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Effect of Coating Material on The Quality of Oil Uptake and Potato Chips

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REDUCING fat content of fried foods by application of coating is an alternative solution to comply with both health concerns and concumer preferences. The objective of the present work was to analyse the effect of soy protein isolate (SPI) and whey protein isolate (WPI) as coating agent on the quantity and quality of oil uptake and on sensory attributes of potato chips in comparison with control (uncoated potato chips). The deteruration of samples were evaluated after 0, 4, 8, 12 and 16 hours. Decreased degradation of frying oils extracted from potato chips was recorded when product coated with WPI followed by SPI compared with uncoated products.

The obtained results showed that the product coated with whey protein isolate had the least increase in oil uptake, polar components, oxidized fatty acid, color, viscosity (cp), UV absorbtion and polymeric materials followed by the product coated with soy protein isolated (SPI) compared with uncooted products (control). Sensory evaluation showed that sample coated with WPI increased hardness and crispiness compared to control. Also sensory evaluation show that the best color was related to whey protein isolated followed by soy protein isolate compared to uncoated sample and with regard to flaver evaluation was in whey protein isolated, soy protein isolate and control respectively. Sensory evaluation show that coated with whey protein isolate and soy protein isolated and control uncoated ones had no different for appearance and taste.

Keyword: Sunflower oil, Potato chips, Coated material (soy protein isolate and whey protein isolate), Polar and polymer compounds, Oxidized fatty acid

Introduction

Frying is one of the oldest methods known to human kind for preparing food. Fried foods are among the favorites for people around the world. Some fried products could contain high amount of fat due to the normal fat absorption during deep-fat frying (Makinson et al.,1987).

Mallikarjuman et al.,(1997) and Huse et al., (1998) demonstrated the effectiveness of various edible coating in reducing oil absorption in starchy products.

Rayner et al.(2000) studied that a soy protein film coating was developed and evaluated to reduce fat transfer in deep-fried foods during frying. SPI solution (10% SPI) with 0.05% gellan gum as plasticizer cooled after being held at 80°C for 20 min provided suitable films. They found that was a significant fat reduction between fired uncoated and coated discs of doughnut mix. The same films were used on potato fires.

Trezza and Krochta (2000) mentioned that whey protein isolate coating had lower yellowing rates than whey protein concentrate.

Aminlari et al. (2005) reported that potato slices were prepared, blanched, immersed in solutions of sodium caseinate, whey proteins concentrate, or egg white and deep-fried in a mixture of corn oil and commercial hydrogenated oil. Protein coating resulted in significantly lower oil uptake of potato chips. Coating potato chips with sodium caseinate, whey proteins concentrate and egg white proteins resulted in 14.5 and 12% reduction in oil uptake, respectively. Water retention and protein content significantly increased in protein-coated chips.Fried food normally absorb great amounts of oil during frying. However, they still remain popular although excess fat consumption

is considered as the key dietarz contributor to high blood cholesterol, high blood pressure and coronary heart disease (Lee et al 2008). Also found that the soybean hulls were microparticulated by jet mill and were dry-coated to the wheat flour by hybridization system at different ratios. These composites were applied to reduce fat uptake of doughnues in frying.

Malak (2014) reported that sensory evaluation on the quality of the products is important whey protein isolate coating films was improved all sensorial features of potato pellets chips compared to control. Also Added that whey protein isolate coating films was reducting fat uptake more than whey protein.

The present study aimed to better results concerning oil up take reduction in the fried potatoes chips, during deep frying with sunflower oil. This was verified by appling coating with SPI and WPI then heat treatment was used over to form good film to achieve a balance between moisture content and oil up take in potato chips.

Materials and Methods

Materials:

- The experments were conducted using two types of coating ingredients : soy protein isolate and whey protein isolate. Soy protein isolate and whey protein isolate were obtained from Food Technology Research Instituts.
- Sunflower oil was obtained from local market. Potatoes tubers were purchased daily from local market.

Preparation of potatoes chips

Potato tubers were washed, hand- peeled and cut with a monual operated potato-cutting to potato slices were weighted and dipped in the coating suspensions for (2-4 min). The ratio of suspension volum to potato slices was 3:1 (vol/wt) and the solution was kept under constant stirring. The coating films were dried in under vacum over at 70°C.

Frying process

Frying was carred out in frying pane having a capacity of 2L oil. The potato slices were fried at 180ºC for 8 min in sunflower oil. All fried samples were allowed to cool at room temperature; then analyzed for its oil content by soxhlet apparatus. All experments were run in triplicate and the present results are the average of obtained results.

sensory evaluation

Fried potatoes were sensorial evaluated by ten ponalists for its appearance, color, hardness, crispiness, flavor and taste as described by Hallabo et al.,(1985).

Methods:

Refractive index (RI)

RI was determined according to A.O.A.C. (2005) by using refractometer (NXRL-3 poland). at 25ºC

Absorbency in ultravioletat 232 and 268 nm.:

U.V. absorbency at 232nm. (diene) and 268 nm. (trine) were measured according to the method reported by Basile and Warner (1977). 0.1 ml oil were dissolved in freshly distilled cyclohexane and the absorption were measured at 232 and 268 nm. Using shemadze spectrophotometric uv vis 170.

Acidity, peroxide value, iodine value, color intensity, viscosity and oxidized fatty acid were determined according to the method described in the A.O.A.C (2005).

Fatty acids composition

The fatty acids methyl esters were were prepared using trans-estrification with cold methanolic solution of potassium hydroxide. The fatty acids methyl esters were identified by GC- capillary column according to the method of IOOC (2001).

Polar and non-polar components were measure by the column chromatography method described by Waltking and Wessels (1981).

polymers content was determined according to the method described by Pel-Fen and Nawar (1986).

Results and Discussion

Physiochemical properties and fatty acid composition of sunflower oil (frying oil) are tabulated in Table 1 .

Refractive index, color, viscosity, acid value, peroxide value, iodine value, polar component, polymer content and oxidized fatty acid were 1.4714, 0.2, 55, 0.06, 2.24, 128.99, 0.24, 0.08 and 0.06 respectively. Also the results show that absorbance at 232nm and 268nm were 0.76 and 0.14 respectively. data in Table (1) show that the unsaturated fatty acids accounted 89% of whole

fatty acids which consists of oleic, linoleic and linolenic in the amount of 39.01%, 49.71 and 0.28% respectively. Meanwhile the saturated fatty acids consist of palmitic and stearic in the amount of 8.02, 2.66% respectively.

The data presented in Table 2 show that the most effective coating formulation reduced oil uptake were whey protein isolate about 38.8% from 12.68 to 7.76 followed by soy protein isolate about 24.7% after 4 hours fried from (12.68 to 9.55), about 16.7% from 16.20 to 13.50 and 11.4% from 16.20 to 14.36 after 8 hours, about 14.3 and 8.1% after 12 hours and 12.9 and 8.2% after 16 hours respectively. The increase of reduced oil uptake by increasing of frying time due to the viscosity of oil during frying which increase by increase frying time. These results are in agreement with that reported by Habib et al., (2015). Their results show that coating whey protein isolate and soy protein isolate reduced oil absorption in comparison to uncoated sample (control). These results agreed with those reported by Aminlari et al., (2005), Lee et al., (2008), Amir et al., (2008) and Malak (2014) who reported that the coating treatment reduced the oil up take and increased the water retention of the fried potato samples compared with uncoated ones.

TABLE 1. Physiochemical properties and fatty acid composition of sunflower oil (frying oil)

Characteristics of sunflower oil	Values
Color : yellow	**35**
red	**0.2**
Refractive index at 25ºC	1.4714
Viscosity (cp)	55
K232 nm.	0.76
K268 nm.	0.14
Acidity (%)	0.06
Peroxide value (meq O_2 /kg oil)	2.24
Iodine value (I_2 /100g oil)	128.99
Polar component (%)	0.24
Polymer content (%)	0.08
Oxidized fatty acid (%)	0.06
Fatty acid composition (%)	8.02
C16:0	
C18:0	2.66
C18:1	39.01
C18:2	49.71
C18:3	0.28
C20:0	0.32
TSFA	11.00
TUSFA	89.00

TABLE 2. Effect of frying time coated with SPI and WPI (of frying potato chips) on oil uptake of potato chips (%)

Samples / Frying time (hr.)	Oil uptake (%)				
	uncoated	SPI		WPI	
	Oil uptake%	*	Oil uptake%	*	Oil uptake%
4	12.68	24.7	9.55	38.8	7.76
8	16.20	11.4	14.36	16.7	13.50
12	18.94	8.1	17.40	14.3	16.24
16	21.11	8.2	19.38	12.9	18.39

* oil uptake reduction

Effect of coated with SPI and WPI of frying potato chips on the polar compounds:

The results in Table 3 show the formation of polar compounds, which indicates of oil deteruration, is strongly related with the primary and secondary oxidation that take place during frying. These results illustrate that polar compounds formed during frying process increased with the time of frying increment. Also these results illustrated that frying potato chips in sunflower oil with coated SPI had the highest level of polar compounds was (25.61%) followed by sample coated with WPI was (23.15%) compared to uncoated sample was (18.22%). These results are in agreement with Dimitra et al.,(2002). They found that polar content increase linearly with time during heating of various oils at constant temperature.

Effect of coated with SPI and WPI of frying potato chips on the polymer compounds:-

Polymer material one of the most important changes in oil during frying**.** The formation of polymers during frying is mainly responsible for the changes in viscosity of oil. The polymer content of sunflower oil extracted from frying potato chips with and without coated by SPI and WPI are labulated in Table (4). It could be noticed that polymers content in all samples increased gradually with increasing frying time . Data show that polymers content for non-fried sunflower oil was (0.08). Also the results show that more polymers was formed in samples coated with SPI (1.35) follow by samples coated with WPI (1.02) compared with control (uncoated) samples (0.92) at the end of frying process.

Effect of coated with SPI and WPI on the formation of oxidized fatty acid during frying potato chips :-

TABLE 3. Effect of coated with SPI and WPI of frying potato chips on the polar compounds (%)

Samples / Frying time (hr.)	Polar compound		
	Uncoated	SPI	WPI
Zero	0.24	0.24	0.24
4	3.56	6.82	5.11
8	7.91	12.70	10.34
12	10.84	18.59	14.89
16	18.22	25.61	23.15

TABLE 4. Effect of coated with SPI and WPI of frying oil extracted from potato chips on the polymer compounds (%)

Samples / Frying time (hr.)	Polymer compound		
	Uncoated	SPI	WPI
Zero	0.08	0.08	0.08
4	0.18	0.41	0.23
8	0.59	0.80	0.68
12	0.83	1.11	0.97
16	0.92	1.35	1.02

The results in Table 5 show the formation of oxidized fatty acids of sunflower oil extracted from frying potato chips with and without coated by SPI and WPI. It could be noticed that oxidized fatty acids in all samples increased gradually with increasing frying time incrase. From the same results it could be noticed that more oxidized fatty acids was formed in sample coated with SPI than that samples coated with WPI in the same time of frying. Data also showed that oxidized fatty acids for non-fried sunflower oil was 0.06, on the other hand, oxidized fatty acids of sunflower oil fried uncoated sample at the end of fring process was 0.98 lower than that of sunflower oil fried sample coated with SPI and WPI were 1.55 and 1.26 % respectively. These results are in agreement with that reported oxidized fatty acid increased gradually with increasing frying time increase by Kun (1988) and Xin et al., (1999) .

TABLE 5 . Effect of coated with SPI and WPI on oxidized fatty acids (%)during frying potato chips :-

Samples / Frying time (hr.)	Oxidized fatty acids		
	Uncoated	SPI	WPI
Zero	0.06	0.06	0.06
4	0.22	0.69	0.54
8	0.46	0.97	0.78
12	0.73	1.24	1.13
16	0.98	1.55	1.26

Effect of coated with SPI and WPI of frying potato chips on the oil color:

The color of the fried potato chips is one of the most quality factors of the acceptance for fried products. Frying process caused an increase of darkness. The results present in Table 6 show that the increase of darkness of fried sunflower oil gradually with increasing of fring time increase. Meanwhile potato chips coated with WPI caused decreased in color value followed by potato chips coated by SPI compared with control. Also show that color of sunflower oil fried uncoated potato chips at the end of process was (4.6) lower than that of sunflower oil fried potato chips coated with SPI. The obtained results are in agreement with Trezza and Krochta (2000).

Effect of coated with SPI and WPI on viscosity (cp) during frying potato chips

One of the most important changes in oils during frying is the formation of polymeric materials. The polymers are mainly responsible for the increase of viscosity in oil . The changes of viscosity of sunflower oil used for frying potato chips with and without coated by SPI and WPI presented in Table 7 . The results clearly showed that the viscosity of all sample increased gradually with the increase of frying time increased. Also the sample with the lowest level of viscosity for the chips oil extracted from sample without coated of potato chips and the highest level of the oil extracted from sample coated with SPI followed by oil extracted from sample coated with WPI. These results are in agreement with Tygi and vasishtha (1996). They attributed the increase in color and viscosity to the rapid polymerization in oil during frying.

TABLE 6. Effect of coated with SPI and WPI on color during frying potato chips

Samples / Frying time(hr.)	Color (red)		
	Uncoated	SPI	WPI
Zero	0.1	0.1	0.1
4	0.9	1.8	1.5
8	1.6	3.0	2.2
12	2.8	5.1	3.6
16	4.6	6.4	5.1

at yellow : 35

TABLE 7. Effect of coated with SPI and WPI on viscosity during frying potato chips :-

Samples / Frying time (h r.)	Viscosity (cp)		
	Uncoated	SPI	WPI
Zero	55	55	55
4	57	61	59
8	60	64	62
12	63	68	65
16	66	70	68

Effect of coated with SPI and WPI on absorbance at 232 and 268nm during frying potato chips :-

The absorbance at 232 and 268 nm usually measure the diene and triene content respectively. Both readings showed the some trened during frying as thus increased progressively with the increase in frying time. Also the increaments were really due to the relatively increase in diene and triene content. The absorbance at 232 and 268 nm of sunflower oil (frying oil) used for frying potato chips with and without coated by SPI and WPI are labulated in Table (8). Data show that, oil, time and interaction between oil and time affected these parameter. Also data show an increase with the frying time in both parameter in these experimental oil with the lowest level for frying oil extracted from samples without coated of potato chips and highest level with oil extracted from sample coated with SPI. Also the results show that absorbance at 232 and 268 were 0.76 and 0.14 respectively compared with control (uncoated) samples.

TABLE 8. Effect of coated with SPI and WPI on absorbance during frying potato chips

Samples / Frying time (hr.)	Absorbance					
	Uncoated		SPI		WPI	
	232 nm	268 nm	232 nm	268 nm	232 nm	268 nm
zero	0.76	0.14	0.76	0.14	0.76	0.14
4	0.84	0.17	0.92	0.23	0.88	0.20
8	0.89	0.20	0.99	0.29	0.96	0.26
12	0.97	0.24	1.15	0.37	1.11	0.30
16	1.13	0.29	1.21	0.40	1.17	0.35

Sensor evaluation

The effect of using SPI and WPI as coating material to reduce oil uptake during frying were evaluated sensorial. The results show that big different between sample coated with SPI and WPI compared with uncoated sample . Also sensory evaluation show that the best color was related to whey protein isolated followed by soy protein isolate compared to uncoated sample and with regard to flaver evaluation was observed in whey protein isolated, soy protein isolate and control respectively. Also sensory evaluation showed that coated with SPI and WPI and uncoated samples had no differents for appearance, and taste. Sample coated with WPI increased hardness and crispiness. Sample coated with WPI and control were acceptable to the consumers more than sample coated with SPI. These results are in agreement with that reported by Malak (2016) who reported that all coated treatment were improved all sensory attributes comparing to the control.

Conclusion

This study showed that coating with whey protein isolate gave better results oil uptake reduction followed by soy protein isolate. Also, it was found that both whey protein isolate and soy protein isolate acceptable to consumers. Consumption of reduced fat of french fries potatoes chips would lower daitory fat for many consumer and could reduce risk of obesity and chronic disease such as heart disease hypertension.

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تأثير مواد التغطية على جودة الزيت الممتص وجودة البطاطس المحمرة

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الزيت الممتص وعلى الخواص الحسية لشرائح البطاطس المقلية مقارنة بالكنترول ويمكن تلخيص النتائج :

- تم تقييم درجة التدهور فى زيت القلى الممتص بعد ٤, ٨, ١٢, ١٦ ساعة على ١٨٠م° ووجد أن التغطية ببروتين اللبن المستخلص أدى الى انخفاض فى درجة التدهور فى الزيت الممتص سريعا عن الزيت المستخلص من العينات المغطاه ببروتين الصويا المستخلص مقارنه بالعينة الكنترول .
- أظهرت النتائج أن العينات المغطاه ببروتين اللبن المستخلص كان أقل زيادة فى الزيت الممتص والبولر و الاحماض الدهنية المؤكسدة واللون واللزوجة والامتصاص على ٢٣٢ , ٢٦٨ نانوميتر والبولمرات يليه العينات المغطاه ببروتين الصويا المستخلص مقارنة بالعينات الكنترول .
- التقييم الحسى أظهرت النتائج زيادة صلابة وقرمشة شرائح البطاطس فى العينات المغطاه ببروتين اللبن المستخلص مقارنة بالكنترول .
- أظهرت نتائج التقييم الحسى انه لايوجد اختلاف واضح فى المظهر والطعم بين كل من العينات المغطاه ببروتين اللبن المستخلص , والمغطاه ببروتين الصويا المستخلص مقارنة بالكنترول.