1, t-9, and C18:2, t-6. In the control, the total trans-fat with 1.0% trans double bond in 800 ppm and 1,200 ppm sweet potato extracts increased

CC BY NC ND
https://doi.org/10.18697/ajfand.142.25660

ajfand Since 2001 AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

from 0.02% to 1.45%. The findings were analogous to earlier research by Filip *et al.* [36], which indicated that trans double bond levels rose from 0.91% to 1.71% in sunflower vegetable oil when heated at 180 °C for 120 h. In the oil samples containing 1,600 and 2,000 ppm potato peel extracts, C18:1, t-9, and C18:2, t-6 gradually escalated from 0.04±0.00 to 0.16±0.03% from the initial day to the final day over 35-h frying period. During heat oxidation, unsaturated fatty acids may experience hydrogen abstraction, resulting in the formation of corresponding radicals. The thermodynamically unstable radicals are promptly transformed into peroxyl radicals during the ensuing oxidative process. Antioxidants interact with peroxyl radicals to create a stable molecule, therefore halting more lipid oxidation [37].

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

Sweet potato peel extract exhibited significant antioxidant activity in terms of total phenolic content, total flavonoid content, total anthocyanin content, and the DPPH free radical assay. The analysis of PV, TBA, FFA, total polar compounds, and fatty acid content of palm oils treated with 1,600 and 2,000 ppm of sweet potato peel extract demonstrated the strongest antioxidant potential. It may also be concluded that sweet potato peel extract at 1,600 ppm and 2,000 ppm can efficiently stabilize palm oil at its legal limit during deep-frying at 180±5°C. They did not only inhibit oxidation, but also prevent the isomerization of trans fats during the frying process. Sweet potato peel extract may be advocated and utilized as a robust source of antioxidants for the stabilization of oil-based food systems.

ACKNOWLEDGEMENTS

This work was financially supported in part by a Grant-in-Aid from Naresuan University (R2560B010).

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 1: **Antioxidant activities of sweet potato peel extract**

Antioxidant activity	Mean ± SD
Total phenolic (mg GAE/100 g)	157.84 ± 6.10
Total flavonoid (mg QE/100 g)	370.17 ± 16.67
Total monomeric anthocyanin (mg/100 g)	126.84 ± 9.31
Inhibition of DPPH radical scavenging (%)	80.72 ± 2.98

Total phenolics values are expressed in mg GAE/100 g, dw
Total flavonoid values are expressed in mg QE/100 d, dw
Total monomeric anthocyanins are expressed as mg cyanidin-3-glucoside/100 g, dw
Inhibition of DPPH radical scavenging are expressed as percentage.
Values are means of 3 replicates ± the standard deviation of the mean
dw means dry weight

CC BY NC ND

ajfand Since 2001 AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Table 2: Fatty acid compositions (%) of palm oil during frying for 35 h

Sweet potato peel extract (ppm)	Frying time (h.)	C12:0	C14:0	C16:0	C18:0	C18:1 n-9 *cis*	C18:1 n-9 *trans*	C18:2 n-6 *cis*	C18:2 n-6 *trans*	SFA	UFA	Trans fat
Control	0	0.98	1.21	40.11	4.19	42.89	0.02	10.34	0.02	46.49	53.27	0.04
	5	1.23	1.98	41.54	5.89	40.01	0.06	8.89	0.08	50.64	49.04	0.14
	10	1.89	2.01	41.96	6.03	39.53	0.09	8.02	0.09	51.89	47.73	0.18
	15	1.97	2.54	42.06	6.62	36.89	1.02	7.56	1.06	53.19	46.53	2.08
	20	2.23	2.89	42.56	6.89	36.02	1.10	6.98	1.23	54.57	45.33	2.33
	25	2.67	3.13	42.98	7.11	35.23	1.20	6.19	1.29	55.89	43.91	2.49
	30	2.99	3.21	43.45	7.34	34.32	1.23	5.99	1.35	56.99	42.89	2.58
	35	3.00	3.30	44.60	7.80	33.60	1.45	4.81	1.42	58.70	41.28	2.87
800	0	0.89	1.11	42.03	4.09	42.31	0.03	9.34	0.03	48.12	51.71	0.06
	5	1.12	1.45	42.89	4.16	41.40	0.05	8.87	0.06	49.62	50.38	0.11
	10	1.56	1.89	43.34	4.79	39.61	0.09	7.71	1.01	51.58	48.42	1.10
	15	1.76	1.98	43.76	5.65	37.30	1.04	6.94	1.08	53.15	46.36	2.12
	20	1.99	2.12	43.98	6.01	36.41	1.09	6.40	1.12	54.10	45.02	2.21
	25	2.00	2.23	44.01	6.45	35.98	1.18	6.00	1.20	54.69	44.36	2.38
	30	2.20	2.54	44.12	6.79	35.10	1.24	5.77	1.25	55.65	43.36	2.49
	35	2.60	2.89	44.23	7.03	34.86	1.28	5.21	1.29	56.75	42.64	2.57
1200	0	0.99	1.21	41.11	4.19	40.89	0.02	11.34	0.02	47.50	52.27	0.04
	5	1.11	1.34	41.98	4.68	40.01	0.05	10.40	0.05	49.11	50.51	0.10
	10	1.12	1.45	42.06	4.79	39.56	0.09	9.92	1.01	49.42	50.58	1.10
	15	1.56	1.89	42.56	5.65	37.46	1.05	9.18	1.06	51.66	48.75	2.11
	20	1.76	1.98	42.98	6.01	36.87	1.09	8.28	1.09	52.73	47.33	2.18
	25	1.99	2.12	43.34	6.45	36.89	1.11	7.02	1.12	53.90	46.14	2.23
	30	2.00	2.23	43.76	6.79	36.02	1.14	6.98	1.15	54.78	45.29	2.29
	35	2.20	2.54	43.98	6.98	35.23	1.15	6.32	1.18	55.70	43.88	2.33
1600	0	0.98	1.21	41.11	4.19	42.89	0.02	8.97	0.02	47.49	51.90	0.04
	5	1.10	1.28	41.16	4.11	42.81	0.02	8.97	0.03	47.65	51.83	0.05
	10	1.02	1.23	41.10	4.19	42.70	0.03	8.93	0.03	47.54	51.69	0.06
	15	1.00	1.20	41.98	4.21	42.60	0.04	8.95	0.04	48.39	51.63	0.08
	20	1.12	1.24	41.06	4.22	42.81	0.05	8.96	0.05	47.64	51.87	0.10
	25	1.09	1.20	41.00	4.21	42.20	0.05	8.90	0.05	47.50	51.20	0.10
	30	1.06	1.19	41.10	4.23	41.98	0.07	8.89	0.06	47.58	51.00	0.13
	35	1.03	1.19	41.20	4.31	42.78	0.05	8.89	0.05	47.73	51.77	0.10
2000	0	0.98	1.21	40.11	4.19	42.89	0.02	10.34	0.02	46.49	53.27	0.04
	5	1.10	1.28	41.16	4.11	42.81	0.02	8.97	0.03	47.65	51.83	0.05
	10	1.02	1.23	41.10	4.19	42.70	0.03	8.93	0.03	47.54	51.69	0.06
	15	1.00	1.20	41.98	4.21	42.60	0.04	8.95	0.04	48.39	51.63	0.08
	20	1.12	1.24	41.06	4.22	42.81	0.05	8.96	0.05	47.64	51.87	0.10
	25	1.09	1.20	41.09	4.21	42.20	0.05	8.90	0.05	47.59	51.20	0.10
	30	1.06	1.19	41.50	4.23	41.98	0.07	8.89	0.06	47.98	51.00	0.13
	35	1.08	1.21	41.50	4.31	42.89	0.07	8.92	0.09	48.10	51.97	0.16

https://doi.org/10.18697/ajfand.142.25660

REFERENCES

1. **Ghafoorunissa G** Role of trans fatty acids in health and challenges to their reduction in Indian foods. *Asia Pac. J. Clin. Nutr.* 2008; **17(1) (Suppl.):** 212-215.

2. **Dhaka V, Gulia N, Ahlawat KS and BS Khatkar** Trans fats-sources, health risks and alternative approach - A review. *J. Food Sci. Technol.* 2011; **48(15):** 534-541.

3. **Przybylski O and FA Aladedunye** Formation of trans fats during food preparation. *Can J. Diet Pract. Res*. 2012; **73(2):** 98-101.

4. **Stevenson SG, Vaisey-Genser M and NAM Eskin** Quality control in the use of deep-frying oils. *J. Am. Oil Chem. Soc*. 1984; **61:** 1102-1108.

5. **Akoh CC and DB Min** Food lipids: chemistry, nutrition, and biotechnology. Marcel Dekker, New York. 1998. 1014 p.

6. **Moya-Moreno MCM, Mendoza-Olivares D, Amezquita-Lopez F, Gimeno-Adelantado JV and F Bosch-Reig** Determination of unsaturation grade and trans isomers generated during thermal oxidation of edible oils and fats by FTIR. *J. Mol. Struct.* 1999; **482-483:** 551-556. https://doi.org/10.1016/S0022-2860(98)00937-5

7. **Rossell JB** Measurement of rancidity. In "rancidity in foods". 3rd ed. by J.C. Allen. Elsevier Science publishers, Hamilton. 1994. 22–53 p.

8. **Kim SY, Kim JH, Kim SK, Oh MJ and MY Jung** Antioxidant activities of selected oriental herb extracts. *J. Am. Oil Chem. Soc.* 1994; **71:** 633–640.

9. **Bae RN, Kim KW, Kim TC and SK Lee** Anatomical Observations of Anthocyanin Rich Cells in Apple Skins. *J. Am. Soc. Hortic. Sci.* 2006; **41:** 733–736.

10. **Ravindran V, Ravindran G, Sivakanesan R and SB Rajaguru** Biochemical and nutritional assessment of tubers from 16 cultivars of sweet potato (*Ipomoea batatas* L.). *J. Agric. Food Chem.* 1995; **43:** 2646-2651.

11. **Arun KB, Chandran J, Dhanya R, Krishna P, Jayamurthy P and P Nisha** A comparative evaluation of antioxidant and antidiabetic potential of peel from young and matured potato. *Food Biosci.* 2015; **9:** 36-46.

12. **Koduvayur Habeebullah SF, Nielsen NS and C Jacobsen** Antioxidant activity of potato peel extracts in a fish-rapeseed oil mixture and in oil-in-water emulsions. *J. Am. Oil Chem. Soc.* 2010; **87:** 1319-1332.

13. **Singleton VL, Orthofer R and RM Lamuela-Raventós** Analysis of total phenols and other oxidation substrates and antioxidants by means of folin-ciocalteu reagent. In Methods Enzymol. Academic Press. 1999; 52-178 pp.

14. **Turkmen N, Sari F and YS Velioglu** The effect of cooking methods on total phenolics and antioxidant activity of selected green vegetables. *Food Chem*. 2005; **93**: 713–718.

15. **Chang CC, Yang MH, Wen HM and JC Chern** Estimation of Total Flavonoid Content in Propolis by Two Complementary Colorimetric Methods. *J. Food Drug Anal*. 2002; **10**:178-182.

16. **Giusti MM and RE Wrolstad** Characterization and Measurement of Anthocyanins by UV-Visible Spectroscopy. *Curr. protoc*., 2001; **1**: F1.2.1–F1.2.13.

17. **AOCS.** Official Method Ce 1b89, Fatty Acid Composition of Marine Oils by GLC. In American Oil Chemists Society. Champaign. 2009.

18. **Buege JA and SD Aust** Microsomal lipid peroxidation. In Methods in enzymology 52. **1978**; Elsevier, United States, pp. 302–310.

19. **Akyol H, Riciputi Y, Capanoglu E, Caboni MF and V Verardo** Phenolic compounds in the potato and its byproducts: An overview. *Int. J. Mol. Sci.* 2016; **17(6):** 835.

20. **Rumbaoa RGO, Cornago DF and IM Geronimo** Phenolic content and antioxidant capacity of Philippine sweet potato (*Ipomoea batatas*) varieties. *Food Chem.* 2009; **113(4):** 1133–1138.

21. **Kim MY, Lee BW, Lee HU, Lee YY, Kim MH, Lee JY, Lee BK, Woo KS and HJ Kim** Phenolic compounds and antioxidant activity in sweet potato after heat treatment. *J. Sci. Food Agric*. 2019; **99(15):** 6833-6840.

22. **Khoo HE, Azlan A, Tang ST and SM Lim** Anthocyanidins and anthocyanins: Colored pigments as food, pharmaceutical ingredients, and the potential health benefits. *Food Nutr. Res.* 2017; **61(1):** 1361779.

23. **Floegel A, Kim DO, Chung, SJ, Koo SI and OK Chun** Comparison of ABTS/DPPH assays to measure antioxidant capacity in popular antioxidant-rich US foods. J. *Food Compost. Anal.* 2011; **24(7):** 1043-1048.

24. **Hoensch HP and R Oertel** The value of flavonoids for the human nutrition: Short review and perspectives. *Clin. Nutr. Exp.* 2015; **3:** 8-14.

CC BY NC ND

Since 2001 ajfand AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
SCHOLARLY, PEER REVIEWED
Volume 25 No. 5
June 2025
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

25. **Che-Man YB and WR Wan-Hussin** Comparison of the frying performance of refined, bleached and deodorized palm olein and coconut oil. *J. Food Lipids.* 1998; **5(3):** 197-210.

26. **Samarin AM, Hematyar N, Elhamirad A and H Poorazarang** Phenolics in potato peels: Extraction and utilization as natural antioxidants. *World Appl. Sci. J.* 2012; **18(2):** 191-195.

27. **Che-Man YB, Liu JL, Jamilah B and RA Rahman** Quality changes of refined-bleached-deodorized (RBD) palm olein, soybean oil and their blends during deep-fat frying. *J. Food Lipids.* 1999; **6(3):** 181-194.

28. **Zainol MK, Abd-Hamid A, Yusof S and R Muse** Antioxidative activity and total phenolic compounds of leaf, root and petiole of four accessions of *Centella asiatica* (L.) Urban. *Food Chem.* 2003; **81(4):** 575-581.

29. **Habib F and W Shah** Utilization of potato peels extract as a natural antioxidant in soy bean oil. *Food Chem.* 2004; **85(2):** 215-220.

30. **Tarmizi AHA, Lin SW and A Kuntom** Development of palm-based reference materials for the quantification of fatty acids composition. *J. Oleo Sci.* 2008; **57(5):** 275-285.

31. **Delfanian M, Esmaeilzadeh Kenari R and MA Sahari** Effect of natural extracted antioxidants from *Eriobotrya japonica* (Lindl.) fruit skin on thermo oxidative stability of soybean oil during deep frying. *Int. J. Food Prop.* 2016; **19(5):** 958-973.

32. **Kalogianni EP, Karapantsios TD and R Miller** Effect of repeated frying on the viscosity, density and dynamic interfacial tension of palm and olive oil. *J. Food Eng.* 2011; **105(1):** 169-179.

33. **Lumley I** Polar compounds in heated oils. In “Frying of food. principles, changes, new approaches,” ed. by G. Varela, A. E. Bender and I. D. Morton. Ellis Horwood, Chichester.1988. 166-173 pp.

34. **Casarotti SN and N Jorge** Antioxidant activity of rosemary extract in soybean oil under thermoxidation. *J. Food Process. Preserv.* 2014; **38(1):** 136-145.

35. **Ahmad Tarmizi AH and R Ismail** Comparison of the frying stability of standard palm olein and special quality palm olein. *J. Am. Oil Chem. Soc.* 2008; **85(3):** 245-251.

cc BY NC ND

36. **Filip S, Hribar J and R Vidrih** Influence of natural antioxidants on the formation of trans-fatty-acid isomers during heat treatment of sunflower oil. *Eur. J. Lipid Sci. Technol.* 2011; **113(2):** 224-230.

37. **Tsuzuki W** Study of the Formation of trans Fatty Acids in Model Oils (triacylglycerols) and Edible Oils during the Heating Process. *Jpn. Agric. Res. Q.* 2012; **46(3):** 215-220.