Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 12 Issue 11, November-2023

Oil Absorption, Peroxide Values and Shelf-life of Different Oils on Potato Processing

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Abstract
Various vegetable oils are used in a variety of food processing activities, including frying. Frying performance is affected by changes in the oil's physical, chemical, and nutritional qualities. Chips or French fries are the most important fried potato product. On frying results revealed that different oil has peculiar oil absorption rates and the values for the oil absorption ranged from 10 to 22.90% in rice bran and mustard oil. Coconut oil indicated 15.90% absorption in potato chips, 21.7%, mustard oil at 20.1 and soybean at 20.1%. Among the different oil absorbed mustard oil indicated 20.8% oil absorption followed by soybean and palm oil 19.2%. Coconut oil had 17.3% oil absorption, whereas, it was 10% in rice bran at the beginning of the storage. Coconut oil has minimum peroxide value at 14 days of observation followed by 7 and 21 days of storage. Palm oil registered with low peroxide value at 14 day of observation, 10 milliequivalents in a week. Whereas, mustard oil has same rates of peroxide values after one week. Soybean oil has least peroxide value 10 milliequivalents at 21 days of storage followed by at '0' day of 9 milliequivalents.

Keywords: vegetable oil, potato, oil absorption, peroxide value, storage

INTRODUCTION

Potato (*Solanum Tuberosum* L.) is a nutritious food high in carbohydrates, proteins, minerals, dietary fibre and antioxidants. Potatoes are used all over the world for a variety of purposes including boiling, steaming, microwaving, roasting and frying. In India, approximately 75% of total potato production is consumed as a vegetable. Around 10% is used as seed, less than 10% is used for processing, another less than 1% is exported, and the remaining 15% is wasted due to post-harvest losses. The status of potato processing varies from country to country and around the world. Potato chips are generally enjoyed by people of all ages at all stages of their meals. Different types of oils are used in various types of food processing. Sunflower oil is a popular frying oil due to its high smoke point. Other cooking oils may also be used in place of sunflower oil. Sunflower oil contains approximately 48-74 percent linoleic acid, whereas corn oil contains approximately 34-65 percent linoleic acid (Desanka *et al*., 1997). Peanut oil, as we all know, is extremely beneficial to human health. It contains two essential fatty acids, oleic acids and linoleic acid. As a result of oil breakdown caused by air, heat, and water, toxic chemicals may emerge in the oil pan during frying. Palm oil, contains 50% saturated fatty acids, 40% monounsaturated fatty acids, and 10% polyunsaturated fatty acids. Palm oil has been shown to be effective in maintaining desirable plasma cholesterol and lipoprotein cholesterol levels when consumed as part of a low-fat (30% energy) diet and is beneficial. Palm oil is used directly in a variety of food processing without being hydrogenated. Some of the cis-double bonds are converted to trans-configuration. As a result, it is worth noting that there are no trans-unsaturated fatty acids in palm oil. Even though deep fried, still the crowd enjoy the potato chips and French fries. Deep-fat frying is one of the oldest methods of food preparation. Many countries' civilization progress has been accompanied by an increase in the consumption of fried potato such as snacks, crisps, and French fries. French fries are particularly popular due to their favourable organoleptic properties and ease of preparation for consumption at home. High cooking rates are used to achieve desired end product characteristics and to change the eating quality of food. Deep-fat frying involves immersing food in hot edible oil at temperatures above the boiling point of water for a set amount of time. During this process, mass transfer is accomplished through water loss and oil uptake, as well as heat transfer (Vitrac *et al.,* 2002). Deep-fat fried foods have a distinctive flavour and texture. Consumers are particularly interested in the appropriate oil content, which contributes to the high and consistent quality of fried products. The porous structure of the product and the oil influence the oil uptake. Pore formation during processing is caused by water loss from the produce formed during the cooling period. The effect of frying oil temperature, frying time, chemical and physical changes, and chip or French fry oil uptake play an important role. Fried foods contain a significant amount of oil because foods with low fat content absorb a large amount of oil during deep-fat frying. Many factors, including processing, can influence oil absorption. Everyone enjoys potato chips, and the lifestyles of developing and developed countries are constantly changing. Deep-fat frying is used not only in restaurants, hotels, and roadside dhabas, but also in the home. According to Vision 2050, potato consumption will rise at a faster rate for French fries (11.6 percent annual compound growth rate (ACGR) over the next 40 years, followed by potato flakes/powder (7.6 percent) and chips (4.5 percent). The demand for processed potatoes, which was 2.8 million t in 2010, will rise at a 5.61 percent annual growth rate. Aside from external characteristics, the first quality parameter is the colour of the potato chips, which should be acceptable; dry matter and reducing sugars should be greater than 20% and 150mg/100g fresh water, respectively. Consumers have differing views on the consumption of various oils. During the frying process, a variety of chemical reactions occur due to the high temperature, the presence of water in the potato (80%), come in contact with the fat on the surface with air. As a result, air is released into the frying medium or oil, initiating an oxidation reaction cycle that produces free radicals. These changes may reduce the stability and quality of fried products. Therefore, a study was carried out to study the effect of different oils on quality of chips, shelf-life and organo-leptic evaluation.

International Journal of Engineering Research & Technology (IJERT)
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MATERIAL AND METHODS

During the main crop season, the potato variety Kufri Chipsona-1 was obtained from the ICAR-Central Potato Research Institute Campus in Modipuram. For cultivars, the fertiliser dose was 270:80:150 NPK kg ha^{-1}. The experiments was laid out in complete randomized design (CRD) with three replications. To avoid abiotic stress on the crop, the crop was irrigated by furrow by flood irrigation, a method commonly used in the region. At the time of planting, half N (nitrogen) and full doses of P (phosphorus) and K (potassium) were placed in bands below the seed tubers, and the remaining N was applied at hilling (25 days after planting). The crop was harvested when it reached chemical maturity (90-110 days depending on the variety). Grading was done manually after harvesting and for processing cultivars (process grade). For the analysis, approximately 25 tubers from each replication were used.

CHEMICALS

Petroleum ether, potassium iodide, glacial acetic acid, chloroform, starch, sodium thiosulphate, copper tartrate, anhydrous sodium carbonate, sodium bicarbonate, potassium sodium tartrate, sulfuric acid, glucose, anthrone, sulphuric acid, potassium hydroxide, sucrose and Folin-Ciocalteau reagent from the Sisco research laboratory chemicals.

Preparation of chips

Five different oils were purchased from the local market: rice bran, coconut, palm, mustard, and refined soybean. Processable potato tubers were washed and air dried. The round tubers were peeled with an abrasive peeler and were sliced uniformly with an electric cutter to a thickness of 2mm and a diameter of 3.5cm. For 10 minutes, the slices were blanched in water at 75° C. Potato slices were dried on blotting paper, and were then fried at 180°C in different medias. The slices were washed. The dryer removed excess water from the surface of the slices. Potato slices were fried at 180°C until crispy and bubbling ceased. Draining was used to remove excess oil. The chips were packed in laminated propylene bags. Chip colour score was calculated using a 1-10 scale. Chip colour of scale 3.0 was considered acceptable, whereas score of 10 (black/ brown) was considered not acceptable (Ezekiel *et al.*, 2003).

OIL EXTRACTION

A folded piece of filter paper was used to keep crushed potato chips. Using a soxhlet extraction device, material was placed in the tubes and extracted for 4-6 hours with petroleum ether (50ml) and constant moderate heating. The extraction flask was disassembled after the contents had cooled. On a heated pan, ether was evaporated. Content was allowed to cool to room temperature before using. The flask was weighed. Repeat the heating process until a steady weight was achieved. After refluxing, the solvent was dried at ambient temperature for a few hours before being placed in an oven set at 70-80° C. Oil uptake was measured in triplicate in potato chips.

The following formula was used for calculation of oil absorption (%):

% Oil absorbed = Weight of oil× 100/ Weight of sample

PEROXIDE VALUE

Oil or fat after extraction from chips was taken into a clean and dry test tube, 1 gram of powdered potassium iodide and 20 ml of solvent was added. The test tubes were immersed in boiling water and boiled for 30 seconds. Content was titrated with sodium thiosulfate ($Na_2S_2O_3$) N/500 solution until the yellow color almost disappeared. Contents were transferred to an Erlenmeyer flask containing 20mL potassium iodide solution. Added 0.5 ml starch, shake vigorously and titrate thoroughly until blue color appeared.

Peroxide volume milliequivalent peroxide/kg sample= S×N×1000/g sample

Where

N= normality of Na_2S_2

S= ml $Na_2S_2O_3$ (test blank)

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SENSORY EVALUATION

When raw potatoes are processed, structural changes, chemical reactions, water loss, and oil absorption occur, resulting in potato chips' sensory qualities. As a result, raw potato dry matter components (such as starch and reducing sugars) are critical, as their conversion during the frying process determines organoleptic quality (Bennet, 2001). Potato chips fried in different oils were coded and presented to 10 panelists. Panel members sensed and scored for color, flavor, crispiness, taste, and overall acceptability on a point rating scale that varied from 1 to 10.

SHELF LIFE STUDY

Potato chips made with various oils were tagged, and 200 g of Kufri Chipsona-1, chips were packaged in polythene bags (gauge 150 microns), wrapped in aluminum packs, and were stored at 25°±0.5C. At the 7th, 14th, and 21st days, the chips were assessed for overall acceptability in terms of taste, flavour, and appearance. The peroxide value of the chips was also determined at different days of storage.

DATA ANALYSIS

Crop Stat, 2008, was used to do an analysis of variance (ANOVA) and a least significant difference (LSD) test on the variables. Differences with a p0.05 significance level were judged significant.

RESULTS AND DISCUSSION

Different oil has different oil absorption rates and the values for the oil absorption ranged from 10 to 22.90% in rice bran and mustard oil at zero and at seventh day only. Rice bran oil showed 22.50% oil absorption at '21' day of the experiment. Whereas, coconut oil indicated 15.90% absorption in potato chips, 21.7%, mustard oil at 20.1 and soybean at 20.1% (Figure 1). It has been well understood that oil uptake during frying takes place as moisture is released from the food (Kochhar and Gertz, 2004).

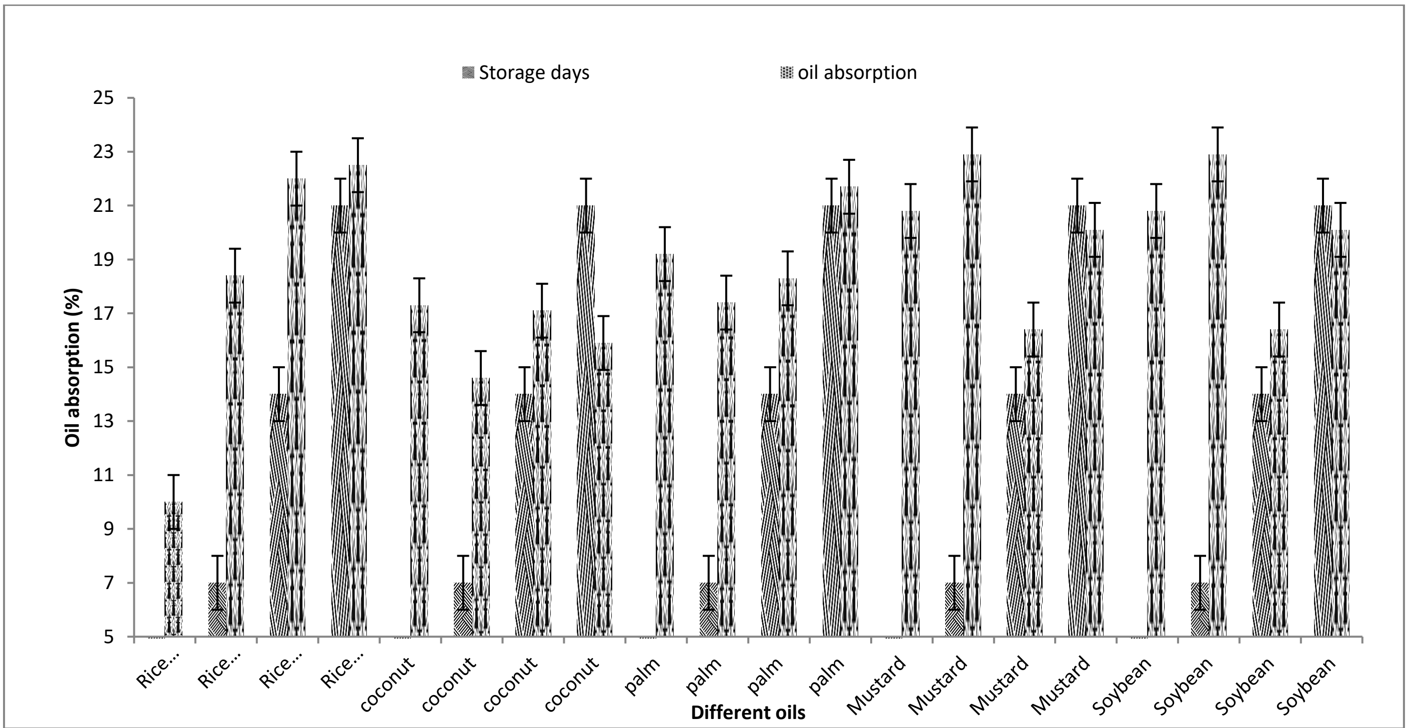

Figure 1. Different oil absorption rates on potato processing

However the actual mechanisms of oil uptake are not clearly understood (Saguy and Dana, 2003). It has been suggested that oil penetrates the voids created as the water evaporates during frying (Pedreschi *et al*., 2001). Higher moisture content may increase the internal volume (voids) left in the cellular structure of a frying. Among the different oil absorbed mustard oil indicated 20.8% oil absorption followed by soybean and palm oil 19.2%. Coconut oil had 17.3% oil absorption, whereas, it was 10% in rice bran

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at the beginning of the storage. It is also suggested that oil uptake is a result of a decrease in internal vapour pressure due to condensation of steam upon cooling leading to sucking of the adhering oil on the surface of the product (Ufheil and Escher, 1996).

PEROXIDE VALUE

The peroxide value is defined as the amount of peroxide oxygen per one 1000 g of fat or oil. Rice bran oil has maximum 10 milliequivalents at 21 days followed by value of milliequivalents of 13 at 14 day and initiation of the experiment. Oxidation of fats and oils is an important indicator for performance and shelf life of oils used for frying food products.

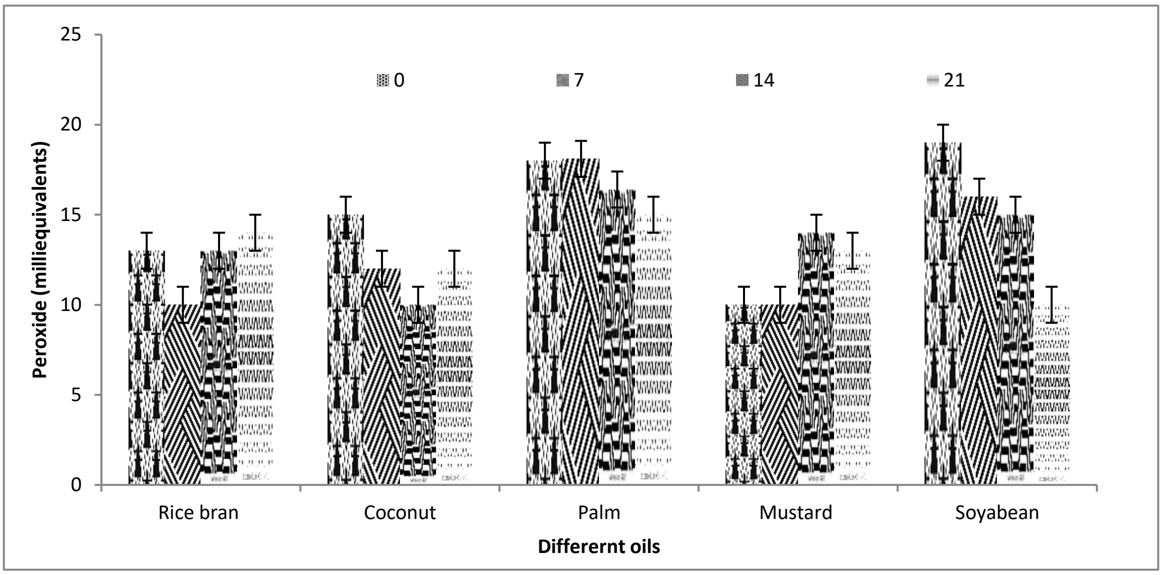

Figure 2. Peroxide value of different oils

The process is very complex, dependent on the light intensity and temperature. In the first stage is formed hydro peroxides, peroxides, and followed by polymers of peroxides (Lupea, 2004).Coconut oil has minimum peroxide value at 14 days of observation followed by 7 and 21 days of storage. Palm oil registered with low peroxide value at 14 day of observation, 10 milliequivalents at 7 days and maximum at zero day of observation. Whereas, mustard oil has same rates of peroxide values at 0 and 7 (Figure 2). At 14 and 21 days the peroxide value were 14 and 13 milliequivalents respectively. Soybean has least peroxide value 10 milliequivalents at 21 days of storage followed by at '0' day of 9 milliequivalents. 14 days of storage indicated 10 milliequivalents and and 10 milliequivalents 7 days of storage. According to the United Nations' FAO (2013), the maximum concentration of active oxygen in refined oil is up to 10 milliequivalents per kilogramme of oil. The increase in peroxide value is linked to the formation of peroxide during storage. A peroxide value of less than 1 meq/kg oil is regarded fresh, and a peroxide value of more than 10 meq/kg oil is deemed rancid (Adrover-Obrador *et al.*, 2012). A good quality frying vegetable oil should have a peroxide value (PV) of less than 2 meq/kg, according to reports.

SENSORY EVALUATION

During a 21-day storage period, the study indicated that potato chips made in various oils had an overall acceptability score. On the seventh, fourteenth, and twenty-first days, the finest potato chips were made with rice bran oil, coconut oil, soybean oil and palm oil. It can be interpreted from this that rice bran oil, coconut oil, soybean and palm oil used in the preparation of potato chips were deemed the best oils when compared to other oils used in the preparation of potato chips over a 21-day storage period. The results of this investigation show that the overall acceptability of potato chips made in various oils varied and according to per person choice (Table 1).

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Table 1. Sensory evaluation of chips in different oils

	Rice bran oil	Coconut oil	Palm oil	Soybean oil	Mustard oil
Colour	4	5	3	4	1
Flavour	3	4	4	3	4
Crispiness	5	4	5	4	3
Taste	5	3	4	4	1
Overall	5	4	3	4	2
Bitterness	0	0	0	0	0

Where bad =1,Fair =2,Good=3,Very good=4,Excellent =5

The study revealed that there was a significant difference of 1% ($p<0.01\%$) in overall acceptability score of potato chips prepared in different oils during the storage period of 21 days.

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