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The usage of high oleic sunflower oil in production of "Tortilla Chips" type product

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Abstract

Lipids are a group of naturally occurring compounds that include fats, waxes, monoglycerides, diglycerides, triglycerides, phospholipids, sterols, fat-soluble vitamins (such as vitamins A, D, E, and K), and others. The basic biological roles of lipids include energy storage, signaling, and acting for the structural components of thecell membranes. Lipids have many applications in the cosmetic and food industries as well as in nanotechnology. This research studies the use of high oleic sunflower oil in the tortilla chips industry. If in the past, the most common oil used in the chips industry was palm oil, nowadays the high oleic sunflower oil is gaining importance in the chips industry because of its rich content in oleic acid , being more oxidative stable than conventional sunflower oil, more resistant at thermo oxidation and because is considered healthier than other type of oils.

Keywords: lipids, high oleic sunflower oil, tortilla chips

1. Introduction

This research highlights the high-oleic sunflower oil oxidation and its higher stability than conventional sunflower oil and corn oil used in the production of "tortilla chips" type products. If in the past, the most common oil used in the chips industry was palm oil and corn oil, nowadays high-oleic sunflower oil is gaining importance in the chips industry because of its rich content in oleic acid, being more oxidative stable as conventional sunflower oil, more resistant at thermo oxidation and because is considered healthier than other type of oils.

Oleic acid, a monounsaturated omega-9 fatty acid, 18:1 cis-9, with the formula CH3(CH2)7CH = CH(CH2)7COOH, is found in many foods, but mainly in olive oil and seeds oils. Even if other mono-unsaturated fatty acids are present in olive and seed oil oleic acid, it is receiving great attention worldwide for its health benefits. The FDA in 2018 had evidence to support a health claim associated to consume the oleic acid, and to its benefits against coronary heart disease [1].

A lot of studies show the benefits of high-oleic sunflower oil in food industry. Significant changes in the last nine years have been the development of seeds producing oils with a different fatty acid composition based on current nutritional views.

Vegetable oil is subject to significant and complex physical and chemical changes during the food processing when exposed to heat, oxygen, and moisture. Chemical degradation of oil in deep-frying can be categorized into hydrolysis and oxidation [2].

Apart from its role to create sunflower hybrids with genetic potentials for the high yield of seed and high content of seed oil, the constant efforts of sunflower breeders have also been directed towards improving the quality of the obtained hybrids. Namely, the aim is to increase the nutritional value of the oil and its shelf life, and these characteristics are mainly determined by the composition of the fatty acids involved and contents of minor oil products such as tocopherols, sterols, carotenoids, etc. [3].

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Even though the involvement of peroxides in lipid oxidation has been known for over 100 years and the free radical mechanism of auto oxidation was proposed over 60 years ago, many challenges still exist in controlling oxidative rancidity in foods. These challenges exist because the lipid oxidation process is influenced by a huge number of factors, many of which are specific for different food items. Early studies show in regards to oxidative rancidity,that,these chemical pathways are dependent on temperature, oxygen concentrations and lipid type. Lipid hydroperoxides are the primary products of autoxidation and decomposition of the hydroperoxides leads to the formation of aldehydes, ketones, alcohols, hydrocarbons, volatile organic acids, and epoxy compound production; collectively these compounds are known as secondary oxidation products.

The presence of these compounds account for the perception of off flavors, rancidity and loss of nutritional value in the food, which can eventually lead to rejection by the customer. Autoxidation of oil has been identified as the main cause of crisps quality deterioration and the reaction rate of autoxidation has been shown to strongly correlate with the shelf-life of the product [4].

2. Materials and Method

2.1 Freshly-fried tortilla chips

Freshly-fried tortilla chips crisps were obtained from a commercial batch frying line.

2.2. Oil

Crisps were fried in 100% high oleic sunflower oil (HOSO)

2.3. Test frying

Tortilla chips were made on industrial production line. JC Ford, Co. manufactures tortilla chip equipment.

2.4 Physical chemical evaluation of the finished product and of the high oleic sunflower oil (HOSO)

Acidity of oil, acidity index of the oil, peroxide value (PV), fat content in finished product by Soxhlet method, moisture content in finished product.

Also, the temperature of the product was monitored throughout the entire flow, to see if it had any effect on the fat content in the final product.

Table 1. The physic-chemical characteristics of HOSO

Week	Day 1		Day 2		Day 3		Day 4		
	Acidity % acid oleic	Acidity index mg KOH/g	Acidity % acid oleic	Acidity index mg KOH/g	Acidity % acid oleic	Acidity index mg KOH/g	Acidity % acid oleic	Acidity index mg KOH/g	Peroxid value meq/g
Week 1	0,11	0,22	0,45	0,89	0,62	1,23	0,84	1,68	15,8
Week 2	0,56	1,12	0,67	1,23	0,67	1,23	0,84	1,68	8,5
Week 3	0,26	1,12	0,62	1,2	0,67	1,23	0,78	1,57	1,8

Table 2. Monitoring of temperatures on the technological flow

	Temperature ˚C					
Samples	Oven exit	Cooler exit	Fryer exit	Seasoning exit	Packing machine	Finished product
Tortilla Chips Nacho Cheese	100	35	115	110	95	77
Tortilla Chips Salted	108	39	135	123	94	70
Tortilla Chips Chili	93	36	130	108	95	70
Tortilla Chips Salted	100	43	121	118	92	72

2.5. Statistical analysis

Statistical analysis was performed by using Minitab statistical software version 16 (Minitab Inc., State College, PA, USA) and by using two-way analysis of various (ANOVA) and LSD multiple comparison test.

3.Results and Discussion

3.1High oleic sunflower oil – frying stability

Experimental evidence showed that high oleic-rich oils generate lower levels of aldehydes than PUFA, offering a health-friendly alternative for frying [5].

HOSO contains 84% oleic acid, about 60% more oleic acid than regular sunflower oil, and 9% linoleic acid, which is about 54% less than regular sunflower oil.

Due to its fatty acidic profile, HOSO is expected to have better oxidative stability than regular SO which supports the data [4].

The degradation of oil in discontinuous frying is increased compared to continuous frying [10].

3.2. Physical Chemical analysis of HOSO

Acidity of oil, acidity index of the oil. The amount of FFA increased slowly during frying but did not exceed the limit of 2% established by European regulations [6]. FFA levels may not affect frying efficiency in practice but they may have significant unfavorable effects on health or sensory evaluation. [7].

Peroxide value (PV). Generally, with an increase in the frying cycle, frying oils show an increase in PV, followed by a slight decrease in the last cycle. Previous studies have also reported an initial PV increase during frying, followed by a later decrease [6].

Fat content and moisture content in the finished product(tortilla chips)

As can be observed in table 3, the obtained results conform to the limits stipulated by the quality standards for all analyses parameters.

Generally, the oil absorption takes place as a result of moisture removal from the food products. It has been reported that if the fat uptake is high, then it is due to higher initial moisture content.

If initial moisture content is low, it minimizes the internal volume of the food that could be occupied by oil during frying and would also shorten the frying time [9].

Monitoring of temperatures on the technological flow

At the beginning of every week the line starts with fresh oil. The research was designed as follows:

- In the first week of study, the line worked on a single shift, from 6 a.m until 2 p.m.
- In the second week of study, the line worked on two shifts, from 6 a.m until 10 p.m.
- In the third week of study the line worked in a continuous flow.

Table 3. The fat content and moisture content in finished product

Samples	Fat content %	Moisture %
Tortilla Chips Nacho Cheese	16,44±0,15	2,9±0.07
Tortilla Chips Salted	17,47±0.11	2,39±0.05
Tortilla Chips Chili	20,52±0.09	2,25±0.03
Tortilla Chips Salted	18,53±0.19	2,46±0.09

All analyses were made in triplicate and mean value was recorded;

The results show that the best values indicating the quality of the oil were on the third week . Due to the continuous flow and the fact that the line did not stand like in the previous weeks when the oil was in the fryer for 16 hours, the quality of the oil did not degrade as much.

Oil stability and frying time were an interplay between the fatty acid composition and, the presence, type, and amount of different minor bioactive compounds present in the oils [8].

During frying, the material undergoes physical and chemical transformation at a high temperature range of about 140–180 ˚C [9].

At lower frying temperature the residence time for the product tends to be higher, which improved the oil absorption [9].

Temperature is the most important factor to be considered in evaluating the oxidative stability of fats, especially unsaturated fats, because the mechanism of oxidation changes with temperature, and changes the hydroperoxides of linoleate, acting as precursors of volatile flavours, decompose at different temperatures.

Furthermore, as the rate of oxidation is exponentially related to the temperature, the shelf life of a food lipid decreases logarithmically with increasing temperature [11].

Essentially, frying is a process of dehydration in which high oil temperature (160 to 180 °C) enables rapid heat transfer and a short cooking time.

Also reported that, the slower temperature changes in oven baking method causing it to have lower moisture content [12].

A decrease in oil temperature does not only depend on the amount of food placed in oil but it also depends on the amount of water or the food's moisture content [13].

4. Conclusion

This research focused on the changes made by high oleic sunflower oil in the production of tortilla snacks.

In relation to the proposed objectives, the following can be observed:

The evaluation of the quality parameters of the finished product and of the oil was made by conducting the following physico-chemical analysis: acidity of oil, acidity index of the oil,peroxide value, fat content in finished product by Soxhlet method,the moisture content.
Following the evaluation of the oil quality parameters, certain changes were made on the technological flow such as: modification of baking and roasting times; working at full production capacity to avoid oil degradation due to flow stops; increase in the cooling time before packaging.

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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