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Moisture loss and oil uptake kinetics in French fries (var. *Kufri bahar*) during frying in different oils and treatments

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Abstract

The relationship between moisture loss and oil uptake at different treatment of sample and time during deep-fat frying of french fries was investigated in this study. French fries samples were diced and fried at different oil (Mustard oil, Soybean refined oil, Sunflower oil,) in a fryer for periods varying from 50 to 200 sec. The relationship between moisture loss and oil uptake during the frying was erratic and appeared to be independent of frying oil. The relationship Oil uptake was positively to moisture loss in the range of frying times 50 sec. to about 200 sec. After 100 sec, oil uptake tended to decrease while moisture loss continued. The relationship between moisture loss and oil uptake is an important phenomenon in the context of characterizing the physical properties of French fries.

Keywords: Potato French fries, Blanching, Frying, Oil uptake, moisture loss.

Introduction

Potato (*Solanum tuberosum L.*) is grown in more than 100 countries in the world. India ranks third, after China and Russia. It has become an integral part of breakfast, lunch and dinner among the larger population. Being a short duration crop, it produces more quantity of dry matter, edible energy and edible protein in lesser duration of time compared to cereals like rice and wheat. Hence, Potato is considered to be an important crop to achieve nutritional security of the nation. It can be processed into variety of products such as cubes, chips, flakes, granules, powder, French fries and dehydrated dice. In India, Potato processing industry mainly comprises four segments: Potato chips, French fries, Potato flakes/powder and other processed products such as dehydrated chips, Alu Bhujia, Samosa, and Tikkis. Krokida *et al.*, (2001) ^[3] reported that blanching reduces oil absorption of fried potatoes by gelatinizing the surface starch, while air dehydration also leads to reduced oil absorption. Santis *et al.*, (2007) ^[5] showed that longer soaking time and higher NaCl concentrations improved the texture. Potato slices were darker after frying with increase of blanching temperature from 60°C/5min to 80°C/5min, for NaCl soaked slices against water-soaked slices. Blanching temperatures before frying enhanced the color of the potato chips. Ahmad *et al.*, (2008) ^[1] reported that frying is extensively employed in the domestic and industrial sectors due to its ability to create unique sensory characteristics in food. Mir-Bel *et al.*, (2009) ^[4] studied that during frying, heat transfer causes protein denaturation, starch gelatinization, water evaporation, crust formation and color development. Mass transfer is characterized by water and some soluble material escaping from the product during the process, combined with oil penetrating the food.

Materials and Methods

Present investigation was carried out to develop potato French fries and to evaluate relationship between moisture loss and oil uptake during frying in different oils; in the Laboratory of the Department of Agricultural Engineering, Sardar Vallabhbhai Patel university of Agriculture and Technology, Meerut (UP) India, during year 2012-14. Chemicals like NaCl, KMS, CaCl₂ and frying oil viz. mustard oil, refined soybean oil and sunflower oil and other raw materials were procured from the local market. Potatoes (var. *Kufri bahar*) were collected from the farmer, washed with clean water to remove dust and dirt followed by peeling, cutting with the help of french fries cutter then blanching. The samples were fried in different oils (mustard oil, refined oil, sunflower oil) followed by packing.

The French fries sample were blanched in four different treatments namely, (i) 3% NaCl at 90°C for 3 min, (ii) 0.5% KMS solution at 90 °C for 3 min, (iii) 3% NaCl + 0.5% KMS solution at 90 °C for 3 min, and (iv) 0.5% CaCl₂ solution at 90°C for 3 min. After blanching, the samples were cooled for 30 min in ceiling fan. Deep frying process is followed in which heat is transferred from the oil to the food, water is evaporated from the food and oil is absorbed in it.

Frying conditions: The potatoes cut into rectangular pieces and samples of the same mass were selected. The samples were washed in distilled water and excess surface water was removed using tissue paper. The potato to oil ratio was kept at 1:5. The samples were blanched with different treatments and frying was performed for four different times of 50, 100, 150, 200 sec. After each frying experiment, the level of oil was measured.

Moisture content: Moisture content of samples was determined by method as recommended by AOAC (2000) [2].

Oil uptake: Oil uptake is measured as difference in mass of oil in pan during frying.

Results and discussions

Moisture loss during frying: The moisture content of the samples decreased during frying time increase. As expected, water evaporation took place quicker when the higher temperatures are applied. There are important differences between 50 to 200 sec., while increase has additional effect on moisture reduction when it is compared with 50 sec.

Effect of mustard oil: The experimental result for moisture content or moisture loss during frying in mustard oil is given in Table 1; represents that moisture loss was increased with increasing the frying period among the entire samples. The pretreatment also affect the moisture loss during frying. Initial moisture content of sample was found 488 % db. The highest moisture loss was observed at first 50 sec. in KBM T₂ (488 - 98.50% db) and lowest in sample KBM T₁ (488 - 255% db). Frying for 100 sec. highest moisture loss was observed in sample KBM T₂ (488 - 56.71% db) and lowest in sample KBM T₁ (488 - 180% db). Frying at 150 sec. highest moisture loss was observed in sample KBM T₄ (488 - 16.66% db) and lowest in sample KBM T₁ (488 - 118% db). Frying at 200 sec. highest moisture loss was observed in sample KBM T₂ (488 - 1.49% db) and lowest in sample KBM T₄ (488 - 1.51% db). The study was noticed that moisture loss was lost rapidly in first 50 sec of frying. The moisture was lost from 488 % (db) to 1.49% (db) during frying.

Table 1: Effect of mustard oil on moisture content (% db) of potato French fries.

Time (sec.)	KBM T ₁	KBM T ₂	KBM T ₃	KBM T ₄	KBM T ₅
0	488	488	488	488	488
50	255	98.50	144.82	150.87	103.03
100	180	56.71	93.10	85.96	59.09
150	118	19.40	44.82	43.85	16.66
200	59	1.49	17.24	15.78	1.51

Effect of refined oil: The experimental result for moisture content loss during frying in refined oil is given in Table 2 represents the highest moisture loss was observed in first 50 sec. in KBR T₅ (488 - 117.46% db) and lowest in KBR T₂ (488 - 326.3% db). Frying at 100 sec highest moisture loss

was observed in KBR T₄ (488 - 37.50% db) and lowest in KBR T₂ (488 - 218.42% db). Frying at 150 sec highest moisture loss was observed in KBR T₄ (488 - 5.55% db) and lowest moisture loss in sample KBR T₂ (488 - 139.47% db). Frying at 200 sec highest moisture loss was observed in sample KBR T₅ (488 - 3.17% db) and lowest moisture loss in sample KBR T₂ (488 - 94.73% db). The moisture was lost during frying from 488 % (db) to 3.17% (db).

Table 2: Effect of refined oil on moisture content (% db) of potato French fries.

Time (sec.)	KBR T ₁	KBR T ₂	KBR T ₃	KBR T ₄	KBR T ₅
0	488	488	488	488	488
50	276.19	326.30	163.63	122.58	117.46
100	214.28	218.42	103.63	37.50	61.90
150	121.42	139.47	50.90	5.55	15.87
200	44.73	94.73	36.36	4.61	3.17

Effect of sunflower oil: The experimental result for moisture loss during frying in sunflower oil is given in Table 3; represents the highest moisture loss was observed in first 50 sec. in KBS T₂ (488 - 112.50% db) and lowest in KBS T₁ (488 - 184.61% db). Frying at 100 s highest moisture loss was observed in KBS T₂ (488 - 60.93% db) and lowest in KBS T₁ (488 - 117.30% db). frying at 150 sec highest moisture loss was observed in KBS T₄ (488 - 20.96% db) and lowest moisture loss by sample KBS T₁ (488 - 50.00% db). Frying at 200 sec highest moisture loss was observed in sample KBS T₄ (488 - 1.61% db) and lowest moisture loss in sample KBS T₁ (488 - 19.23% db). It was noticed that the moisture was lost during frying from 488 % (db) to 1.61% (db).

Table 3: Effect of sunflower oil on moisture content of potato French fries.

Time (sec.)	KBS T ₁	KBS T ₂	KBS T ₃	KBS T ₄	KBS T ₅
0	488	488	488	488	488
50	184.61	112.50	138.98	122.58	163.60
100	117.30	60.93	84.74	64.51	74.54
150	50.00	21.87	35.54	20.96	34.54
200	19.23	6.25	22.03	1.61	9.09

Oil absorption during frying

Effect of mustard oil: The experimental data for change in oil uptake of potato french fries fried in mustard oil are shown in Table 4. It is clear that french fries oil uptake first increase then decrease with increase in time. Frying at 50 sec highest oil uptake by control sample KBM T₁ (34 g) and lowest in KBM T₃ (20.68 g). Frying at 100 sec highest oil uptake by control sample KBM T₁ (25 g), and lowest oil uptake by sample KBM T₅ (6.06 g). Frying at 150 sec highest oil uptake by control sample KBM T₁ (13.60 g) and lowest oil uptake by sample KBM T₂ (5.91 g). Frying at 200 sec highest oil uptake by control sample KBM T₁ (11.30 g) and lowest oil uptake by sample KBM T₂ (4.47 g). Frying for 50-200 sec highest oil uptake was by control sample KBM T₁ (34 g) and lowest oil uptake by sample KBM T₂ (4.47 g).

Table 4: Effect of mustard oil on oil uptake of potato French fries.

Time (sec.)	KBM T ₁	KBM T ₂	KBM T ₃	KBM T ₄	KBM T ₅
50	34.00	25.37	20.68	31.57	28.78
100	25.00	10.44	12.06	10.52	6.06
150	13.60	5.91	8.62	12.28	9.09
200	11.30	4.47	6.89	8.77	7.57

Effect of refined oil: The experimental data for change in oil uptake of potato french fries fried in refined oil are shown in Table 5. Frying at 50 sec highest oil uptake by pretreated sample KBR T₂ (42.10 g) and lowest oil uptake by KBR T₅ (20.63 g). Frying at 100 sec highest oil uptake by control sample KBR T₁ (19.04 g) and lowest oil uptake by sample KBR T₄ (6.94 g). Frying at 150 sec highest oil uptake by control sample (14.28 g) and lowest oil uptake by sample KBR T₃ (5.45 g). Frying at 200 sec highest oil uptake by KBR T₂ (7.89 g) and lowest oil uptake by sample KBR T₄ (4.16 g). Frying at 50-200 sec highest oil uptake by sample KBR T₂ (42.10 g) and lowest oil uptake by sample KBR T₄ (4.16 g).

Table 5: Effect of refined oil on oil uptake of potato French fries.

Time (sec.)	KBR T ₁	KBR T ₂	KBR T ₃	KBR T ₄	KBR T ₅
50	38.09	42.10	27.27	22.22	20.63
100	19.04	15.78	10.90	6.94	9.52
150	14.28	10.52	5.45	8.33	7.93
200	7.14	7.89	7.27	4.16	6.34

Effect of sunflower oil: The experimental data for change in oil uptake of potato French fries fried in Sunflower oil are shown in Table 6. Frying at 50 sec highest oil uptake was by control sample KBS T₁ (30.76 g) and lowest oil uptake by KBS T₄ (25.80 g). Frying at 100 sec highest oil uptake by sample KBS T₄ (14.54 g) and lowest oil uptake by sample KBS T₂ (10.93 g). Frying at 150 sec highest oil uptake by sample KBS T₄ (12.90 g) and lowest by sample KBS T₂ (6.25 g). Frying at 200 sec highest oil uptake by sample KBS T₅ (9.09 g) and lowest oil uptake by sample KBS T₂ (4.68 g). Frying during 50-200 sec highest oil uptake was by controlled sample KBS T₁ (30.76 g) and lowest was by sample KBS T₂ (4.68 g).

Table 6: Effect of sunflower oil on oil uptake of potato French fries.

Time (sec.)	KBS T ₁	KBS T ₂	KBS T ₃	KBS T ₄	KBS T ₅
50	30.76	29.68	30.50	25.80	27.27
100	13.46	10.93	11.86	14.51	14.54
150	9.61	6.25	8.47	12.90	10.90
200	5.76	4.68	6.77	6.45	9.09

Conclusion

This study shows relationship between oil uptake and moisture loss during deep-fat frying of French fries. The relationship between moisture loss and oil uptake is an important phenomenon in the context of characterizing the physical properties of fried product. Highest moisture loss in case of French fries fried in mustard oil was observed in samples pre-treated with 3% NaCl at 90 °C for 3 min and than the other pre-treated samples; oil uptake was found highest in controlled sample. Effect of refined oil on moisture content of French fries blanching with CaCl₂ at 90 °C for 3 min highest moisture loss and oil uptake was found in controlled sample. Effect of sunflower oil on moisture content of French fries was highest found in blanching with 3%NaCl + 0.5% KMS at 90 °C for 3 min and oil uptake was highest found in controlled sample

Abbreviations

KB= Kufri Bahar, M = Mustard oil, R = Refined oil, S = Sunflower oil, T₁= Simple blanching treatment, T₂= Blanching with 3% NaCl at 90°C for 3 min, T₃= Blanching with 0.5% KMS at 90°C for 3min, T₄= Blanching with 3% NaCl + 0.5% KMS at 90°C for 3 min, T₅= Blanching with CaCl₂ at 90 °C for 3 min.

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