

## Investigate French Fries Cooking Practices in Restaurants and the Implications on Public Health in Muscat, Oman

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### Abstract

The purpose of this study is to identify the frying practices such as frying time and frying temperature followed in Food Service Establishments (FSEs) in Muscat and assess the awareness of shift supervisors about the presence of acrylamide in French fries. The cooking instructions from 34 frozen pre-fried French fries products were recorded. An open-ended questionnaire was used and distributed to shift supervisors in 83 FSEs to assess the Frying practices followed in restaurants. The results showed a statistically significant ( $p < 0.05$ ) variation in the frying practices adopted by the international and local FSEs which include frying time and frying temperature. This can be due, at least in part, to the fact that the majority of respondents did not consider the possible formation of acrylamide during frying. However, shift supervisors in international FSEs were better informed about the nature of French fries than their counterparts in the local FSEs because of the training and the follow up they have received.

In conclusion, a clear variation in frying practices followed by FSEs which would suggest a possible variation in amount and concentration of acrylamide in the French fries served in these establishments.

**Keywords:** Acrylamide; French Fries; Public Health; Food Service Establishments; Frying Practices

### Introduction

White potatoes have been a staple food in many traditional diets of the Western world [1]. In public health point of view potatoes represent a contradictory food because they contain both macro- and micronutrients with possible beneficial and harmful effects on health. Potatoes are rich in starch and have a high glycemic index, which has been associated with an increased risk of developing obesity, diabetes, and cardiovascular disease (CVD) [2,3]. On the other hand, potatoes provide other important micronutrients including potassium, fibers, magnesium, and vitamins B6 and C which are all associated with a decreased risk of morbidity and mortality [4].

Frying is one of the common techniques of food preparation in households, fast food outlets and restaurants [5]. The process of frying involves oxidation, hydrolysis and polymerization, as a result of which a large group of undesirable components is produced such as acrylamide [5]. High acrylamide concentrations in food were detected first in 2002 by the Swedish National Food Administration, and the mechanism of acrylamide formation in food has been described thoroughly in the literature [6,7].

Acrylamide is formed during high-temperature processing of food rich in carbohydrates, especially potato-based products; such as French fries and potato crisps, cereal products and coffee through the process of turning brown during baking, roasting

and frying [8]. This finding caused distinct concern in the scientific community; since animal experiments had shown that acrylamide is a genotoxic, neurotoxic and carcinogenic agent, and its presence in food products was considered of high risk on human health. In May 2007, the EU Commission decided to monitor the level of acrylamide in food [8]. Knowing that elimination of acrylamide from foods is virtually impossible; the objective was to reduce the amount formed in a given product. The amount of acrylamide in food depends on processing conditions, such as the temperature used in cooking and the duration of keeping food at such temperature [1]. Actually, it is the thermal input that is crucial, that is to say the combination of temperature and heating time to which the product is subjected.

The highest content of acrylamide was found in French fries and in potato chips [8]. Fried potato products, mainly French fries and potato crisps, are consumed across all age groups and socio-economic status and provide between-the-meal snacks for many consumers all over the world [4]. Muscat is the capital city of Oman, a country located in the southeastern corner of the Arabian Peninsula. Oman is one of the developing countries in the Arabian Gulf, where the westernisation of lifestyle is associated with high consumption of fast food (>4 times/week) and French fries and potato chips ( $\geq 3$  times/week) [9]. Therefore, such products are considered as a predominant source of acrylamide because they are extensively consumed [1].

French fries are widely prepared in restaurants which can be referred to as Food Service Establishments (FSEs) and the frying practices in these outlets are crucial; because acrylamide is formed towards the end of the frying process. Therefore, the purpose of this study was to record contents and the typical cooking instructions written on the outer package of frozen pre-fried French fries products marketed in Oman. Moreover, to identify the frying practices followed in local and international brands FSEs; in order to determine the level of knowledge among restaurant supervisors about acrylamide and their adherence to the typical frying instructions. This small-scale study is meant to give a glimpse over a possible variation in frying practices of pre-fried French fries which could have an impact on the acrylamide formation and concentration in the final product.

## Methods

This study was conducted in 2018 and an ethical approval was granted by the Institutional Ethical Committee of College of Pharmacy, the National University of Science and Technology and it was designed to investigate the following:

### Record the contents and cooking instructions on the pre-fried French fries products

Thirty four frozen pre-fried French fries products marketed in Muscat were selected for this study. The selection of these products based on that these products clearly mentioned on the outer package the term: 'French fries' and whether they were 'straight cut fries' or 'thin cut fries' which typically represent the standard French fries commonly served in FSEs. Other types of potato products such as curly fries and potato wedges were excluded. The information about the content and cooking instructions was found at the back side of all the selected products and in different languages.

### Survey on frying practices followed in local and international brands FSEs

A cross sectional small-scale survey, based on 83 respondent FSEs; 46 local and 37 international brands restaurants (such as Burger King, McDonalds, Checking, KFC, Pizza Hut, Hardes. etc.) in Muscat, was conducted using a questionnaire designed to be simple and to achieve the purpose of this study. The selected restaurants offer French fries as single and/or part of a main dish/meal in the main menu. The survey was carried out by a direct contact with shift supervisors in these restaurants whom were given the choice to participate in the questionnaire by providing a consent form. Many of them declined to participate in the survey claiming that they cannot disclose the frying practices followed in their restaurant branch as it is confidential information. The questionnaire was composed of 19 close-ended questions/statements grouped into demographic, knowledge based- and practice based- ques-

tions. Demographic questions included: gender, years of experience in the restaurant branch, level of education and nationality. Some of the knowledge based questions were: people consider French fries as essential component in any meal they buy from this restaurant branch (Agree, Neutral, disagree); French fries are rich in carbohydrates (Agree, Neutral, disagree); do you use frozen pre-fried French fries in this restaurant branch? (Agree, Neutral, disagree); there are additives and preservatives added to French fries (Agree, Neutral, disagree); acrylamide (a hazardous chemical) can form in French fries upon frying in hot oil (Agree, Neutral, disagree). Practice base questions were as follows: what type of frying oil you use? (sunflower oil, corn oil, vegetable oil, sesame oil, others); the size of French fries you are using is: (8x8mm, 9x9mm, 10x10mm, 11x11mm, I don't know); optimal frying temperature of the oil used to fry French fries is (<170C°, 170-175C°, 176-180C°, 181-190C°, >190C°); the frying time required to get crunchy golden French fries is (<3 minutes, 3-5 minutes, >5 minutes); you learned about the optimal frying temperature and time from: (your own experience, senior staff/member in the restaurant, training when you first joined the work, others).

### Statistical analysis

Statistical analysis of the results was conducted by using SPSS 19.0 package program. The knowledge about French fries and frying practices in local and international FSEs were assessed using cross tabulation analysis. The results were considered statistically significant at  $p < 0.05$ .

## Results

Analysis of the data obtained from the selected pre-fried French fries products and the survey distributed to FSEs revealed the following information:

### Record the contents and cooking instructions on the pre-fried French fries products

Looking into the nutrition panel of the pre-fried French fries products, the mean carbohydrate (g) in 100g was  $21.3g \pm 1.7$  and the mean amount of energy (kcal) from 100g was  $134.9 \text{ kcal} \pm 8.5$ . Meanwhile, the outer package of all the products provides information about the content and the cooking instructions as summarized in Table 1.

### Survey on frying practices followed in local and international brands FSEs

A general overall view of the results obtained from the participating FSEs as presented in Table 2 revealed that the education qualifications among shift supervisors are diploma or BSc or BA with equal distribution. Most of the participating shift supervisors (69.8%) are Indians and Asians, and about 69.9% have more than 5 years experience in the food industry. Among these restaurants

Pre-fried French fries (n = 34)				
General information		Cooking instructions		
Pre-frying oil	additives	Time (minutes)	Temperature (C°)	Color outcome
Sunflower oil = 10	Disodium diphosphate (E450) = 5	3 to 3.30 = 4	175 = 27	golden yellow = 9
Palm oil = 19	Not disclosed = 29	3 to 4 = 14	180 = 4	golden brown = 5
Vegetable oil = 5		3 to 5 = 3	170 - 175 = 2	Not disclosed = 20
		5 to 6 = 3	180 -190 = 1	
		4 to 6 = 2		
		3 = 3		
		4 = 3		
5 = 2				

**Table 1:** General information including the content of the pre-fried French fries products (n = 34) and cooking instructions; frying time, frying temperature and color outcome of the French fries.

Questions	Answers	Number (%)
Restaurant type?	International	37 (44.6)
	Local	46 (55.4)
Years of experience in current restaurant?	<1 years	17 (20.5)
	1-5 years	44 (53.0)
	>5 years	22 (26.5)
Years of experience in food Industry?	<1 years	4 (4.8)
	1-5 years	21 (25.3)
	5-10 years	36 (43.4)
	>10 years	22 (26.5)
Level of education?	Diploma	28 (33.7)
	BSc	27 (32.5)
	Others (BA and MBA)	28 (33.7)
Nationality?	Indian subcontinent	29 (34.9)
	Asian	29 (34.9)
	Arabic	19 (22.9)
	Omani	3 (3.6)
	Others	3 (3.6)
People consider French fries as essential component in any meal they buy from this restaurant branch.	Agree	60 (72.3)
	Neutral	17 (20.5)
	Disagree	6 (7.2)
French fries are rich in Carbohydrates.	Agree	55 (66.3)
	Neutral	24 (28.9)
	Disagree	4 (4.8)
Do you use frozen pre-fried French fries in this restaurant branch?	Agree	56 (67.5)
	Neutral	16 (19.3)
	Disagree	11 (13.3)
There are additives and preservatives added to the French fries.	Agree	21 (25.3)
	Neutral	23 (27.7)
	Disagree	39 (47)
Acrylamide (a hazardous chemical) can form in French fries upon frying in hot oil.	Agree	14 (16.9)
	Neutral	38 (45.8)
	Disagree	31 (37.3)

What type of frying oil you use?	Sunflower	48(57.8)
	Corn oil	30 (36.1)
	Sesame oil	1(1.2)
	Vegetable oil	2(2.4)
	Other	2(2.4)
The size of French fries you use?	8x8	11 (13.3)
	9x9	14 (16.9)
	10x10	21 (25.3)
	11x11	8 (9.6)
	I don't know	27 (32.5)
	Variable	2 (2.4)
The optimal frying temperature of the oil used to fry French fries is:	< 170	12 (14.5)
	170-175	15 (18.1)
	176-180	25 (30.1)
	181-190	20 (24.1)
	>190	11 (13.3)
The frying time required to get crunchy golden French fries is:	< 3 mints	2 (2.4)
	3-5 mints	57 (68.7)
	>5 mints	24 (28.9)
You learned about optimal frying temperature and time from:	Your own experience	11 (13.3)
	Senior staff/member in restaurant	19 (22.9)
	Training when first joined work	51 (61.4)
	Others	2 (2.4)

**Table 2:** The results with overall view of the collected data from 83 FSEs participated in the survey.

67.5% use frozen pre-fried French fries, 19.3% use either frozen pre-fried French fries or freshly prepared potato fries and 13.3% regularly use freshly prepared potato fries. When viewing the frying practices in participating restaurants, two types of frying oils are used; sunflower and corn oil, and it is clearly evident that frying temperature used in the frying process varies but the frying time (3-5 minutes) is a common time frame followed by 68.7% restaurants.

When statistical analysis performed to investigate the possible variation in the knowledge about French fries and frying practices in both local and international FSEs, the following results were obtained as shown in Table 3. There is a clear trend that shift supervisors in international FSEs are, in some knowledge aspects, better informed about the nature of French fries than their counterparts in the local FSEs. Regarding the level of respondents' knowledge about acrylamide, only 16.9% of respondents (from both local and international FSEs) declared that they consider the possible formation of Acrylamide (a hazardous chemical) in French fries upon frying in hot oil. In terms of frying practices, there are practice differences in the used frying oil, frying temperature and frying time settings. Furthermore, this gap in knowledge and difference in practices can be due to the fact that shift supervisors in international FSEs are better trained to do their work.

## Discussion and Conclusion

Eating out of home is growing and has gained an important place in the habitual diet for Western countries and, preferably in the urban environments. Almost all FSEs whether local or international have French fries as an essential item in their menu and it is always children's favorite. There are many research reporting the presence of acrylamide in French fries through using analytical techniques such as GC-MS-SIM, GC-TOF-MS, LCMS [1,10,11]. There is a general consent that level of acrylamide content is strongly associated with and influenced by the frying practices; mainly frying temperature and time [12-14]. Moreover, several research done in France, Spain and Malaysia concluded that the content of acrylamide in French fries served in local restaurants is significantly higher than that served in international fast food chains [1,2,11]. Sanny, *et al.* (2012) investigated the variation in acrylamide content in French fries served in FSEs. The authors concluded that the variable practices, including lack of standardized frying temperature and time, of food handlers in FSEs (chain fast food vs institutional caterers) seem to contribute to the large variation of acrylamide content in the served French fries [1].

The results in this study showed that the instructions found on the package of the pre-fried French fries products clearly suggest a minimum frying time of 3 and a maximum of 6 minutes (with 3-5

Questions		Restaurant type			
		International		Local	
		Count	Percentage	Count	Percentage
Years of experience in current restaurant?	<1 years	0 <sup>a</sup>	0%	17 <sup>b</sup>	37.0%
	1-5 years	22	59.5%	22	47.8%
	>5 years	15 <sup>a</sup>	40.5%	7 <sup>b</sup>	15.2%
Do you use frozen pre-fried French fries in this restaurant branch?	Agree	33 <sup>a</sup>	89.2%	23 <sup>b</sup>	50%
	Neutral	1 <sup>a</sup>	2.7%	15 <sup>b</sup>	32.6%
	Disagree	3	8.1%	8	17.4%
There are additives and preservatives added to French fries.	Agree	5 <sup>a</sup>	13.5%	16 <sup>b</sup>	34.8%
	Neutral	7	18.9%	16	34.8%
	Disagree	25 <sup>a</sup>	67.6%	14 <sup>b</sup>	30.4%
Acrylamide (a hazardous chemical) can form in French fries upon frying in hot oil.	Agree	5	13.5%	9	19.6%
	Neutral	8 <sup>a</sup>	21.6%	30 <sup>b</sup>	65.2%
	Disagree	24 <sup>a</sup>	64.9%	7 <sup>b</sup>	15.2%
What type of frying oil you use?	Olive oil	0	0%	0	0%
	Sunflower	26 <sup>a</sup>	70.3%	22 <sup>b</sup>	47.8%
	Corn oil	6 <sup>a</sup>	16.2%	24 <sup>b</sup>	52.2%
	Sesame oil	1	2.7%	0	.0%
	Vegetable oil	2	5.4%	0	.0%
	Others	2	5.4%	0	.0%
The optimal frying temperature of the oil used to fry French fries is:	< 170	11 <sup>a</sup>	29.7%	1 <sup>b</sup>	2.2%
	170 -175	9	24.3%	6	13.0%
	176 - 180	12	32.4%	13	28.3%
	181 - 190	5 <sup>a</sup>	13.5%	15 <sup>b</sup>	32.6%
	> 190	0 <sup>a</sup>	0%	11 <sup>b</sup>	23.9%
The frying time required to get crunchy golden French fries is:	< 3minutes	2	5.4%	0	0.0%
	3 - 5 minutes	31 <sup>a</sup>	83.8%	26 <sup>b</sup>	56.5%
	> 5 minutes	4 <sup>a</sup>	10.8%	20 <sup>b</sup>	43.5%

**Table 3:** A comparison between international and local FSEs. Questions which revealed significant statistical outcome were presented here. Statistical significance ( $p < 0.05$ ) is represented by the different superscript letters (<sup>a,b</sup>).

minutes as the average) while the frying temperature is suggested to be in the range of 170-175 C° (Table 1). Shift supervisors in FSEs in Muscat are in general educated (66.2%) and 61.4% were provided training when they first joined the FSE, among whom 89.2% are working in international FSEs. Frozen pre-fried French fries products were the main choice in 67.5% of the sample restaurants and when the shift supervisor asked about the presence of additives and preservatives in the frozen French fries the response was either not sure/neutral (27.7%) or disagree (47%). This comes in agreement to the fact that only 5 frozen French fries products contain food additives (14.7% - Table 1). In relation to acrylamide

presence in French fries, it is clear that in all sample restaurants the shift supervisors are either not sure (45.8%) or miss informed/lack of awareness (47%) and this has a clear association with the lack of consistency in the frying practices; especially frying temperature which drastically varies among all restaurants (Table 2).

When investigating the relationship between the type of restaurant and the standard frying practice suggested by the frozen pre-fries French fries products (170-175 C° and 3-5 minutes), a strong correlation was observed by which international FSEs are more likely to follow the standard frying practice than local FSEs

do. This could be due to the fact that 89.2% of the shift supervisors are trained on the standard practices that must be followed in general kitchen settings and frying of French fries in particular. The results in Table 3 could also indicate that shift supervisors follow the standard frying practice without being aware about its link with acrylamide formation in French fries and this explain the existence of slight deviation in frying temperature and time used in the international FSEs. The type of frying oil used in both types of FSEs varies; in international FSEs it is mostly sunflower oil (70.3%) while in local restaurants it is mainly either corn oil (52.2%) or sunflower oil (47.8%). Meanwhile, the pre-frying oils used in the preparation of frozen pre-fried French fries are palm oil (55.9%) and sunflower oil (29.4%). Researchers have investigated effect of the type of frying oil on acrylamide formation in French fries as well as the effect of heat on frying oil [15-17]. Mestdagh, *et al.* (2005) showed that there is no effect of oil type on acrylamide concentration in French fries if frying conditions were 175 C° for 5 minutes. In another study done by Daniali, *et al.* (2016) reported that heating of the frying oil at 180 C° for 30 minutes would make the frying oil prone for the formation of large amount of acrylamide specially with sunflower and soybean oils.

This study highlighted the fact that there is a variation in frying practices of French fries in FSEs in general and in between international and local FSEs, which was also observed in other studies [1,2,11]. This has a potential impact on the quality of French fries, represented by possible high acrylamide content, served in these establishments which could pose a public health concern hence this issue requires further investigation.

### Future Research

As there is no studies conducted in the Middle East region reporting and discussing the actual acrylamide content in French fries served in international and local FSEs, this pilot study is an open invitation to give this issue a priority. Furthermore, another research direction is to identify the frying practices followed in the households in Oman and the region and measure the impact of these practices on acrylamide levels in French fries. This issue has an effect on large number of population, especially children to whom French fries are always presented to them as a totally safe food item to consume.

### Author Disclosure Statement

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