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QUALITY OF DEEP-FAT FRYING *FALAFEL* BALLS AS INFLUENCED BY VARIOUS FIBERS AND HYDROCOLLOIDS

E.H. Mansour
Department of Food Science and Technology, Faculty of Agriculture,
Minufiya University, Shibin El-Kom, Egypt
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ABSTRACT: *Falafel balls are one of the most popular deep-fat fried products in some Arab countries due to its desirable organoleptic profile. The effects of adding different levels of fibers or hydrocolloids to Falafel composite on oil uptake, moisture retention and compressibility were studied. The best four treatments were subjected to sensory evaluation. Addition of fibers or hydrocolloids to Falafel composite reduced the oil uptake, increased moisture retention and compressibility as compared to control. Corn bran, wheat bran, locust bean gum and guar gum at 4% level were found to be more effective in reducing the oil uptake (53.1-61.6%) and increasing the moisture retention (231.3-244.8%) and compressibility (77.0-101.1%) than other fibers or hydrocolloids. Crust color and crust thickness of Falafel balls contained 4% corn bran, wheat bran, locust bean gum and guar gum were lighter and thinner than control. Also, Falafel balls were firmer than control although they contained more bound water. Addition of fibers or hydrocolloids to Falafel balls did not affect flavour acceptability. The overall acceptability of Falafel balls contained fibers or hydrocolloids was higher than control. Compressibility was highly correlated with moisture (r = 0.95) and oil (r = – 0.94) contents and could be predicted from the following simple regression equations:*

Compressibility (kg force/g) = 3.38 + 0.30 × moisture content

Compressibility (kg force/g) = 23.84 – 0.36 × oil content

Key words: *Deep-fat frying, Falafel balls, fibers, hydrocolloids, compressibility, oil content, moisture content*

INTRODUCTION

Lipids consumption especially saturated fat is considered as the major factor that elevates health risks such as coronary heart disease, cancer, diabetes and hypertension and even linked to increase causes of deaths (Saguy and Dana, 2003). Deep-fat frying is a widely used method for preparing foods with a particular taste and texture, providing increased palatability (Saguy *et al.*, 1998). However, the absorption of oil renders the fried food unhealthy because of the consumption of excess fat in the diet (Krokida *et al.*, 2001).

Several factors have been reported to affect oil uptake, including oil quality, frying temperature and duration, product shape, its content of moisture, solids, fat and protein, pre-frying temperatures and coating (Berry *et al.,* 1999, Vitrac *et al.,* 2002).

The desire of consumer to more nutritious and healther foods has created significant pressure on the industry to reduce fat of fried products (Saguy *et al.,* 1998). Most investigations to lower oil uptake during deep-fat frying have focused on ingredient and cooking technology (Berry *et al.,* 1999). Food hydrocolloids with thermal gelling or thickening properties have been widely investigated. Adding food hydrocolloids as dry ingredients is a practical way to lower oil uptake of deep-fat fried foods (Malikarjunan *et al.,* 1997, Khalil, 1999, Williams and Mittal, 1999, Albert and Mittal, 2002). Cellulose derivatives, including methyl cellulose, sodium carboxy methyl cellulose and hydroxypropyl methyl cellulose have been reported to reduce oil pick up during deep-fat frying (Berry *et al.,* 1999, Albert and Mittal, 2002).

The current study addresses one of the most popular deep-fat fried products in the Arab countries (*Falafel*) due to their desirable organoleptic profile. The objective of the present study was to evaluate the effect of adding different levels of fibers or hydrocolloids on oil reduction, water content and sensory properties of *Falafel* balls. The correlations between compressibility and each of oil content and moisture content were also estimated.

MATERIALS AND METHODS

A- Materials:

Dehulled faba beans and other ingredients (onion, leek, coriander, garlic and salt) used in the present study were obtained from local market of Shibin El-Kom, Egypt. Faba beans were manually cleaned to remove foreign materials prior to soaking in tap water (1:20 w/v) for 12 h at room temperature (~25 °C).

The fibers and hydrocolloids used in the present study were as follows: (1) Sugar beet hull (Duofiber, American Crystal Sugar Co., Moorhead, MN, USA); (2) Pea hull (Nutrio P-Fiber 150, Grinsted Products, Inc. Industrial Airport, KS, USA); (3) Corn bran (Williamson Fiber Products, Inc., Louisville, KY, USA); (4) Pectin, cellulose and carboxy methyl cellulose (Sigma Chemical Co., St-Louis, MO, USA); (5) Sodium alginate (Aldrich Chemical Co., Milwaukee, WI, USA); (6) Carrageenan (Sanofi Bio-Industries, Inc. Waukesha, WI, USA); (7) Modified starch (National Starch and Chemical Co., Bridgewater, NJ, USA); (8) Fenugreek hull, potato peel, locust bean gum and guar gum (Dr. Fawzy A. El-Soukkary, Department of Food Science, Faculty of Agriculture, Minia University, El-Minia, Egypt) and (9) Wheat bran (Alexandria Milling Company, Alexandria, Egypt).

Preparation of *Falafel* balls: The basic formula of *Falafel* balls is given in Table (1). Control *Falafel* was prepared by mixing soaked faba bean, onion, leek, coriander, garlic and salt for 5 min in Hobart mixer (Model No. 4046, Hobart Manufacturing Co., Troy, OH, USA). *Falafels* containing fibers or hydrocolloids were prepared by replacing different levels (1, 2, 3, 4 and 5%) in regular formula with equal amounts of hydrated fibers or hydrocolloids (1:1 w/v). The *Falafel* mixtures of both control and fibers or hydrocolloids were allowed to rest for 10 min, and then manually rounded into balls of approximately 40 mm diameter. The *Falafel* balls were fried in pre-heated bench top deep fryer containing 3 litters of cottonseed and soybean oil blend. The frying temperature was 180°C. The *Falafel* balls were fried for 90 sec on each side; removed from the fryer and allowed to cool at room temperature (~25°C).

Table (1): The basic formula for *Falafel* ball preparation

Ingredients	(%)
Faba bean	75.5
Onion	10
Leek	10
Coriander	1
Garlic	1
Table salt	2.5

B- Methods:

1- Analytical Methods: Moisture (method No. 925.09) and oil contents (method No. 920.39c) were estimated according to AOAC (1995).

2- Compressibility: Lee-Kramer shear force values were measured on three *Falafel* balls from each treatment after being fried and cooled to room temperature (~25°C) using the Ottawa Texture Measuring System (Canners Machinery LTD, ON, Canada) with 900S mainframe Daytronic Digital Indicator and recorder (Model SP-G 5P, Ricken Denshi CO. Ltd, Japan). The peak force was determined and divided by the weight of each piece to obtain force/gram.

3- Sensory evaluation: Sensory evaluation of *Falafel* balls was carried out by eight-trained panellists who represented graduate students and staff members in the Department of Food Science and Technology, Menofiya University. Randomly coded samples were served to panellists individually. Six sensory attributes were evaluated (crust color, crust thickness, firmness, flavour, appearance and overall acceptability) using a hedonic scale of eight-points for each trait where 8 = excellent and 1 = extremely poor.

4- Statistical analysis: A completely randomized 6 (fat replacer level) × 14 (fat replacer type) × 3 (replication) factorial design was used. Data were statistically analyzed using SAS (1995). When a significant main effect was detected, the means were separated with the Student-Newman-Keuls test.

Differences between treatments at 5% ($P \leq 0.05$) level were considered as significant. Comparison between compressibility and each of oil content and moisture content was evaluated by simple regression analysis.

RESULTS AND DISCUSSION

1- Oil content:

Data presented in Table 2 show the oil content of *Falafel* balls containing different levels of fibers or hydrocolloids. Addition of fibers or hydrocolloids to *Falafel* composite reduced the oil content compared to control. The *Falafel* balls contained potato peels showed the lowest oil content followed by *Falafel* balls contained locust bean gum, guar gum, wheat bran and corn bran. Also, as the concentration of fibers or hydrocolloids increased, oil content of *Falafel* balls decreased.

Table (2): Oil content (%) of *Falafel* balls containing different concentrations of fibers and hydrocolloids

Treatment	Concentration (%)				
	1	2	3	4	5
Fibers					
Sugar beet hull	26.54	22.43	20.76	19.22	19.37
Fenugreek hull	28.51	24.78	21.83	19.96	20.15
Pea hull	27.50	25.82	22.50	20.11	20.03
Potato peel	20.38	18.44	16.55	14.98	14.95
Corn bran	25.23	23.33	20.87	18.93	18.83
Wheat bran	24.10	22.41	19.90	17.54	17.60
Cellulose	25.58	23.37	21.15	19.40	19.42
Hydrocolloids					
Locust bean gum	21.63	19.23	17.35	15.50	15.45
Guar gum	22.90	20.91	18.99	16.99	16.87
Carrageenan	26.52	24.65	22.07	20.12	20.02
Pectin	28.85	26.13	23.22	21.51	21.56
Sodium alginate	27.87	25.33	22.92	20.88	20.91
Carboxy methyl cellulose	27.01	25.18	23.08	20.78	20.65
Modified starch	28.47	26.29	24.09	22.11	22.08

The oil content of control = 40.38%

2- Moisture content:

Data presented in Table 3 indicate that *Falafel* balls contained either fibers or hydrocolloids had higher moisture content than control. The highest moisture content was observed in *Falafel* balls contained potato peels followed by *Falafel* balls contained locust bean gum, guar gum, wheat bran and corn bran. Also, elevating the level of fibers or hydrocolloids addition resulted in increment the moisture contents.

Table (3): Moisture content (%) of *Falafel* balls containing different concentrations of fibers and hydrocolloids

Treatment	Concentration (%)				
	1	2	3	4	5
Fibers					
Sugar beet hull	35.05	39.97	43.13	46.55	46.57
Fenugreek hull	31.99	37.83	39.78	41.17	41.14
Pea hull	34.74	36.36	39.69	43.35	43.44
Potato peel	44.93	46.62	48.47	52.63	52.86
Corn bran	40.96	43.68	45.09	47.94	47.88
Wheat bran	41.92	44.22	46.46	48.66	48.73
Cellulose	34.38	36.86	38.02	40.35	40.42
Hydrocolloids					
Locust bean gum	43.42	45.70	47.81	50.75	50.54
Guar gum	42.24	44.75	46.53	49.70	49.82
Carrageenan	36.79	38.16	41.67	43.75	44.00
Pectin	37.86	39.43	41.08	42.97	43.14
Sodium alginate	33.54	35.23	37.43	39.47	39.68
Carboxy methyl cellulose	38.87	40.15	42.35	44.37	44.39
Modified starch	28.71	30.11	32.83	35.22	35.13

The moisture content of control = 20.73%

3- Compressibility:

Compressibility values of *Falafel* balls containing fibers or hydrocolloids are shown in Table 4. The *Falafel* balls contained fibers or hydrocolloids exhibited higher compressibility values and thereby they were more softer than control. Potato peels, locust bean gum, guar gum, wheat bran and corn bran showed the highest compressibility among all treatments. Increasing the level of fibers or hydrocolloids addition resulted in increasing the compressibility of *Falafel* balls. The highest compressibility of *Falafel* balls was observed at 4 and 5% replacement levels.

Table (4): Compressibility (kg force/g) of *Falafel* balls containing different concentrations of fibers and hydrocolloids

Treatment	Concentration (%)				
	1	2	3	4	5
Fibers					
Sugar beet hull	13.88	14.68	15.71	16.21	16.30
Fenugreek hull	12.71	13.45	14.95	15.70	15.70
Pea hull	13.45	14.20	15.70	16.29	16.15
Potato peel	18.04	18.79	19.54	20.29	20.29
Corn bran	14.20	14.95	16.45	17.20	17.20
Wheat bran	14.08	15.57	17.07	18.57	18.57
Cellulose	13.66	14.41	15.35	15.91	15.76
Hydrocolloids					
Locust bean gum	16.85	17.75	18.80	19.55	19.40
Guar gum	15.79	16.69	18.00	18.49	18.49
Carrageenan	13.46	14.21	15.70	16.45	16.30
Pectin	12.71	13.76	14.95	16.45	16.30
Sodium alginate	13.16	14.21	15.40	16.75	16.60
Carboxy methyl cellulose	13.40	14.21	14.95	16.45	16.30
Modified starch	12.69	13.76	14.65	15.40	15.55

The compressibility value of the control = 9.72 kg force/g

4- Effect of fiber or hydrocolloid types on oil, moisture and compressibility:

Statistical analysis of oil content, moisture content and compressibility of *Falafel* balls as influenced by fiber or hydrocolloid types is shown in Table 5. The *Falafel* balls contained potato peels had the lowest ($P \leq 0.05$) oil content, and the highest ($P \leq 0.05$) moisture content and compressibility among all treatments, followed by locust bean gum, guar gum, wheat bran and corn bran. The basic physical effect of deep-fat frying is water replacement by oil (Pinthus *et al.*, 1993, Krokida *et al.*, 2000, Shain *et al.*, 2000). Addition of fibers or hydrocolloids to *Falafel* formula may alter the water holding capacity and consequently affect the oil uptake. Potato peels ability to reduce oil uptake during frying Is probably due its effect in increasing the water holding capacity by entrapping moisture and consequently prevention of moisture replacement by oil. The effect of locust bean gum and guar gum to reduce oil uptake during frying may be due to their thermal gelation and film forming effectiveness (Rayner *et al.*, 2000), and also may be related to the surface roughness reduction and possible change in *Falafel* porosity which prevent the migration of water to the outer surface and consequently the replacement by oil. Pinthus *et al.*, (1993) reported that oil uptake in deep-fat frying was affected by porosity. The *Falafel* balls contained sugar beet hull, fenugreek hull, pea hull, cellulose, carrageenan, pectin, sodium alginate, carboxy methyl cellulose and modified starch showed moderate effect in reducing oil uptake and moisture loss during deep-fat frying. This is may be due to the weak ability of such materials to entrap moisture.

Compressibility of *Falafel* balls was influenced ($P \leq 0.05$) by fiber or hydrocolloid types. The *Falafel* balls prepared with potato peels, locust bean gum, guar gum, wheat bran and corn bran were more significantly ($P \leq 0.05$) compressible (softer) than other fibers and hydrocolloids. The increase in softness may be due to the increase in water holding capacity as a result of fibers or hydrocolloids (Malikarjunan *et al.*, 1997, Funami *et al.*, 1999).

Locust bean gum, guar gum, wheat bran and corn bran were considered as the best four treatments followed the potato peels in reducing the oil uptake (53.1-61.6%) and increasing the moisture retention (231.3-244.8%) and compressibility (77.0-101.1%). Although potato peels addition to *Falafel* balls showed the highest oil uptake reduction (62.9%), moisture retention (253.9%) and compressibility (108.7%), the resultant colour of *Falafel* balls was very dark and the appearance was not accepted. Therefore, the potato peels treatment was excluded from the selected fibers or hydrocolloids (Locust bean gum, guar gum, wheat bran and corn bran) to be used in the preparation of *Falafel* balls for sensory evaluation.

Table (5): Effect of replacer type on the moisture, oil and compressibility of *Falafel* balls containing different concentrations of fibers and hydrocolloids

Replacer type (%)	Oil %	Moisture %	Compressibility kg force/g
Fibers			
Sugar beet hull	26.08^{b}	38.67^{f}	14.42^{f}
Fenugreek hull	25.94^{b}	35.44^{i}	13.71^{gh}
Pea hull	26.06^{b}	36.39^{h}	14.25^{fg}
Potato peel	20.89^{g}	44.37^{a}	17.78^{a}
Corn bran	24.60^{c}	41.05^{e}	14.86^{e}
Wheat bran	23.66^{d}	41.79^{d}	15.60^{d}
Cellulose	25.74^{b}	35.13^{i}	14.14^{fgh}
Hydrocolloids			
Locust bean gum	21.61^{f}	43.16^{b}	17.01^{b}
Guar gum	22.84^{e}	42.30^{c}	16.20^{c}
Carrageenan	25.63^{b}	37.52^{g}	14.31^{f}
Pectin	26.94^{a}	37.54^{g}	13.98^{fgh}
Sodium alginate	26.72^{a}	34.34^{j}	14.31^{f}
Carboxy methyl cellulose	26.18^{b}	38.48^{f}	14.17^{fgh}
Modified starch	27.24^{a}	30.46^{k}	13.63^{h}
LSD	0.48	0.41	0.39

$^{a-k}$ Means in the same row with different letters are significantly different ($P \leq 0.05$)

5- Effect of fiber or hydrocolloid levels on oil, moisture and compressibility:

The *Falafel* balls prepared with fibers or hydrocolloids at 4 and 5% levels had the lowest ($P \leq 0.05$) oil content and the highest ($P \leq 0.05$) moisture content and compressibility (Table, 6). Non-significant differences ($P > 0.05$) in oil content, moisture content and compressibility were observed between *Falafel* balls contained 4 and 5% fibers or hydrocolloids. Therefore, fibers or hydrocolloids at 4% level were selected as the optimum level to be incorporated in the preparation of *Falafel* balls for sensory evaluation.

Table (6): Effect of replacer level on the moisture, oil and compressibility of *Falafel* balls containing different concentrations of fibers and hydrocolloids

Replacer level (%)	Oil %	Moisture %	Compressibility kg force/g
0	40.38[a]	20.73[e]	9.72[e]
1	25.82[b]	37.53[d]	14.18[d]
2	23.52[c]	39.93[c]	15.07[c]
3	21.22[d]	42.17[b]	16.21[b]
4	19.37[e]	44.78[a]	17.09[a]
5	19.18[e]	44.84[a]	17.03[a]
LSD	0.31	0.27	0.26

[a-d] Means in the same row with different letters are significantly different ($P \leq 0.05$)

6- Sensory evaluation:

The sensory properties of *Falafel* balls contained 4% of corn bran, wheat bran, locust bean gum and guar gum are shown in Table 7. Crust colour of *Falafel* balls contained corn bran, wheat bran, locust bean gum and guar gum possessed higher acceptability ($P \leq 0.05$) than control. At the same time, crust thickness of the above mentioned treatments was less ($P \leq 0.05$) than control. This may be due to the effect of fibers or hydrocolloids in increasing the moisture retention and lowering the oil uptake as compared to the control. Increasing the gel strength during deep-fat frying may provide an explanation for the effectiveness of the hydrocolloids as a reducer of oil uptake. Pinthus *et al.*, (1995) reported that crust thickness and crust oil content of deep-fat fried potato product were found to decrease considerably as the gel strength increased. Increasing the migration of water in control during deep-fat frying resulted in increasing the oil uptake and burning the crust of control (dark color) as well as increases the thickness of crust. The *Falafel* balls contained corn bran or wheat bran had higher ($P \leq 0.05$) scores of crust colour and crust thickness than *Falafel* balls contained locust bean gum or guar gum.

The *Falafel* balls contained either locust bean gum or guar gum showed the highest ($P \leq 0.05$) firmness scores. This may be due to the thermal gelation effect of these hydrocolloids. Also, *Falafel* balls contained corn bran or wheat bran were firmer ($P \leq 0.05$) than control, the flavour of *Falafel* balls was not influenced ($P > 0.05$) by the addition of fibers or hydrocolloids.

The appearance of *Falafel* balls contained fibers or hydrocolloids was significantly ($P \leq 0.05$) better than control. No differences ($P > 0.05$) could be traced in appearance between *Falafel* balls contained fibers or hydrocolloids. It is worth to mention that, control *Falafel* balls showed deformability and oily appearance after the deep-fat frying. This may be due to the increase in moisture loss and consequently increase the oil uptake, which led to the weak structure of the control. The overall acceptability of *Falafel* balls contained fibers or hydrocolloids was significantly ($P \leq 0.05$) higher than control. No significant differences ($P > 0.05$) in overall acceptability were observed between *Falafel* balls contained fibers or hydrocolloids

Table (7): Sensory properties of *Falafel* balls containing 4% of corn bran, wheat bran, locust bean gum and guar gum

Properties	Control	*Falafel* containing 4% of				LSD
		Corn bran	Wheat bran	Locust bean gum	Guar gum	
Crust color	7.54^{c}	8.64^{a}	8.42^{a}	8.00^{b}	7.92^{b}	0.32
Crust thickness	7.04^{c}	8.21^{a}	8.23^{a}	7.70^{b}	7.61^{b}	0.21
Firmness	7.13^{c}	8.30^{b}	8.23^{b}	8.71^{a}	8.72^{a}	0.33
Flavour	8.13^{a}	8.05^{a}	8.14^{a}	8.11^{a}	8.04^{a}	0.32
Appearance	7.32^{b}	7.94^{a}	8.07^{a}	8.13^{a}	8.01^{a}	0.24
Overall acceptability	7.43^{b}	8.24^{a}	8.23^{a}	8.12^{a}	8.08^{a}	0.34

$^{a\text{-}c}$ Means in the same row with different letters are significantly different ($P \leq 0.05$)

7- Correlation between compressibility and each of oil and moisture content:

Fig. (1) shows the correlation between compressibility and both moisture content and oil content of *Falafel* balls containing different levels of fibers or hydrocolloids. Compressibility was highly correlated with moisture ($r = 0.95$) and oil ($r = -0.94$) contents. The results showed that compressibility could be predicted from the following simple regression equations:

Compressibility (kg force/g) $= 3.38 + 0.30 \times$ moisture content

Compressibility (kg force/g) $= 23.84 - 0.36 \times$ oil content

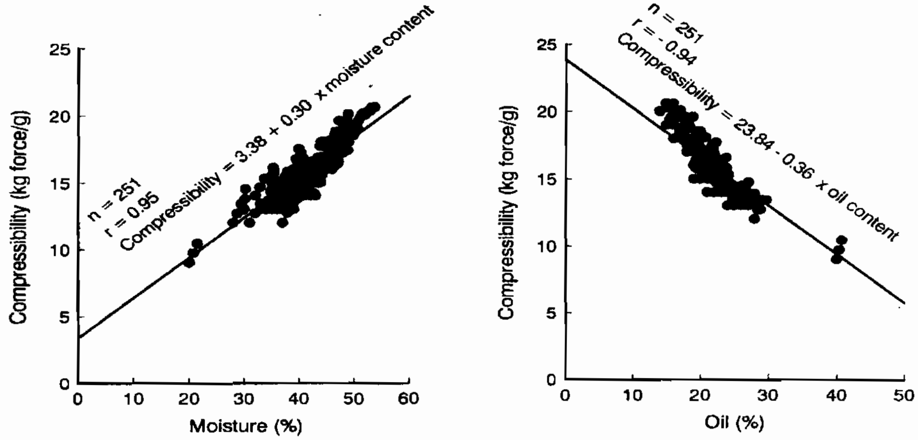

Fig. (1): Relationship between compressibility and both moisture and oil content of Falafel balls containing different levels of fibers and hydrocolloids

CONCLUSION

In the light of data presented here, it could be concluded that fibers or hydrocolloids were effective in reducing oil uptake and increasing the moisture retention and compressibility of *Falafel* balls during deep-fat frying. Adding 4% of corn bran, wheat bran, locust bean gum and guar gum to *Falafel* composite led to improve the sensory properties of *Falafel* balls as compared to control.

REFERENCES

A.O.A.C. (1995). Official Methods of Analysis, 16th ed.; Association of Official Analytical Chemists: Gaithersburg, MD.

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

Berry, S. K., R. C. Sehgal and C. L. Kalra (1999). Comparative oil uptake by potato chips during frying under different conditions. J. Food Sci., Technol.-Mysore, 36: 519-521.

Funami, T., M. Funami, T. Tawada and Y. Nakao (1999). Decreasing oil uptake of doughnuts during deep fat frying using curdlan. J. Food Sci., 64: 883-888.

Khalil, A. H. (1999). Quality of french fried potatoes as influenced by coating with hydrocolloids. Food Chem., 66: 201-208.

Krokida, M. K., V. Oreopoulou, Z. B. Maroulis (2000). Water Loss and oil uptake as a function of frying time. J. Food Engineering, 44:39-46.

Krokida, M. K., V. Oreopoulou, Z. B. Marloulls, D. Marinos-Kouris (2001). Deep fat frying of potato Strips - quality issues. Drying Technol., 19: 879-935.

Malikarjunan, P., M. S. Chinnan, V. M. Balasubramanian, R. D. Phillip (1997). Edible coatings for deep-fat frying of starchy products. Lebensm.-Wiss. u.-Technol., 30: 709-714.

Pinthus, E. J., P. Weinberg, I. S. Saguy (1993). Criterion for oil uptake during deep fat frying. J. Food Sci., 58: 204-205.

Pinthus, E. J., P. Weinberg and I. S. Saguy (1995). Deep-fat fried potato products, oil uptake as affected by crust physical properties. J. Food Sci., 60: 770-772.

Rayner, M., V. Ciolfi, B. Maves, P. Stedman, G. S. Mittal (2000). Development and application of soy protein films to reduce fat intake in deep-fried foods. J. Sci. Food Agric., 80: 777-782.

Saguy, I. S., G. Ufheil, S. Livings (1998). Oil uptake in deep fat frying - Review. Oel – Oleagineux Corps Gras Lipides, 5:30-35.

Saguy, I. S. and D. Dana (2003). Integrated approach to deep fat frying: Engineering, nutrition, health and consumer aspects. J. Food Engineering, 56:143-152.

Sahin, S., S. K. Sastry and L. Bayindirli (2000). Combined effects of frying parameters and oil content on moisture levels in French fries. J. Food Sci., Technol-Mysore, 37:557-560.

SAS (1995). Institute, Inc. *SAS. User's Guide Statistics*, SAS Institute: Cary, NC, USA.

Vitrac, O., D. Dufour, G. Trystram and A. L. Raoult-Wack (2002). Characterization of heat and mass transfer during deep fat frying and its effect on cassava chip quality. J. Food Engineering, 53: 161-176.

Williams, R. and G. S. Mittal (1999). Water and fat transfer properties of polysaccharide films on fried pastry mix. Lebensm.-Wiss. u-Technol., 32: 440-445.

تأثير الألياف والغرويات على جودة الفلافل المقلية بطريقة القلي العميق

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قسم علوم وتكنولوجيا الأغذية - كلية الزراعة - جامعة المنوفية - شبين الكوم

الملخص العربي

تعتبر الفلافل من أكثر أنواع المنتجات المقلية بطريقة القلي العميق شيوعاً في بعض الدول العربية وذلك لطعمها المقبول والمرغوب. وفى هذا البحث تم دراسة تأثير إضافة تركيزات مختلفة من الألياف أو الغرويات على كل من كمية الزيت المكتسب والرطوبة المحتفظ بها أثناء القلي ومقدرة الفلافل على تحمل الضغط Compressibility. وقد أدى إضافة الألياف أو الغرويات لعجينة الفلافل لتقليل كمية الزيت المكتسب وزيادة كمية الرطوبة المحتفظ بها أثناء القلي وكذلك زيادة مقدرة الفلافل على تحمل الضغط مقارنة بالعينة غير المضاف إليها هذه المواد. وقد وجد أن هذا التأثير يزداد بزيادة تركيز كل من الألياف أو الغرويات، وكان تركيز ٤% هو أفضل التركيزات المستخدمة. كما وجد أن ردة الأذرة وردة القمح وصمغ ثمرة الخروب وصمغ الجوار هم أفضل أنواع الألياف والغرويات التي يمكن استخدمها لتقليل كمية الزيت المكتسب (٥٣,١-٦١,٦%) وزيادة كمية الرطوبة المحتفظ بـها (٢٣١,٣ - ٢٤٤,٨%) وكذلك زيادة مقدرة الفلافل على تحمل الضغط (٧٧,٠-١٠١,١%)، لذلك اختيرت هذه المواد وأضيفت إلى عجينه الفلافل بنسبة ٤% واستخدمت الفلافل الناتجة في دراسة الخصائص الحسية.

وبينت نتائج الاختبارات الحسية للفلافل على أن الطبقة الخارجية للفلافل المصنعة بإضافة هذه المواد كانت ذات لون أفتح وأقل سمكاً عنها في الفلافل المصنعة بدون إضافتها، كما أن الفلافل المصنعة بإضافة هذه المواد كانت أكثر تماسكاً عن الفلافل المصنعة بدون إضافتها، وأن طعم ورائحة الفلافل لم يتأثر بإضافة هذه المواد، وكان تقبل الفلافل المصنعة بإضافة هذه المواد أعلى من الفلافل المصنعة بدون إضافتها.

وكان معامل الارتباط بين مقدرة الفلافل على تحمل الضغط ونسبة الرطوبة (٠,٩٥) ونسبة الزيت (- ٠,٩٤) ويمكن التنبؤ بمقدرة الفلافل على تحمل الضغط من المعادلات الآتية:

Compressibility (kg force/g) = 3.38 + 0.30 × moisture content
Compressibility (kg force/g) = 23.84 – 0.36 × oil content