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USING OF SOME HYDROCOLLOIDS TO DECREASE OIL ABSORPTION AND THEIR EFFECT ON THE QUALITY OF FRIED POTATO CHIPS

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ABSTRACT

The objective of this study was to determine the changes in the quality of edible-coated potato (*Solanum tuberosum*) chips to obtain low fat product .Potato chips were treated with calcium chloride alone(0.2, 0.4, 0.6 and 0.8%) and combination of calcium chloride and k-carrageenan; guar gum and chitosan at level(1%, 2% and 3%) and then fried. Oil absorption, moisture content and sensory evaluation were analyzed. Also, Thiobarbituric acid (TBA) value and microbiological profile were determined during storage at – 18 ^{o} C for 3 months. Results indicated that, fried potato chips treated with k-carrageenan, guar gum and chitosan showed a lower fat content (7.6 – 46%) and the same trend was observed with those treated only with calcium chloride (6 – 21.5%). In addition, potato chips treated with a combination of 0.6% calcium chloride and 3% k-carrageenan had the highest reduction level of oil content (46%) as well as moisture content and sensory scores compared to the control. Physicochemical and microbiological properties indicated that using of k-carrageenan, guar gum and chitosan pre-frying could be minimized TBA values and total bacterial count throughout storage period compared to control sample. Therefore, this work suggests that some edible coating materials could by used to improve total quality of fried potato chips.

Keywords: Potato chips, coating materials, oil absorption, microbiology, storage.

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INTRODUCTION

Potatoes (*Solanun tuberosum* L.) tubers is one of the world major agricultural crops in all over the world and it is consumed daily by millions of people from diverse cultural backgrounds. Potatoes are grown in approximately 80% of all countries and world wide production stands in excess of 300 millions tons/year. Potato chips are very thin pieces (1.27–1.78 mm thick) of sliced raw potatoes that are fried to a final oil content of 33–38 g/100 g (wet basis). Potato chips have been a popular salty snacks for 150 years. Approximately 1.2 billion pounds of potato chips are consumed in the US each year (Clark, 2003).

Potato chips contain significant amount of fat, reaching in many cases _1/3 of the total food product by weight (Mellema, 2003). This ensures a high level of satiety, but can also pose a risk. Especially, over the last decade the desirability of reducing fat content of deep fried products has been recognized. Therefore, consumer trends are moving toward healthier foods and low fat products, creating the need to develop technologies to reduce the amount of oil in end fried products (Bouchon, *et al.*, 2003).

Deep-fat frying is a widely used food process, which consists basically of immersion of food pieces in hot vegetable oil. The high temperature causes partial evaporation of the water, which moves away from the food and through the surrounding oil, and a certain amount of oil is absorbed by the food. Frying is a process used widely both in domestic and industrial cooking. It basically consists of cooking food in oil or fat at a temperature above the boiling point of water, usually between 150 and 200^{o} C. This quick and easy preparation results in products with organoleptic qualities (color, texture, and flavor) much in demand by appreciative consumers. However, these products have a high fat content that in some cases reaches a third of their total weight (Pedreschi and Moyano 2005). Fried foods also contain high amount of fat consumption is considered to heighten blood cholesterol, high blood pressure and coronary heart disease. Thus, research in reducing oil absorption during deep-fat frying has been intense in recent years (Mellema, 2003).

In order to obtain low-fat potato chips, it is useful to understand the mechanisms involved during the frying process, so that oil migration into the structure can be minimized. Numerous studies showed that most of the oil is confined to the surface region of the fried potatoes (Bouchon *et al.*, 2001), and there is evidence that it is mostly absorbed after frying during the cooling period (Aguilera and Gloria-Herna´ ndez, 2000;). Bouchon *et al.,* (2003) explained that three different oil fractions can be identified as a consequence of the different absorption mechanisms in fried potato cylinders, that is: (i) structural oil (STO) which represents the oil absorbed during frying, (ii) penetrated surface oil (PSO) which represents the oil suctioned into the food during cooling after removal from the fryer, and (iii) surface oil (SO) which is the oil that remains on the surface. These authors showed that a small amount of oil penetrates during frying because most of the oil was picked up at the end of the process, suggesting that oil uptake and water removal are not synchronous phenomena.

Therefore, in recent decades many food research projects attempted to examine oil uptake during the frying process (Ziaiifar et al., 2008), proposing numerous complementary operations or alternatives to these processes in order to reduce the fat content while retaining sensorial qualities.

In recent years, several procedures proposed to reduce the amount of absorbed oil in fried potatoes to make such products more acceptable to health-conscious consumer. Since most of the fat is taken up after removal of fried potatoes from the fat, the conditions in which the potato pieces are removed from the fryer are important for fat uptake. Besides, properties of the surface of the potatoes are highly relevant for fat uptake, so the application of a coating is a promising route to reduce oil content (Mellema, 2003). For instance, Rubnov and Saguy (1997) added fructose to a restructured potato product that resulted in a change of the surface properties with a reduction of absorbed oil after frying. On the other hand, soaking of potato strips in NaCl solutions could reduced oil uptake in _15% in French fries after frying (Bunger, et al., 2003 and Moyano *et al*., 2002). Increasing the gel strength of restructured potato products reduces oil uptake during deep-fat frying (Pinthus *et al*., 1992).

Hydrocolloids are of special interest because they possess good barrier property against oxygen, carbon dioxide and lipids which could reduce oil absorption during deep-fat frying (Albert and Mittal, 2002 and Rimac-Brncic et al., 2004). Some of the most useful hydrocolloids are cellulose derivatives such as methyl cellulose (MC), hydroxypropyl cellulose (HPC), hydroxypropyl methyl cellulose (HPMC) and carboxyl methyl cellulose (CMC). All these cellulose derivatives are water soluble with good film-forming properties (Priya, et al., 1996). Alginate and pectin are widely used in food systems to stabilize and to modify the rheology of food. The most useful property is gelation, which is formed by intermolecular association with polyvalent cations (Albert and Mittal, 2002 and Rimac-Brncic et al., 2004).

Several hydrocolloids with thermal gelling or thickening properties, like proteins and carbohydrates, have been tested to reduce oil and water migration (Debeaufort and Voilley, 1997 and Williams and Mittal, 1999). Adding food hydrocolloids as dry ingredients is a practical way to lower oil uptake of deep-fat fried foods, since the addition does not change conventional production procedures (Meyers, 1990).

The main objective of this study was to investigate the influence of some hydrocolloids (k-carrageenan; guar gum and chitosan) on the oil absorption, water retention and organoleptic properties of potato chips. Also, studies the effect of different coating on the TBA and microbiological profile of potato chips during storage at – 18^{o} C for 3 months were evaluated.

MATERIALS AND METHODS

Materials

Potatoes (*Solanum tuberosum*) used in this research had a yellow color in the tuber (thus called ‘‘golden potato’’); with a name of the variety called AGRIA, which have been grown in Egypt. Agria potato tubers weighed above 200 g and less than 300 g each with a diameter larger than 50 mm which were obtained from local supermarkets, Dec. 2009.

Coating materials

Kappa carrageenan type111, chitosan and guar gum were purchased from Sigma Chemical Co., St. Louis Mo., USA.

Potato chips preparation

The potato chips was processed according to (Suzana et al,. 2004) thickness of 2.0 mm. were divided into five portions. The first portion was blanched by heating at 85°C for 6 min in water (without calcium chloride), while the other four portions were blanched in an aqueous solution of calcium chloride of different concentrations (0.2, 0.4, 0.6and 0.8%).Slices were then dried in a convection oven at150°C for 10 min. The coating with hydrocolloid was achieved by soaking the chips of each portion, in an aqueous solution of k-carrageenan, guar gum and chitosan at different concentrations (1, 2, and 3%), at 37°C for 5 min. Slices were then dried at 150°C for 10 min and fried at 170°C for 3 min in sunflower seed oil using a deep-fat fryer. All fried samples were drained for 1.5 min and cooled to room temperature before analysis.

Analytical Methods

Moisture, protein, fat and ash contents were determined according to the method of AOAC (1990). The tests were done in triplicates. Carbohydrate were calculated by differences.

Sensory evaluation

The sensory evaluation of the potato chips was conducted by 10 panelists, who were students and staff members in the Department of Food Science and Technology, Fac. of Agric. Al-Azhar University, Assiut, Egypt. Randomly coded samples were served to panelists individually. Six sensory attributes were evaluated (color, appearance, texture, taste, odor and overall acceptability) using a 9-point hedonic scale for each trait, where 9- excellent and 1- extremely poor (Po-Jung 2007).

Thiobarbituric acid (TBA)

TBA value was determined by the method of Pearson (1976) and expressed as mg malonaldhyde/ kg sample.

Microbiological analysis

The microbiological characteristics of a 10 g sample were obtained after homogenization in 90 ml 0.1% peptone water (Difico,). Other decimal dilutions were prepared from a 10^{-1}dilution. The total count was determined using the pour plate method, and Plate Count Agar (Difco,) as the medium. Plates were incubated at 35°C for 48 h (Harrigan and McCance, 1976). Three samples in each group were tested. All counts were presented as average values over three samples.

Statistical analysis

Results are expressed as the mean values of three separate determinations. Data were subjected to analysis (±SD) of variance using a completely randomized design. Differences between any two means were determined using LSD with a $P < 0.05$ significance level (Steel & Torrie, 1980).

RESULTS AND DISCUSSION

Chemical composition of potato (*Solanun tuberosum L.*) variety (AGRIA) in wet basis are presented in Table 1. Proximate analysis showed that potato variety had 80.25% moisture content, 1.68% protein, 0.54% fat, 1.46% ash and 15.23% carbohydrates. Data revealed that potato variety had a low lipid and protein content and high amount of moisture content followed by carbohydrate content these results agree with that found by Duran et al (2007).

Table 1. Chemical composition of potatoes Agria variety

Component	g/100g (wet basis)
Moisture	80.25±3.25
Protein	1.68±0.45
Fat	0.54±0.06
Ash	1.46±0.38
Carbohydrates	15.23±1.12

Oil Content in Fried Potato Chips

The oil content of coated potato chips was significantly ($p \leq 0.05$) affected by calcium chloride level and hydrocolloid treatment Table 2. Data indicated that samples blanched with calcium chloride at different levels (0.2, 0.4, 0.6 and 0.8%) had a moderate reduction in oil content compared to control (6-21.5% reduction). These results indicated that calcium chloride is able to stabilize the tissue structure against the violence of the frying process. The influence of various hydrocolloids in decreasing of oil uptake during deep fat frying of potato chips is given in Table 2. The results showed that immersion of potato chips in hydrocolloid solution had a significant effect on the fat uptake ($p \leq 0.05$). It could be seen that all three hydrocolloids were effective in decreasing oil absorption and this decreasing was increased by increasing the concentration of coating materials. The highest effect was showed by hydrocolloid of k- carrageenan (14.9 to19.6%), followed by chitosan (8.8 to13.9%), while guar gum exhibited the lowest effect (7.6 to10.5%).On the other hand, the combination of various levels of calcium chloride and hydrocolloids on oil absorption of potato chips were more effective in the reduction of oil content in the potato chips and this effect was increased by increasing the concentration of calcium chloride up to 0.6% and decreased at 0.8%, the reduction was 23.4 – 46%, 12 – 38.7% and 19.3 – 41.9% for k-

Table 2. Effect of coating with combination of various levels of calcium chloride and different hydrocolloids on fat content (g/100g sample) of potatoes chips

Treatment	Coating agent concentration %	*Calcium chloride concentration %*				
		0	0.2	0.4	0.6	0.8
Control		31.5±1.51	29.6±1.46	26.2±1.27±	25.9±1.18	24.7±1.16
Ķ-carrageenan	1	26.8±1.43	24.1±1.24	20.9±1.12	18.4±1.14	18.2±1.32
	2	26.0±1.39	22.4±1.35	19.7±1.08	17.2±1.10	17.3±1.19
	3	25.3±1.13	21.6±1.19	19.1±1.05	17.1±1.07	17.0±1.12
guar gum	1	29.1±1.38	27.7±1.29	23.6±1.26	20.8±1.29	20.2±1.21
	2	28.9±1.22	25.1±1.16	21.8±1.07	19.7±1.17	19.9±1.14
	3	28.2±1.18	24.5±1.12	21.3±1.02	19.5±1.12	19.3±1.10
Chitosan	1	28.7±1.32	25.4±1.25	21.9±1.22	19.8±1.13	19.1±1.16
	2	27.5±1.16	23.7±1.14	20.8±1.13	18.5±1.07	18.7±1.04
	3	27.1±1.11	22.6±1.06	20.1±1.08	18.6±1.01	18.3±1.06
LSD		0.95	1.02	1.17	0.87	0.92

carrageenan, guar gum and chitosan, respectively.

These results indicated that coating with calcium chloride/carrageenan, guar gum and chitosan interaction might form a rigid crosslinked network which helps to cement the cell walls and enclose the outer surface of the tissue and consequently prevent the oil penetration into the potato tissue. (Pinthus *et al.*, 1992).

Moisture content in fried potato chips

The effect of coating with different levels of calcium chloride and k-carrageenan; guar gum and chitosan on moisture content of potato chips was shown in Table 3. The basic physical effect of deep-fat frying is water replacement by oil (Pinthus *et al.*, 1992). Coating with k-carrageenan, guar gum and chitosan as gel-forming compounds and calcium chloride as cross- linking agent may alter the water-holding capacity and consequently affect oil uptake. Data indicated that potato chips coated with k-carrageenan, guar gum; chitosan and calcium chloride had higher ($p \leq 0.05$) moisture contents than control. Potato chips coated with 0.8% calcium chloride and 3% k-carrageenan had the highest ($p \leq 0.05$) moisture content among all coated samples. It has been established that the deep-fat frying process causes damage to the cellular structure in plant tissues which may allow more water to evaporate (Toma et al., 1986).

Sensory properties

The sensory scores for color, taste, odor, texture, appearance and overall acceptability were significantly increased ($p \leq 0.05$) as the level of calcium chloride increased up to 0.6% concentration and then decrease at level 0.8%.On the other hand, organoleptic properties of potato chips were increased significantly($p \leq 0.05$) as the level of hydrocolloids(k-carrageenan, chitosan and guar gum increased compared to control sample (Tables 4, 5and 6). Potato chips coated with k- carrageenan at 1, 2and 3% levels and 0.6 calcium chloride had higher ($p \leq 0.05$) sensory scores than the control for all the sensory attributes followed by, potato chips coated with guar gum and chitosan at all tested levels .These results agree with that found by Bravin et al., (2006).

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Table 3. Effect of coating with combination of various levels of calcium chloride and different hydrocolloids on moisture content (%) of potatoes chips

Treatment	Coating agent concentration %	Calcium chloride concentration %				
		0	0.2	0.4	0.6	0.8
Control		19.25±0.86	20.56±0.93	22.48±0.98	23.15±1.08	23.87±1.005
Ķ-carrageenan	1	20.11±0.92	27.63±1.23	33.68±1.27	35.31±1.47	35.58±1.32
	2	22.52±0.97	29.16±1.18	34.24±1.31	36.42±1.52	36.71±1.40
	3	23.46±1.12	30.94±1.27	34.84±1.38	37.29±1.35	37.89±1.47
Guar gum	1	16.94±0.84	22.61±1.13	28.38±1.24	31.25±1.28	31.58±1.30
	2	18.57±0.81	24.17±1.22	29.76±1.30	32.49±1.32	32.67±1.34
	3	19.26±0.91	2536±1.08	30.48±1.26	32.68±1.33	32.91±1.36
Chitosan	1	18.54±0.86	23.15±1.03	30.26±1.33	32.31±1.42	32.84±1.38
	2	19.62±0.90	25.48±1.11	31.81±1.37	33.28±1.25	33.67±1.50
	3	20.87±0.0.98	26.82±1.20	32.46±1.35	34.25±1.34	34.89±1.48
LSD		0.65	1.35	1.68	1.87	1.96

Table 4. Effect of coating with combination of various level of calcium chloride and level of Ķ-carrageenan on sensory evaluation of potatoes chips

$CaCL_2$ (g/100ml)	Ķ-carrageenan %	Sensory evaluation					
		Color	Taste	Odor	Texture	Appearance	Overall acceptability
Control	-	5.2±0.28	5.1±0.21	5.4±0.29	5.3±0.24	5.2±0.35	5.1±0.39
0	1	5.6±0.23	5.4±0.28	5.8±0.34	5.6±0.29	5.4±0.39	5.6±0.38
	2	5.8±0.27	5.6±0.24	6.0±0.36	5.8±0.27	5.6±0.34	5.8±0.41
	3	6.0±0.35	5.9±0.35	6.2±0.32	5.9±0.38	5.9±0.41	6.0±.0.39
0.2	1	6.4±0.31	6.2±0.39	6.5±0.38	6.3±0.45	6.2±0.38	6.3±0.49
	2	6.7±0.34	6.6±0.31	6.7±0.35	6.5±0.41	6.4±0.46	6.5±0.57
	3	6.9±0.37	6.8±0.37	6.9±0.41	6.8±0.37	6.8±0.51	6.8±0.53
0.4	1	7.3±0.49	7.1±0.42	7.2±0.46	7.0±0.59	7.2±0.47	7.1±0.60
	2	7.5±0.41	7.5±0.46	7.6±0.58	7.5±0.53	7.6±0.52	7.5±0.51
	3	7.8±0.47	7.9±0.45	7.9±0.61	7.7±0.54	7.8±0.56	7.9±0.58
0.6	1	8.1±0.58	8.2±0.59	8.0±0.62	8.1±0.68	8.0±0.59	8.2±0.63
	2	8.4±0.54	8.5±0.54	8.3±0.54	8.5±0.62	8.4±0.66	8.5±0.64
	3	8.7±0.36	8.8±0.57	8.6±0.59	8.7±0.64	8.6±0.57	8.8±0.61
0.8	1	7.4±0.39	7.6±0.51	7.2±0.47	7.5±0.58	7.1±0.67	7.2±0.55
	2	7.6±0.54	7.4±0.56	7.4±0.42	7.2±0.59	7.2±0.63	7.1±0.56
	3	7.5±0.48	7.2±0.60	7.1±0.48	7.0±0.51	7.2±0.61	7.1±0.58

Table 5. Effect of coating with combination of various level of calcium chloride and level of guar gum on sensory evaluation of potatoes chips

$CaCL_2$ (g/100ml)	Guar gum %	Sensory evaluation					
		Color	Taste	Odor	Texture	Appearance	Overall acceptability
Control	-	5.2±0.28	5.1±0.22	5.7±0.26	5.3±0.20	5.2±0.18	5.1±0.25
0	1	5.6±0.31	5.3±0.36	5.7±0.32	5.5±0.27	5.4±0.29	5.3±0.27
	2	5.7±0.27	5.5±0.29	5.8±0.34	5.7±0.30	5.6±0.25	5.5±0.32
	3	5.9±0.23	5.6±0.34	5.9±0.37	5.8±0.32	5.7±0.21	5.7±0.30
0.2	1	6.1±0.34	5.9±0.26	6.2±0.30	6.0±0.29	5.9±0.28	6.0±0.40
	2	6.3±0.38	6.2±0.29	6.4±0.36	6.2±0.33	6.1±0.30	6.3±0.37
	3	6.6±0.39	6.3±0.32	6.5±0.31	6.4±0.39	6.3±0.34	6.4±0.45
0.4	1	6.8±0.42	6.5±0.30	6.7±0.38	6.5±0.37	6.5±0.35	6.6±0.39
	2	6.8±0.45	6.7±0.36	6.8±0.35	6.7±0.32	6.6±0.38	6.8±0.36
	3	6.9±0.47	6.8±0.40	6.8±0.37	6.7±0.39	6.7±0.43	6.9±0.42
0.6	1	7.1±0.58	6.9±0.71	7.2±0.65	6.9±0.70	7.0±0.63	7.1±0.75
	2	7.3±0.64	7.1±0.66	7.3±0.74	7.2±0.76	7.2±0.68	7.3±0.79
	3	7.4±0.67	7.2±0.69	7.5±0.78	7.4±0.68	7.5±0.71	7.5±0.68
0.8	1	6.8±0.41	7.1±0.47	6.4±0.42	6.5±0.39	7.2±0.45	6.5±0.38
	2	6.8±0.39	7.2±0.40	6.5±0.35	6.6±0.34	7.3±0.41	6.6±0.36
	3	6.7±0.36	7.1±0.42	6.5±0.39	6.5±0.38	7.1±0.47	6.4±0.31
LSD		0.75	0.52	0.48	0.59	0.51	0.61

Table 6. Effect of coating with combination of various level of calcium chloride and level of chitosan on sensory evaluation of potatoes chips

$CaCL_2$ (g/100ml)	Chitosan %	Sensory evaluation					
		Color	Taste	Odor	Texture	Appearance	Overall acceptability
Control	-	5.2±0.18	5.1±0.15	5.7±0.21	5.3±0.24	5.2±0.20	5.1±0.17
0	1	5.6±0.24	5.3±0.19	5.9±0.29	5.7±0.22	5.5±0.17	5.4±0.13
	2	5.7±0.23	5.5±0.23	6.0±0.27	5.9±0.23	5.7±0.24	5.6±0.22
	3	5.8±0.20	5.7±0.27	6.2±0.26	6.1±0.28	5.7±0.20	5.8±0.16
0.2	1	6.2±0.30	5.9±0.13	6.4±0.29	6.3±0.30	5.8±0.25	6.1±0.24
	2	6.4±0.36	6.1±0.22	6.5±0.25	6.5±0.36	6.1±0.31	6.3±0.28
	3	6.5±0.41	6.3±0.26	6.7±0.32	6.6±0.32	6.2±0.29	6.4±0.25
0.4	1	6.8±0.38	6.5±0.34	6.8±0.38	6.7±0.35	6.4±0.33	6.6±0.31
	2	6.9±0.43	6.7±0.31	7.0±0.41	6.9±0.39	6.6±0.35	6.8±0.37
	3	6.9±0.40	6.8±0.36	7.1±0.45	6.9±0.37	6.8±0.32	6.9±0.35
0.6	1	7.1±0.48	7.0±0.52	7.3±0.59	7.1±0.52	7.0±0.47	7.1±0.42
	2	7.3±0.56	7.2±0.55	7.4±0.61	7.2±0.49	7.2±0.45	7.2±0.53
	3	7.4±0.59	7.2±0.53	7.3±0.57	7.3±0.54	7.3±0.51	7.2±0.52
0.8	1	7.0±0.54	6.9±0.42	7.1±0.53	6.8±0.48	6.9±0.46	7.0±0.50
	2	7.2±0.58	7.1±0.54	7.0±0.25	6.9±0.44	7.0±0.53	7.1±0.56
	3	7.1±0.51	7.0±0.46	7.1±0.56	6.8±0.39	6.9±0.35	7.0±0.41
LSD		.0.68	0.52	0.46	0.64	0.48	0.62

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Lipid oxidation

Corresponding to the oxidative deterioration of polyunsaturated fatty acids in food tissues, leads to the production of off-flavors and off-odors, thereby shortening the shelf-life of food (Ramanathan and Das, 1992) The TBA value and peroxide value are both well established methods for determining oxidation products(Kulas and Ackman, 2001). There were significant differences ($P < 0.05$) in the TBA values between the control and samples coated with k-carrageenan, guar gum and chitosan, respectively Table 7. After 3 months of storage at –18°C, TBA values were increased in the control sample treated with different coating, but the increasing rate in the control was higher than others, showing that k-carrageenan, guar gum and chitosan reduced lipid oxidation in potato chips. On the other side, no significant differences were found in TBA values between k-carrageenan and chitosan. The lowest TBA value was 1.9 mg MA /kg which found in potato chips coated with 3% k-carrageenan. The lowering values of TBA for potato chips coated with different hydrocolloids compared to control sample may be attributed to the effect of coating consisting of poly saccharides and protein on the surface of potato chips which prevent the interaction between air and the surface of potato chips and therefore the oxidation decreased during storage. (Kilincceker, *et al*., 2009). On the same time, TBA values was decreased as calcium chloride concentration increased to level 0.6 and then increased.

Microbiological analysis

Table 8 presents the results of the microbiological analysis of potato chips coated by k-carrageenan, guar gum, chitosan and uncoated potato chips. The total number of uncoated samples increased from 3.65 to 6.12 log CFU/g at the end of the storage period. The coating of potato chips with k- carrageenan, chitosan and guar gum were effectively inhibited the growth of microorganisms, but increasing the concentration of coating materials from 1% to 3% did not further affect the growth of microorganisms. These results agree with that reported by Chien, et al. (2007).In the same time, a slight decrease in the number of total microorganisms was observed with increasing the concentration of calcium chloride from 0 to 0.8% for both uncoated and coated

Table 7. Thiobarbituric acid (TBA) values of coated potato chips stored at –18° C for 3 months

Treatment	Levels %	Calcium chloride concentration									
		0		0.2		0.4		0.6		0.8	
		0	6	0	6	0	6	0	6	0	6
Control		0.6±0.08	5.1±0.19	0.6±0.03	4.9±0.26	0.5±0.04	4.5±0.21	0.5±0.04	5.2±0.23	0.7±0.03	5.8±0.25
Ķ-carrageenan	1	0.6±0.07	2.8±0.09	0.6±0.03	2.9±0.18	0.5	2.6±0.13	0.5±0.06	2.9±0.17	0.7±0.06	3.1±0.17
	2	0.6±0.05	2.5±0.07	0.5±0.02	2.6±0.14	0.4±0.03	2.4±0.18	0.5±0.04	2.8±0.15	0.6±0.04	3.3±0.12
	3	0.5±0.02	1.9±0.06	0.5±0.04	2.3±0.11	0.3±0.02	2.3±0.14	0.4±0.02	2.8±0.11	0.6±0.05	3.5±0.21
Guar gum	1	0.6±0.01	3.6±0.17	0.5±0.04	3.4±0.12	0.4±0.02	3.2±0.18	0.6±0.05	3.4±0.17	0.7±	3.6±0.18
	2	0.5±0.02	3.5±0.15	0.4±0.01	3.3±0.15	0.4±0.01	3.0±0.13	0.5±0.03	3.5±0.14	0.7±0.02	3.7±0.16
	3	0.5±0.03	3.3±0.18	0.4±0.02	3.1±0.14	0.3±0.01	2.9±0.17	0.6±0.02	3.7±0.16	0.6±0.04	3.7±0.17
Chitosan	1	0.6±0.04	2.9±0.14	0.4±0.02	2.8±0.09	0.5±0.03	2.7±0.16	0.6±0.02	2.9±0.18	0.7±0.05	3.0±0.11
	2	0.6±0.02	2.6±0.15	0.3±0.01	2.5±0.18	0.5±0.01	2.4±0.14	0.50.01	2.8±0.14	0.6±0.03	3.2±0.16
	3	0.5±0.03	2.1±0.13	0.3±0.02	2.4±0.14	0.4±0.02	2.2±0.10	0.5±0.02	2.9±0.15	0.5±0.04	3.4±0.15
LSD		0.39	0.48	0.43	0.80	0.31	0.72	0.39	0.69	0.46	0.76

Table 8. Effect of different coating on microbiological load (CFU/gm) of potato chips stored at –18°C for 3 months

treatment	Levels %	Calcium chloride concentration 0		0.2		0		0.6		0.8	
		0	3	0	3	0	3	0	3	0	3
Control		3.65±0.08	6.62±0.38	3.54±0.16	6.31±0.32	3.47±0.11	6.24±0.35	3.36±0.14	6.18±0.32	3.25±0.13	6.12±0.37
Ķ-carrageenan	1	3.52±0.21	5.76±0.25	3.47±0.11	5.56±0.24	3.42±0.13	5.51±0.21	3.37±0.15	5.48±0.26	3.28±0.14	5.34±0.21
	2	3.48±0.18	5.61±0.22	3.42±0.13	5.49±0.27	3.40±0.12	5.47±0.24	3.31±0.13	5.44±0.23	3.25±0.12	5.30±0.20
	3	3.45±0.16	5.60±0.15	3.40±0.12	5.47±0.13	3.40±0.10	5.46±0.19	3.30±0.10	5.43±0.21	3.21±0.11	5.29±0.21
Chitosan	1	3.17±0.16	5.28±0.28	3.14±0.06	5.24±0.24	2.96±0.02	4.87±0.19	2.91±0.04	4.81±0.20	2.85±2.80±	4.70±0.15
	2	3.12±0.15	5.17±0.15	3.11±0.10	5.13±5.12	2.90±0.04	4.82±0.12	2.88±0.07	4.78±0.16	2.78±0.13	4.65±0.13
	3	3.10±0.12	5.12±0.11	3.09±0.15	5.02±0.10	2.90±0.11	4.81±0.20	2.86±0.10	4.75±0.14	2.51±0.11	4.63±0.19
guar gum	1	3.61±0.16	6.54±0.31	3.51±0.16	6.24±0.34	3.44±0.11	6.18±0.31	3.29±0.13	6.14±0.28	3.21±0.11	6.10±0.24
	2	3.60±0.16	6.51±0.29	3.49±0.15	6.18±0.32	3.41±0.12	1.14±0.29	3.27±0.12	6.11±0.25	3.19±0.10	6.08±0.21
	3	3.60±0.17	6.50±0.33	3.48±0.14	6.15±0.38	3.40±0.11	6.12±0.27	3.26±0.10	6.11±0.26	3.18±0.11	6.07±0.23
LSD		0.51	0.67	0.48	0.72	0.56	0.61	0.46	0.59	0.41	0. 48

potato chips during storage period. On the other hand, chitosan was more significantly effective on the growth of microorganisms; the numbers were 3.17 and 4.70 log CFU/g at zero time and after 3 months respectively followed by k-carrageenan, (3.52 and 5.34 log CFU/g) while guar gum did not effect the microorganisms numbers, (3.61 and 6.54 log CFU/g), it was like to control sample.

CONCLUSION

By suitable selection of edible film it is possible to control moisture and fat between the frying medium and the food. Coating of potato chips with hydrocolloid gel- forming compounds and a calcium cross-linking agent was effective in protecting the potato chips violence of deep fat frying and reducing the oil content of the final products potato chips with hydrocolloid gel- forming compounds and a calcium cross-linking agent was effective in protecting, especially potato chips violence of deep fat frying and reducing the oil content of the final products potato chips treated with a combination of 0.6% calcium chloride and 3% k-carrageenan had the highest reduction level of oil content (46%).. Also, coating prevented the water from evaporation during deep fat frying and improved the sensory characteristics, TBA value and microbiological quality of the potato chips.

REFERENCES

Aguilera, J. M., and H. Gloria-Herna´ ndez . 2000. Oil absorption during frying of frozen parfried potatoes. Journal of Food Science, 65: 476–479.

Albert, S., and G. S. Mittal . 2002. Comparative evaluation of edible coatings to reduce fat uptake in a deep-fried cereal product. Food Research International, 35: 445–458.

AOAC .1990. Official Methods of Analysis, 14th ed. Association of Official Agricultural Chemists, Washington D.C.

Bouchon, P. and J. M. Aguilera . 2001. Micro structural analysis of frying of potatoes. International Journal of Food Science and Technology, 36: 669–676.

Bouchon, P., J. M. Aguilera, and D. L. Pyle . 2003. Structure oil absorption relationships during deep-fat frying. Journal of Food Science, 68: 2711–2716.

Bouchon, P., P. Hollins, M. Pearson, D. L. Pyle and M. J. Tobin . 2001. Oil distribution in fried potatoes monitored by infrared microspectrosc-opy. Journal of Food Science, 66: 918–923.

Bravin, B., D. Peressini, and A. Sensidoni . 2006. Development and appli-cation of polysaccharide lipid edible coating to extend shelf-life of dry bakery products. Journal of Food Engineering, 76: 280–290.

Bunger, A., P. Moyano, and V. Rioseco . 2003. NaCl soaking treatment for improving the quality of French-fried potatoes. Food Research International, 36: 161–166.

Chien, P., F. Sheu and F. Yang . 2007. Effect of edible chitosan coating in the quality and shelf life of sliced mango fruit. Journal of Food Engineering,78:225- 229.

Clark, J. P. 2003. Happy birthday, potato chips and other snack developments. Food Technology, 57(5): 89–92.

Debeaufort, F. and A. Voilley . 1997. Methyl cellulose-based edible films and coatings: 2. Mechanical and thermal properties as a function of plasticizer content. Journal of Agricultural and Food Chemistry, 45: 685–689.

Duran, M., F. Pedreschi, P. Moyano and E. Troncoso, 2007. Oil partition in pre-treated potato slices during frying and cooling. J. Food Engineering, 81:257-265.

Harrigan, W. F. and M. E. McCance . 1976. Laboratory methods in food and dairy microbiology. London: Academic Press, Inc.

Kilincceker, O., I.S. Dogan and E. Kucukoner, 2009. Effect of edible coating on the quality of frozen fish fillets.Journal of Food Science and Technology,42:868-873.

Kulas, E., and G. Ackman, 2001. Different tocopherols and the relationship between two methods for determin- ation of primary oxid- ation products in fish oil. Journal of Agricultural and Food Chemistry, 49(4): 1724–1729.

Mellema, M. 2003. Mechanism and reduction of fat uptake in deep-fat fried foods. Trends in Food Science & Technology, 14:364–373.

Meyers, M.A. 1990. Functionality of hydroco- lloids in batter coating systems. In K. Kulp, R.

Loewe, Batters and breadings in food processing (pp. 17 – 142). St. Paul, MN: American Association for Cereal Chemists.

Moyano, P. C., V. K. Rı´oseco and P. A. Gonza´ lez. 2002. Kinetics of crust color changes during deep-fat frying of impregnated French fries. Journal of Food Engineering, 54, 249-255.

Pearson, D. 1976. The Chemical Analysis of Food. Churchill, New York, London: 374-410.

Pedreschi, F. and P. Moyano . 2005. Oil uptake and texture development in fried potato slices. Journal of Food Engineering, 70: 557-563.

Pinthus, E. J., P. Weinberg and I. S. Saguy . 1992. Gel strength in restructured potato products affects oil uptake during deep fat frying. Journal of Food Science 58: 204–205.

Po-Jung, C., S. Fuu and Y. Feng-Hsu. 2007. Effects of edible chitosan coating on quality and shelf life of sliced mango fruit. Journal of Food Engineering, 64 : 237–241.

Priya, R., R. S. Singhal, and P. R. Kulkarni . 1996. Carboxymethylcellulose and hydroxypropylmethylcellulose as additive in reduction of oil content in batter based deep-fat fried boondies. Carbohydrate Polymers, 29: 333–336.

Ramanathan, L., and N. P. Das . 1992. Studies on the control of lipid oxidation in ground fish by some polyphenolic natural products. Journal of Agricultural and Food Chemistry, 40:17–21.

Rimac-Brncic, S., V. Lelas, D. Rade, and B. Simundic . 2004. Decreasing of oil absorption in potato strips during deep fat frying. Journal of Food Engineering, 64:237–241.

Rubnov, M., and I. S. Saguy . 1997. Analysis and crust water diffusivity of a restructured potato product during deep-fat frying. Journal of Food Science, 62: 135–141.

Steel, R.G. and J.H. Torrie . 1980. Principles and Procedures of Statistics, 2nd ed. McGraw-Hill Book Co : New York.

Suzana R. , L. Vesna , R. Desanka. and S. Borislav . 2004. Decreasing of oil absorption in potato strips during deep fat frying Journal of Food Engineering.:237–241.

Toma, R. B., H. K. Leung, J. Augustin, & W. M. Iritani .

Zagazig J. Agric. Res., Vol. 37 No. (3) 2010

1986. Quality of french fried potatoes as afected by surface freezing and specific gravity of raw potatoes. Journal of Food Science, 51: 1213 -1214.

Williams, R., and G. S. Mittal . 1999. Low-fat fried foods with edible coatings: modeling and simulation. Journal of Food Science, 64: 317–322.

Ziaiifar, A.M., N. Achir, F. Courtois, I. Trezzani, and G. Trystram . 2008. Review of mechanisms, conditions, and factors involved in the oil uptake phenomenon during the deep-fat frying process. International Journal of Food Science and Technology, 43 (8): 1410–1423.

استخدام بعض الغرويات لتقليل كمية الزيت الممتصة وتأثيرها على جودة شرائح البطاطس المحمرة

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يهدف هذا البحث إلى دراسة تأثير إستخدام بعض الأغلفة الغذائية على صفات الجودة لشرائح البطاطس المحمرة.وقد تم في هذا البحث معاملة شرائح البطاطس باستخدام كلوريد الكالسيوم فقط (بتركيزات ٢.٠ - ٤.٠ - ٦.٠ - ٨.٠ %)ومخلوط من كلوريد الكالسيوم وكل من المواد الآتية :كابا-كاراجينان وصمغ الجوار والشيتوزان (بتركيزات ١ %- ٢ %- ٣ %) ثم قلى هذه الشرائح المغلفة في الزيت وبعد ذلك تم تقدير نسبة امتصاص الزيت والمحتوى الرطوبي للشرائح المقلية وكذلك الصفات الحسية. كما تم تقدير مدى التزنخ الذي يحدث في شرائح البطاطس المقلية أثناء التخزين على درجة - ١٨ م لمدة ثلاثة شهور وكذلك المحتوى الميكروبي. وكانت أهم النتائج المتحصل عليها كالتالي:

أدى استخدام كلوريد الكالسيوم فقط في تغليف شرائح البطاطس إلى خفض نسبة الزيت التي امتصتها شرائح البطاطس أثناء عملية القلي بنسبة (٦- ٢١ %) بينما زادت هذه النسبة إلى (٦.٧- ٤٦ %) عند استخدام مخلوط كلوريد الكالسيوم مع الكاراجينان أو مع صمغ الجوار أو مع الشيتوزان. وكان افضل هذه المعاملات هو استخدام ٦.٠ % كلوريد كالسيوم مع ٣ % كابا- كاراجينان حيث قل امتصاص الزيت أثناء تحمير شرائح البطاطس إلى نسبة ٤٦ % كما أن هذه المعاملة حازت علي أعلى نسبة تقدير حسي.كما دلت التقديرات الكيموحيوية والميكروبيولوجية أن معاملة شرائح البطاطس بالكابا كاراجينان وصمغ الجوار والشيتوزان قبل القلي يؤدى إلى تقليل معدل التزنخ والذي يعبر عنه برقم حمض الثيوباربتيوريك كما تؤدى المعاملة بهذه المواد إلى خفض العد الكلي للبكتريا أثناء التخزين.ومن خلال هذه الدراسة يمكن القول أن استخدام بعض الأغلفة مثل الكابا-كاراجينان وصمغ الجوار والشيتوزان يؤدى إلى زيادة جودة شرائح البطاطس المحمره.