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The effect of pre drying, slices dimensions and Psyllium seed hydrocolloid-coating on oil uptake in potato slices during deep fat frying

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ABSTRACT

Nowadays, consumption of fried potatoes is highly growing and due to its high oil uptake during the process, it makes a lot of calories which are harmful to human Health; so, attempts to reduce the amount of absorbed oil will improve the health of society. In this research the effect of Psyllium seed hydrocolloid as coating material (0.5, 1%), changes in slices dimensions (6×1.25×1.25, 6×1.5×1.5) and predrying (reducing moisture to 60%) are assessed on the oil uptake by potatoes in the deep fat frying process individually and together. Results show that coating by Psyllium seed hydrocolloid due to its blocking nature causes decreasing the loss of moisture during the frying while water can control the amount of absorbed oil. Increasing in the concentration of hydrocolloid solution decreased the efficiency of frying, moisture (resulted from coating) and the tissue smoothness. Taste and color improved by predrying. The loss of moisture, the amount of coating and reduction in absorbed oil, also increased. Reducing in slices dimensions increased the efficiency of frying, coating percent and the tissue smoothness.

Introduction

Fries potatoes are slices of potato with 1×1×6-7 cm of dimensions which are fried in hot oil [Lisinska & Leszczynski, 1989]. Deep fat frying is a dry curing process including dipping pieces of food in the hot vegetable oil. During the process the physical, chemical and sensory properties of food will change. The main goal of deep fat frying is preserve the taste of food into a crispy crust by immersion it in hot oil [Moyano et al., 2003]. The amount of dry matter in potato determines the quantity of water that should be removed and vaporized to achieve desired moisture in final product. Increasing in dry matter will decrease the absorbed oil. Fries with high specific gravity have favorable tissue, no shrinkage and depression [Lisinska & Leszczynski, 1989]. Plantago psyllium seeds are rich of mucilage (an enameled compound) which is a polysaccharide that can be used as coating material for food [Amiri et al, 2010]. Coating potato slices with enameled materials by creating a uniform layer will prevent the transfer of moisture between the food and surroundings to maintain product fragility. Drying by microwave, treatment by hot air or cooking before frying will decrease oil uptake. Results showed that the predrying significantly reduced absorbed oil in final product and had a positive effect on the tissue properties [Agnieszka et al., 2008]. One of the most important qualitative features of fried products is the quantity of oil that they could absorb. Frying with small amounts of oil will resulted in hard and undesirable products. Beside, high amount of oil not only is so expensive, but also can lead to the tasteless and oily products that are harmful to health. Pinthus et al [1993] reported that quantity of oil uptake during frying is equal to vaporized water. When the water evaporated and moved out of the food, the surface of food will dried and the crust will form. In deep fat frying, vaporizing of water resulted to swelling of the tissues of nutrients and increasing in tissues porosity. Suzanne et al [2002] found that the oil source doesn't have considerable effect on the fat content of potato. They showed that the pre-frying operations have the greatest influence on the oil uptake. Blanching by Calcium chloride solution yielded the lowest oil uptake and blanching with water vice versa. Immersion in hydrocolloid has also significant effect on the oil uptake. Joukar et al [2006] studied on the low fat potato chips which coated by hydrocolloid. They found that this type of coating will increases the quantity of moisture and decreases the oil uptake percent. 5% of Pectin, made the highest reduction in oil uptake and 1.5% of Carboxymethyl cellulose (CMC) had highest content of moisture. Hydrocolloid coating also decreases the peroxide value and acidic number during warehousing. Amiri et al [2010] studied on the effect of Psyllium seed hydrocolloid (0.1 and 0.2%) on properties of low fat yoghurt. Syneresis of low-hydrocolloid content samples was less than the blank samples. When reservation time increased, the Syneresis reduced. Results of sensory assessments confirmed that the addition of Psyllium seed hydrocolloid in 0.1% level, improved the yoghurt taste. Hosseinabadi et al [2011] found that blanching in Calcium chloride solution decreased the oil uptake in potato slices up to 62.8%. They also found that the CMC coating (1.5%) with Sorbitol (0.5%) reduced oil uptake from 19.85% to 16.29% in comparison with blank samples. The aim of this study was to investigate the effect of predrying slices dimensions and Psyllium seed hydrocolloid -coating on the oil uptake by potato strips during deep fat frying.

Materials and Methods

Potato tubers (cv. Agria) were purchased from a local market in Khorram-darreh. Prior to investigations, their physical and chemical properties were examined and then they were stored at 5-7 ºC and 80% relative humidity. To decrease the reductant sugars, potatoes were kept in the room temperature for two weeks before experiments. The Psyllium seed hydrocolloid powder was prepared in laboratory from seeds and used for Plantago psyllium solution praparation. The oil for frying (mix of Olein and soybean oil) was purchased from Bahar Oil Company.

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Psyllium seed hydrocolloid preparation

100g of Psyllium seed was powdered and using 30 mesh sieve, the crust was removed from the kernel, mixed with water (1:50) and kept in r.t. for 2 hr until it swollen. Then the mixture was centrifuged (10 min, 15000 rpm, Sigma K30K, Germany) and impurities were separated. The obtained gel was mixed with ethanol 96% and allowed hydrocolloid to precipitate and then it was centrifuged (5000 rpm). The last step repeated 3 times to remove all impurities. The product was dried with freeze dryer, powdered and kept in glass container at -20 ºC [Anonymous, 2005].

Psyllium solution preparation

To achieve 0.5% solution, 0.5 g of produced powder was homogenized in 100ml distilled water (70 ºC) until a clear solution was obtained and cooled to for 1% solution, 1g powder was used.

Potato slices preparation

The potato tubers were peeled and cut with a manual operated potato-cutting home device into 1.5×1.5×6 cm slices as control 1 (C1) samples and 1.25×1.25×6 cm slices as control 2 (C2). The slices were blanched in water at 90-95 ºC for 4 min and placed on a clean cloth to remove excess water [Anonymous, 2005]. They were immediately immersed in the prepared colloidal suspension for 1 min. To remove excess amount of colloidal solution, the slices were placed on a latticed tray. The weight of slices was recorded before and after coating. For predrying, slices were placed in oven at 80 ºC to reduce moisture content to 60% [Debnath et al., 2003].

Frying

The slices were fried at 175 ºC for 2.5 min in oil and then placed on a latticed tray to remove excess oil [Fred, 2005]. All fried samples were allowed to cool to r.t and analyzed.

Analytical methods

Solid matter and moisture of raw & fried potato

Experiments were done by drying in an oven at 105 ºC until constant weight was reached. Weighing was performed every 5 min on a analytical balance. Solid matter and moisture content were calculated according to Eq.1and Eq.2 [Lisinska and Leszczynski, 1989]:

$$\text{Solid matter\%} = \text{moisture\%} - 100 \qquad \text{Eq.1}$$

$$\text{moisture\%} = \frac{M1 - M2}{M0} \qquad \text{Eq.2}$$

M1: Weight of sample and container before drying
M2: Weight of sample and container after drying
M0: Weight of sample

Specific Gravity of raw potato

Tubers were placed in a wire mesh and weighed (A1). Then it was dipped into the water container and the weight was read (A2). The weight of mesh in air (B1) and water (B2) also read. The specific gravity was calculated as follows (Eq.3) [Jafarian, 2000]

$$\text{specific gravity} = \frac{A1}{(A1 - A2) - (B1 - B2)} \qquad \text{Eq.3}$$

Oil content

The soxhlet method was used to measure the amount of fat in fried slices. So, 4g of slices were weighted and the fat was extracted by Petroleom ether [Garcia et al., 2001].

Coating percent

The weight difference between the coated and uncoated samples resulted to coating percent according to Eq.4 while I is the weight of un coated samples and C is for coated [Lisinska and Leszczynski, 1989]:

$$\text{Coating\%} = \frac{C - I}{I} \times 100 \qquad \text{Eq.4}$$

Frying efficiency

Frying efficiency, considering the weight of fried and raw slices after coating, was calculated as follows (Eq.5) [Lisinska and Leszczynski, 1989]:

$$\text{Frying efficiency} = \frac{CW}{C} \times 100 \qquad \text{Eq.5}$$

CW: weight of fried-coated slices
C: weight of raw-coated sclices

Measurment of reduced fat

Fat reducing (FR) due to coating measured as follows Eq.6 [Mellema, 2003]

$$FR = \frac{\text{Fat in uncoated} - \text{Fat in coated}}{\text{Fat in uncoated sample}} \qquad \text{Eq.6}$$

Water loss

Water loss reducing (WLR) due to coating calculated by Eq.7 [Mellema, 2003]

$$WLR = \frac{\text{uncoated Moisture loss} - \text{coated Moisture loss}}{\text{uncoated Moisture loss}} \qquad \text{Eq.7}$$

Oil uptake

The Soxhlet method was used also to measure oil uptake. Accurate weights of samples were recorded before and after frying. Eq.8 was used to calculate [Mellema, 2003]:

$$\text{Oil uptake} = \frac{(F2 \times W2) - (F1 \times W1)}{\text{solid matter}} \qquad \text{Eq.8}$$

F2= final fat content F1= Primary fat content
W2= weight after frying W1=weight before frying

Data Analysis

All experiments were conducted in a completely randomized design and repeated 3 times. Experimental data were analyzed by $SPSS_{20}$ (ANOVA). Differences between samples were considered at the 5% significant level.

Results and discussion

According to table 2, highest and lowest of coating percent were obtained by $A_1K_1P_2$ and $A_2K_1P_1$, respectively. So, it was resulted that Increasing in the concentration of hydrocolloid solution increased coat percentage. Highest and lowest of frying were obtained by $A_2K_2P_1$ and $A_2K_1P_2$, respectively. After the treatments applications that raise the humidity level, the frying increased, also pre drying reduced frying (Akdeniz, 2004). According to table 2, highest and lowest of friability were obtained by $A_1K_1P_2$ and C_2, respectively. Friability may be caused by the amount of the amylose and amylopectin in starch. Stanley *et al*., (2005) mentioned that amylose released from the starch by pre drying and it made hydrogen bonds with other cell wall polysaccharides, this fact increased the adhesion and cohesion. Agnieszka *et al*., (2008) showed that by increasing the slices dimensions, Friability increased. $A_1K_1P_2$ and $A_2K_1P_1$ showed highest and lowest oil uptake, respectively. Water evaporation causes the stomata but Psyllium can decrease the amount of oil that this decrease is due to the nature of the barrier properties of the coatings (Varela and Fiszman, 2011). It was also observed that oil reduced by applying a pre-drying process because pre-drying causes shell formation and shell prevented from entering of oil (Pedreschi and Moyano, 2005). By application of Psyllium with 1 percent waste of water is more than using of 0.5 percent treatment. According to table 3, highest and lowest of oil uptake were obtained by C_2 and $A_1K_1P_2$, respectively. Actually, in oil absorption increased with a reduction in slices dimensions of the potatoes (Debnath et al., 2003). Garcia *et al*., (2001) showed that oil uptake reduced after using of high concentration of Psyllium. Consequently, In between treatments, $A_1P_1K_2$ treatment had lowest of oil uptake and water loss, highest coating percent.

Table 1. Treatments

treatments	Coating percent	size	
$A_1K_1P_1$	1	6×1.5×1.5	Without pre-drying
$A_2K_1P_1$	0.5	6×1.5×1.5	Without pre-drying
$A_1K_1P_2$	1	6×1.5×1.5	pre-drying
$A_2K_1P_2$	0.5	6×1.5×1.5	pre-drying
$A_1K_2P_1$	1	6×1.25×1.25	Without pre-drying
$A_2K_2P_1$	0.5	6×1.25×1.25	Without pre-drying
$A_1K_2P_2$	1	6×1.25×1.25	pre-drying
$A_2K_2P_2$	0.5	6×1.25×1.25	pre-drying
C_1	-	6×1.5×1.5	
C_2	-	6×1.25×1.25	

Table 2. Effect of treatments on Coating percent, Frying efficiency and friability

Treatment	Coating percent	Frying efficiency	friability
$A_1K_1P_1$	0.716 ± 0.015 de	78.900 ± 0.435 b	11.751 ± 0.994 a
$A_2K_1P_1$	0.249 ± 0.005 f	53.833 ± 0.416 d	4.476 ± 0.493 bcd
$A_1K_1P_2$	2.418 ± 0.187 a	39.796 ± 0.759 f	13.104 ± 1.803 a
$A_2K_1P_2$	0.683 ± 0.066 de	39.710 ± 1.965 f	8.989 ± 1.698 ab
$A_1K_2P_1$	0.753 ± 0.047 d	75.933 ± 1.747 c	11.234 ± 1.775 a
$A_2K_2P_1$	0.556 ± 0.02 e	83.266 ± 1.436 a	9.408 ± 4.424 ab
$A_1K_2P_2$	2.033 ± 0.1 b	45.07 ± 1.423 e	8.252 ± 1.220 abc
$A_2K_2P_2$	1.54 ± 0.095 c	53.080 ± 1.716 d	5.741 ± 1.295 bcd
C_1	-		3.597 ± 0.549 cd
C_2	-		2.302 ± 0.397 d

Table 3. Effect of treatments on reduced fat percent, Water loss and oil uptake

Treatment	Reduced fat percent	Water loss	Oil uptake
$A_1K_1P_1$	0.993 ± 0.07 bc	0.703 ± 0.011 ab	22.160 ± 0.195 d
$A_2K_1P_1$	0.523 ± 0.035 e	0.260 ± 0.192 d	25.273 ± 0.690 c
$A_1K_1P_2$	1.736 ± 0.137 a	0.770 ± 0.017 a	17.350 ± 0.867 f
$A_2K_1P_2$	0.820 ± 0.017 cd	0.406 ± 0.02 c	19.133 ± 0.872 e
$A_1K_2P_1$	1.056 ± 0.056 b	0.626 ± 0.005 b	19.283 ± 0.265 e
$A_2K_2P_1$	0.690 ± 0.03 de	0.363 ± 0.005 cd	20.156 ± 0.159 e
$A_1K_2P_2$	1.640 ± 0.122 a	0.686 ± 0.03 ab	27.593 ± 0.102 b
$A_2K_2P_2$	1.04 ± 0.210 b	0.363 ± 0.035 cd	18.103 ± 0.60 f
C_1	-		27.046 ± 0.338 b
C_2	-		30.690 ± 0.883 a

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