Research Article

Sensory Evaluation of Olive and Palm Oil Blends During Frying of Potato Chips

Muhammad Siddiq[1*], Sahib Alam[2], Hamid Ullah Shah[2], Zafar Iqbal[2], Kalsoom Siddiq[3] and Taufeq Ahmad[4]

[1]National Tea and High Value Crops Research Institute (NTHRI) Shinkiari Mansehra, Pakistan; [2]Department of Agricultural Chemistry, The University of Agriculture Peshawar- Pakistan; [3]Department of Human Nutrition, The University of Agriculture Peshawar-Pakistan; [4]Nuclear Institute for Food and Agriculture Peshawar, Pakistan.

Abstract | This study aimed to investigate the effect of olive and palm oils blends on the sensory attributes of potato (S*olanium tuberosum* L.) cultivar Carola chips during three successive frying sessions. Olive and palm oils were blended in the ratios of 10:90, 20:80, 40:60 and 60:40% and the blends as well as the sole oils were used for frying of potato chips. The fried potato chips were evaluated for appearance, taste, texture, color and overall acceptability. The results indicated that the highest average scores for appearance (6.90), taste (7.57), texture (8.00), color (7.67) and overall acceptability (7.56) were obtained by potato chips that were fried in 10:90% olive/palm oil blend whereas the minimum scores for the aforementioned parameters were recorded with 60:40% blend. The frying frequency of the oil blends also significantly ($p<0.05$) affected the sensory attributes of potato chips. Generally, the sensory quality of the product was enhanced with consecutive use of the same oils for up to three sessions. However, it is recommended that further studies on the repeated frying practice on the same oil sample beyond three sessions should be undertaken to draw more conclusive results.

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***Correspondence** | Muhammad Siddiq, National Tea and High Value Crops Research Institute (NTHRI) Shinkiari Mansehra, Pakistan; **Email:** msiddiq_k@yahoo.com
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Introduction

Olive oil is considered as one of the best edible oils that has astonishing beneficial effects on human health. This oil is a clear liquor with light yellow, green or brown color tending to green in mild temperature. The oil is extracted from the drupe of olive fruit obtained from olive (*Olea europea*) tree (Reza et al., 2009). The health effect of olive oil is linked to its high levels of monounsaturated fatty acids particularly oleic acid and a number of antioxidants. Monounsaturated fatty acids are considered as healthy dietary fats as opposed to saturated and trans fatty acids (Adel et al., 2011). A number of studies indicate that regular consumers of olive oil suffer less from cardiovascular diseases including hypertension, stroke and hyperlipidemia (Aldo et al., 2000; Gurdal and Kultur, 2013). Olive oil is also beneficial in reducing inflammation, endothelial dysfunction, thrombosis and carbohydrates metabolism (Garcia et al., 2002).

Likewise, palm oil is derived from the mesocarp of the fruit of oil palm (*Elaeis guineensis*) and it is an essential part of almost all dietary fats. This oil is very stable and resistant against stress conditions and chemical deteriorations. However, its chemical composition shows that it is rich in saturated fatty acids and its adverse effects regarding heart related health problems are well proven (Edem, 2002). Therefore, its sole consumption has adverse implications in health-related

problems. Consequently, there is an utmost demand to investigate some indigenous olive oils which could be used as fortificant in palm oil to get a chemically stable and nutritionally sound oil blend to address public health concerns related to fats consumption (Amany et al., 2013).

The blending of vegetable oils has appeared as an economical way of changing the physicochemical and sensory properties of vegetable oils. The hard-pressed olive oil undergoes neither heat nor chemical treatment, so gratifying an attractive interchange for unsurprising oils for consumers who desires for normal and sheltered products. Palm oil is a cheap edible oil in addition to resistant against almost all type of stress conditions. Olive oil has improved nutritive properties as well as resistance to heating and oxidative stresses due to the presence of higher amount of monounsaturated fatty acids than polyunsaturated fatty acids which are abundant in vegetable oils such as soybean and sunflower oil. It has been reported that olive oil remains quite stable during cooking and deep frying whereas sunflower and other vegetable oils do oxidize and form harmful products (Cuesta et al., 2001). However, olive oil offers a little off-flavor due to the presence of oleic acid due to which it is not commonly used in food products. This drawback can be overcome by blending olive oil with the more stable palm oil to enhance its sensory quality, strength and durability (Reza et al., 2009).

Frying is a common and well-known practice for food preparation. It is a quick, suitable, and energy capable cooking procedure that increases palatability and coating formation on fried food surfaces with agreeable flavors and odors (Magda et al., 2015). Even given the importance on low-fat diets, people are still demonstrative of fried foods owing to their fragile texture and attractive flavor. A complex series of chemical reactions takes place in the heated fats, such as thermo-oxidation, polymerization and hydrolysis during frying practice. Frying oils decompose to a variety of volatile compounds with monomeric to polymeric products (Lin, 2002). Many reasons like high temperature, contact with air, heating duration, and type of frying affect the overall performance of frying oils by decreasing their innate features. In some cases, frying oil is usually used for six to ten successive frying sessions which is unfavorable for oil stability (Pantzaris, 1998). Keeping in view the effect of frying practices on the oil chemical and sensory quality, this study was conducted to assess the sensory response of olive/palm oils blends and sole oils during three successive frying sessions of potato (S*olanium tuberosum* L.) cultivar Carola chips. The aim of the study was to find out an appropriate blending ratio of olive and palm oil that could be used to develop a more stable oil blend with acceptable sensory attributes for household and commercial purposes.

Materials and Methods

Oils collection

A laboratory experiment was conducted on the sensory evaluation of olive and palm oils (sole oils and blends) during three successive frying sessions of potato cultivar Carola chips at Nuclear Institute for Food and Agriculture (NIFA) Tarnab, Peshawar. The olive oil was collected from oil extraction mill installed at Agricultural Research Institute Tarnab, Peshawar. Palm oil was obtained from Associated Industries Limited, Manufacturer of Shama Ghee and Oil Products, Nowshera, Pakistan.

Blending of oils

Olive and palm oils were blended in the ratios of 100:00 (sole olive oil), 10:90, 20:80, 40:60, 60:40 and 00:100% (sole palm oil). The blends as well as the sole oils were used for deep frying of potato fillets for subsequent sensory evaluation.

Potato chips preparation and frying

Potato chips were prepared by placing potato slices in a large bowl of cold water and thoroughly rinsed and salted. Carola cultivar was selected for chips preparation because of its good processing attributes such as high dry matter contents, low reducing sugar and acceptable fries colour. The slices were soaked for 30 min in salty water and then drained. Approximately 250 ml of each oil blend and sole oils were taken separately in deep fryers for frying of potato chips. The oils were first heated for 5mn to 190˚C and then used for frying of potato chips for further 4 mn. Three consecutive frying sessions were carried out on each blend and sole oil. The heating sequence was stopped after each cooking cycle and allowed to cool down to room temperature. The oil was kept uncovered during this period.

Sensory evaluation of potato chips

A panel of ten adult volunteers with prior experience in sensory testing underwent sensory training to

evaluate the sensory quality attributes of potato chips using a 9-point hedonic scale (1 extremely disliked, 9 extremely liked). They were then asked to evaluate the samples for appearance, taste, texture, color and overall acceptability by the method as reported by Larmond (1977). The sensory evaluation was carried out under florescent light in a room having uniform impressive conditions.

Statistical analysis

The data were subjected to analysis of variance (ANOVA) using 2-factors completely randomized design (CRD). Means were calculated from triplicate values and separated by least significant difference (LSD) test at p = 0.05 (Steel et al., 1996). All the statistical analyses were carried out by statistical software Statistix ver 8.1.

Results and Discussion

Appearance

The data regarding appearance of fried potato chips showed considerable variations among the various olive/palm oils (OO/PO) blends (Table 1). The highest average score (6.90) was obtained by OO/PO 10:90% blend followed by OO/PO 20:80% blend (6.60) and sole olive oil i.e. 00:100% blend. The lowest score (5.70) was recorded for OO/PO 60:40% blend. It was observed that the appearance of the blends was gradually disliked with the increasing percentage of palm oil in the blend. Frying practice significantly ($p<0.05$) affected the appearance of the oil blends. The appearance of the oils was inferior (5.75) at 1st frying, which increased up to 6.08 after 2nd frying. Excellent appearance (7.15) was recorded at 3rd frying. The appearance of potato chips was improved with consecutive frying for three sessions, but it has been reported that continuous frying practices may deteriorate the oil stability (Pantzaris, 1998). The influence of olive oil fractional substitution with palm olein was consistent with the findings of Naghshineh et al. (2009).

Taste

Statistical analysis of the data highlighted significant ($p<0.05$) differences among various blends for taste of fried potato chips (Table 2). Excellent feel of taste (7.57) was recorded for potato chips that were fried in OO/PO 10:90% blend whereas the lowest score (6.30) was documented for 60:40% blend. The frying sessions also significantly affected the taste of potato chips. The extent of taste was stumpy (6.17) at 1st frying, which increased up to 6.65 after 2nd frying. Highest grade of taste (7.60) was recorded after 3rd frying. The taste of potato chips improved with increasing percentage of palm oil in the blend which may be attributed to the replacement of monounsaturated oleic acid in olive oil with saturated fatty acids in palm oil (Reza et al., 2009). It has also been reported that mixture of olive and palm oils may keep its good taste for a longer time after frying (Roiaini et al., 2015).

Table 1: *Average score for appearance of potato chips fried in blends of olive/palm oil (OO:PO) at three consecutive fryings.*

Oil blends OO:PO (%)	Frying			Overall Mean
	1st	2nd	3rd	
100:00	5.80	6.50	7.50	6.60 ab
00:100	6.40	5.90	6.60	6.30 b
10:90	6.40	6.80	7.50	6.90 a
20:80	5.90	6.10	7.80	6.60 ab
40:60	5.40	5.50	6.70	5.87 c
60:40	4.60	5.70	6.80	5.70 c
Overall Mean	5.75 b	6.08 b	7.15 a	-

Means in each category followed by different letters are not significantly different at p<0.05.
LSD value for frying: *0.39;* **LSD value for oil blends:**= *0.39;* **LSD value for interaction:** *0.68*

Table 2: *Average score for taste of potato chips fried in blends of olive/palm oil (OO:PO) at three consecutive fryings.*

Oil blends OO:PO (%)	Frying			Overall Mean
	1st	2nd	3rd	
100:00	6.00	6.80	7.80	6.87 b
00:100	6.30	6.50	6.50	6.43 c
10:90	6.80	7.30	8.60	7.57 a
20:80	6.50	7.00	8.50	7.33 a
40:60	5.90	6.10	7.00	6.33 c
60:40	5.50	6.20	7.20	6.30 c
Overall Mean	6.17 c	6.65 b	7.60 a	-

Means in each category followed by different letters are not significantly different at p<0.05.
LSD value for frying: *0.26;* **LSD value for oil blends:** *0.36;* **LSD value for interaction:** *0.63*

Texture

Texture is an important feature for the acceptability of the food product by the consumers. It was observed that both the oil blends and frying sessions individually as well as interactively significantly ($p<0.05$) influenced the appearance of potato chips (Table

3). The highest average score (8.00) was obtained by potato chips fried in OO/PO 10:90% blend followed by 20:80% blend that got an average score of 7.60. However, the score for 20:80% blend was statistically at par with that of sole olive oil that received an average score of 7.27. An increasing trend was noted in textural score with frying session. The extent of texture was low (6.58) at 1st frying, which increased up to 7.05 after 2nd frying. Highest level for texture (7.85) was recorded after 3rd frying. The present results are in line with the findings of Basoglu et al. (1996) who reported that texture of potato chips was significantly improved due to frying method.

Table 3: *Average score for texture of potato chips fried in blends of olive/palm oil (OO:PO) at three consecutive fryings.*

Oil blends OO:PO (%)	Frying			Overall Mean
	1st	2nd	3rd	
100:00	6.50	7.20	8.10	7.27 b
00:100	6.80	6.80	6.90	6.83 c
10:90	7.40	7.80	8.80	8.00 a
20:80	6.90	7.40	8.50	7.60 b
40:60	6.40	6.70	7.10	6.73 c
60:40	5.50	6.40	7.70	6.53 c
Overall Mean	6.58 c	7.05 b	7.85 a	-

Means in each category followed by different letters are not significantly different at p<0.05

LSD value for frying: *0.27;* **LSD value for oil blends:** *0.39;* **LSD value for interaction:** *0.67*

Table 4: *Average score for color of potato chips fried in blends of olive/palm oil (OO:PO) at three consecutive fryings.*

Treatments OO:PO (%)	Frying			Overall Mean
	1st	2nd	3rd	
100:00	7.10	7.70	7.90	7.57 a
00:100	6.60	6.70	6.80	6.70 b
10:90	6.70	7.70	8.60	7.67 a
20:80	7.10	7.10	8.50	7.57 a
40:60	6.40	6.90	6.70	6.67 b
60:40	6.20	6.70	6.90	6.60 b
Overall Mean	6.68 c	7.13 b	7.57 a	-

Means in each category followed by different letters are not significantly different at p<0.05

LSD value for frying: *0.28;* **LSD value for oil blends:** *0.40;* **LSD value for interaction:** *0.70*

Color

The color of OO oil plays an important role in its market value and is one of the most important attributes in the selection of process. Significant differences were observed among OO/PO blends for color of fried oils (Table 4). Maximum score for color of potato chips (7.67) was recorded for OO/PO 10:90% blend followed by 20:80% blend and sole olive oil which received average scores of 7.57. Potato chips fried in OO/PO 60:40 % blend was comparatively disliked (average score 6.28) by the panel of judges. Frying sessions of the oil blends significantly (p<0.05) affected the color of the product. It was examined that the color of the product was gradually enhanced with increasing number of frying sessions of the oil blends. The extent of color was low (6.68) at 1st frying, which increased up to 7.13 after 2ndfrying. Highest degree for color (7.57) was recorded after 3rd frying. This showed that frying process significantly changed the color of blended oils which was due to linkage between color and free fatty acids (Naghshineh et al., 2010). The data showed that increased quantity of olive oil improved the fashion of color index and high temperature due to frying initially had positive impact on the color of the product but repeated use of oils for frying purposes deteriorate the color of the products (Man and Tan, 1999).

Overall acceptability

The data regarding overall acceptability of fried products showed considerable variations among various oil blends (Table 5). The OO/PO 10:90% resulted in the highest overall acceptability of the product that achieved an average score of 7.56. The least suitability (6.28) of the products was noted in OO/PO 60:40% blend, followed by appropriateness of 40:60% OO/PO blend, which received an average score of 6.40. The overall acceptability of potato chip was decreased with increasing level in the blends. Likewise, frying practice also significantly (p<0.05) affected the overall acceptability of the products. Very good acceptability (7.54) was seen after 3rd frying where 10:90% and 20:80% OO/PO blends received high scores. The results of the present study are fairly in line with the findings of Abdulkarim et al. (2010). The blends of 10:90% and 20:80% OO:PO oils were comparable after 3rd frying, while 40:60% and 60:40% oil blends were similar after 2nd frying. Very good acceptability (8.37 and 8.32) of the products was noted for 10:90% and 20:80% OO/PO blends at 3rd frying. The observation revealed that olive and palm oils blended in the ratios of 10:90% and 20:80% were approved by the judges as stable combination for frying purpose.

Table 5: *Average score for overall acceptability of potato chips fried in blends of olive/palm oil (OO:PO) at three consecutive fryings.*

Treatments OO:PO (%)	Frying			Overall Mean
	1st	2nd	3rd	
100:00	6.35	7.05	7.82	7.07 b
00:100	6.52	6.47	6.70	6.57 c
10:90	6.87	7.42	8.37	7.56 a
20:80	6.60	6.90	8.32	7.27 b
40:60	6.02	6.30	6.87	6.40 cd
60:40	5.45	6.25	7.15	6.28 d
Overall Mean	6.30 c	6.73 b	7.54 a	-

Means in each category followed by different letters are not significantly different at p<0.05

LSD value for frying: *0.19;* **LSD value for oil blends:** *0.27;* **LSD value for interaction:** *0.48*

Conclusions and Recommendations

It was concluded from the present study that blending of olive and palm oils in the ratios of 10:90% and 20:80% resulted in the highest consumers' overall sensory acceptability of the products that was approved by the panel of judges as stable and cost-effective amalgamation for frying purposes. The frying practice also had a positive influence on the sensory quality of potato chips up to three consecutive frying sessions. However, further study is recommended to investigate the effect of repeated frying practice on the chemical and sensory quality of the product beyond three sessions.

Author's Contribution

Muhammad Siddiq: Carried out the analytical work and manuscript writing.
Sahib Alam: Helped in the statistical analysis and interpretation of data.
Hamid Ullah Shah: Conceived and designed the study.
Zafar Iqbal: Proof read the manuscript.
Kalsoom Siddiq: Helped in the analytical work particularly in the preparation of potato chips.
Taufeq Ahmad: Supervised the analytical work.

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