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A review. Coconut oil - as functional food oil

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Abstract

This is a short review about existing knowledge in researches field: the use of coconut oil as functional food oil based on its oxidative stability during cooking. Coconut oil is known for its use as a cooking oil. Vegetable oils do not possess sufficient oxidative stability, which limits their application for food processing. Oxidative stability is an important indicator to determine quality and shelf life of edible oils. The coconut oil has a long shelf life (2 years). The progress of lipid oxidation was assessed by measuring peroxide (PV) and p-anisidine values (AV). Many factors contribute to stability of oils in foods and must be considered when developing new processing methods.

Keywords: coconut oil, oxidative stability, cooking, fatty acids

1.Introduction

Coconut oil is produced by crushing copra, the dried kernel, which contains about 60 - 65% of the oil. The oil has the natural sweet taste of coconut and contains 92% of saturated fatty acids (in the form of triglycerides) [1]. The coconut oil is one of the richest sources of medium chain fatty acids [2]. Free fatty acid content is an indicator of the hydrolytic rancidity of the coconut oil which causes an undesirable flavor and aroma in the oil. Hydrolytic rancidity is mainly due to the action of lipase or moisture [3]. Oxidation of fats and oils is an important indicator for performance and shelf life of oils [4]. Thus, determination of peroxide value is the most common method of assessing oxidative stability of vegetable oils. The amount of peroxides indicates the degree of primary oxidation and therefore is linked to the rancidity. The steady increase in peroxide indicates the formation of hydroperoxides during oxidation of fat [2].

Lipid oxidation is a major problem that contributes to rancidity, off-flavors and off-odors in foods, resulting in loss of sensory quality and nutritional value and, also, some lipid oxidation products are toxic [5].

Coconut oil can be considered a functional food oil due to its high therapeutic value [4, 6]; this provides energy, soluble vitamins and essential fatty acids required for growth and development of the human body [2].

2.Chemical analysis

The peroxide value (PV) was determined iodometrically according to standard methods for the oils analysis and the results were expressed in meq $O_2 \cdot Kg^{-1}$ oil [7]. The lower peroxide value indicates the freshness of the oil [8] and increases during storage [2]. The high PV value (1.79 to 2.7 meq $O_2 \cdot Kg^{-1}$) may be caused by the lower quality of the raw material copra used for oil extraction [8].

Lipid oxidation is one of the important causes of spoilage in vegetable oils. Hydroperoxides, the major initial reaction products of lipid oxidation, are not stable and decompose spontaneously to form other compounds such as aldehydes, ketones, alcohols, acids, hydrocarbons, etc. These secondary carbonyl breakdown products causing rancidity are mainly measured by the p-anisidine value [2]. According to Codex Alimentarius (2006) [9], the vegetables oils have a 15 meq $O_2 \cdot Kg^{-1}$ peroxides values.

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The p-anisidine value (p-AV) is a measurement of carbonyl content in the oils or fats, and was determined by the standard method according to AOCS [7]. It is based on the reactiveness of the aldehyde carbonyl bond on the p-anisidine amine group, leading to the formation of a Schiff base that absorbs at 350 nm. 2 g (w) of coconut oil samples were dissolved in 25 mL isooctane and absorbance (A_1) of this fat solution was measured at 350 nm against a blank of isooctane. An aliquot (5 mL) of this solution, respectively 5 mL of isooctane (as blank) was transferred to each of two test tubes of 10 mL and 1 mL anisidine solution (0.25% g/v glacial acetic acid) was added to each. After 10 min, the absorbance (A_2) was measured at 350 nm against isooctane containing p-anisidine [7, 10]. p-AV was calculated according to the formula:

$$\text{p-AV} = 25 \times \frac{1.2 \times A_2 - A_1}{w}$$

According to Marina et all. (2013) [4] oils of good quality must have p-anisidine index below 10.

3.Coconut oil in food processing

Coconut oil is one of the widely used cooking oil in Asian countries [2] but the chemical and nutritional aspects are least investigated [11]. Coconut oil has a very gentle aroma and a pleasant taste, but not a strong taste; this oil can replace butter or shortening in all manner of recipes. Coconut oil is known for its use as a cooking oil, but it is also used extensively by the food industry in baked products, processed foods, and infant formulas. Because coconut oil contains saturated fat, it is much less susceptible to heat-induced damage than unsaturated fats [12]. Coconut oil is a cooking oil with unique composition because 91% of fatty acids are saturated and contain only 1-2% of essential fatty acids [11].

The stability of coconut oil for autoxidation and photooxidation was useful to suit the oil type for different cooking or processing techniques [13]. Lipid autoxidation have a straight-forward free radical chain reaction with three stages of activity: initiation, propagation and termination (Figure 1) [5, 14].

High content of saturated fatty acids of coconut oil gives a high oxidative stability to coconut oil. Therefore, peroxide formation is minimum in coconut oil and can be considered as the most stable and most suitable oil for deep-frying [11].

The unsaturated fatty acids present in the oils easily react with atmospheric oxygen and form hydroperoxides. Normally coconut oils exhibit high oxidative stability due to the presence of large amounts of saturated fatty acids. Lauric acid (C12:0) is the major fatty acid present in coconut oil [8]. Rossell (1985) [15] and Laureles et al. (2002) [16] have reported lauric acid values of 45.9–50.3% for coconut oil produced in Asiatic countries. According to Kumar and all. (2015) [8] caprylic acid (C8:0) content ranged from 7.13–8.39%, capric acid (C10:0) level ranged from 5.16–6.13%, myristic acid (C14:0) content was lower: 18.74% - 22.45%, palmitic acid (C16:0) content between 8.49% and 9.90%, stearic acid (C18:0) content 0.17 to 1.22%, oleic acid (C18:1) content showed a 3.31 to 5.23% and linoleic acid (C18:2) content was negligible (0.13%). Based on research by Neering (2016) [5] the coconut oil contains: 5-9% caprylic acid, 6-10% capric acid, 13-19% myristic acid, 8-11% palmitic acid, 1-3% stearic acid, 5=8% oleic acid and 0-1% linoleic acid.

FFAs increase over the time the oil heated and are monitored in frying operations to determine how degraded the oil has become and whether or not the oil is acceptable for cooking; FFA levels >1% are typically considered unacceptable in frying operations [5].

Coconut oil contains high amounts of *saturated fatty acids (SAFA*) as compared to other edible oils. This high SAFA composition provides protection to coconut oil against oxidative rancidity. The monounsaturated fatty acids (MUFA) ranged from 4.01% to 5.23%. The average PUFA value for the coconut oil was found to be between 0.13 - 1.00% [8].

For products that will be used in any form of cooking, thermal degradation is also a limitation. Heat breaks bonds in lipid chains, leading to formation of radicals that add oxygen and initiate a cascade of reactions. Saturated fats have lower smoke points than unsaturated oils, meaning they begin decomposing at lower temperatures [17]. The smoke point of virgin coconut oil is 350°F, the best for baking and sautéing. The smoke point of refined coconut oil is 400°F, which makes it a better option for frying or cooking at higher temperatures [18].

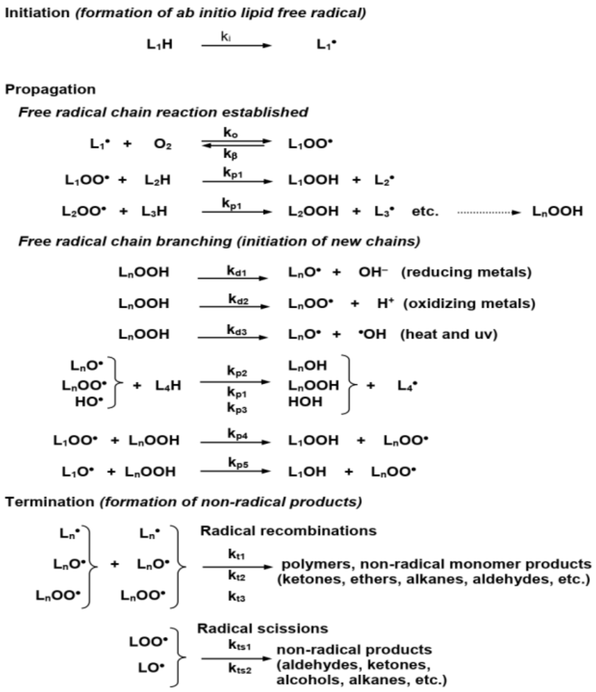

Figure 1. Free radical chain reaction of lipid oxidation [5, 14]

A critical factor in maintaining the oxidative stability of lipids is *temperature*. At the high temperatures endured during baking, cooking, and frying, the dominant degradation products generated are free fatty acids, short-chain alcohols, aldehydes, ketones, acids, hydrocarbons, mono- and di-glycerides, as well as cyclic and epoxy compounds which result from hydrolysis, oxidation, isomerization and polymerization. The mechanisms of degradation of the oils while cooking differ depending on the oils or blends of oils used, the conditions of cooking and other condition (moisture, protein) that may be present and cause other interactions or reactions during cooking [5]. While thermal degradation of unsaturated vegetable oils has been studied extensively, relatively little information is available tracking thermal degradation processes in saturated fats.

Thus, Man and Hussin (1998) [17] studied some oils during intermittent frying of potato chips at 180^{0}C for 5 h/day for 5 consecutive days. The results showed that coconut oil was superior with other oils respect to resistance to oxidation, color and viscosity.

Ultraviolet (UV) light as a important factor of oxidative stability on oil. A small doses of UV light can rapidly catalyze lipid oxidation by decomposing hydroperoxides to alkoxyl and hydroxyl radicals Functional groups that absorb UV light are carbonyls, double bonds and peroxide bonds. Light effects on the rate of oxidation diminishes as temperature increases and thermal degradation of hydroperoxides becomes more competitive [5].

All edible oils contain some naturally-occurring antioxidants such as tocopherols, carotenoids, phenolic compounds and sterols [19]. The antioxidants in oils are critical factors in oil stabilization. Antioxidants are used to limit oxidation by preventing initiation (metal chelators and singlet oxygen quenchers), quenching radicals (phenols and other compounds that transfer electrons or hydrogen atoms to radicals), and controlling environmental factors such as dark, cold, and low water that slow oxidation kinetics [5].

4.Coconut oil on health

The popularity of coconut oil has soared for its health benefits. Coconut oil shows antiviral, antibacterial and antifungal properties because contains lauric acid (50%). When eating coconut oil, a small percentage of lauric acid is transformed into monolaurin (the mono ester of triglycerol and it can destroy lipid-coated viruses) [11].

Coconut oil raise the levels of the “good” HDL cholesterol, relative to total cholesterol and potentially decreasing the risk of heart disease. Coconut oil is rich in lauric acid that improve the composition of blood lipids [20].

5.Conclusion

Coconut oil is not susceptible to lipid oxidation and is considered a suitable source for the frying medium. It is safe for cooking at high temperatures but it is recommended to be used with moderation for cooking.

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human or animal subjects (if exist) respect the specific regulation and standards.

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