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Effects of Pre-Drying on Quality of Fried Breaded Black Pomfret (*Parastromateus niger*) Fillet

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Abstract: The objective of this study was to investigate the effects of pre-drying process on quality of fried breaded fish fillets. For this study, breaded black pomfret (*Parastromateus niger*) fillets were pre-dried in conventional oven at 180°C for 0, 30, 60, 90 and 120 sec. The pre-dried fillets were pre-fried in sunflower oil and stored at -20°C for 1 week. They were then finally cooked in the combination oven. Fat, moisture, texture and color of the cooked fillets were evaluated. Results indicated that moisture loss and the fat uptake of cooked fillets decreased with increasing pre-drying time. Instrumental texture analysis showed that hardness of the pre-dried samples increased as compared to the control. Results from color evaluation showed that the b* (yellowness) values of the samples increased, while L* (whiteness) and a* (redness) values did not change significantly ($p<0.05$). The best quality product was prepared when 90 sec pre-drying time was applied.

Key words: Pre-drying, sunflower oil, oven cooking, quality characteristics

INTRODUCTION

Texture, fat content and color are important quality attributes for the acceptance of battered and breaded foods. The high fat absorption is the most important problem of breaded fried foods. Production of low fat foods is becoming more popular due to the cardiovascular disease implication (Bunger *et al*., 2003). Reducing oil content in fried foods is also motivated by the need to reduce cost of production. The most recommendation methods for reduction of the fat uptake in fried foods are related to the control of the moisture loss during deep-frying. For reduction the fat uptake during deep-frying, only the outer layer of the food needs to have low moisture content, which can be achieved by applying a low-moisture level coating (Mellema, 2003).

The pre-drying technique before frying was used successfully for reducing the oil uptake, moisture loss and increasing the crispness in fried potato products (Franco and Pedro, 2005; Gupata *et al*., 2000; Krokida *et al*., 2001). Reduction the oil uptake during deep-fat frying of chickpea flour-based snack food in a laboratory scale drier by cross flow connective hot air at 65°C for 20, 40, 60 and 90 min was also reported by Sukumar *et al*. (2003). Preparation of breaded foods for consumption is normally based on two steps: pre-frying step prior to freezing for 30 sec in factories to adhere the breading materials on the surface of the food substrate and completely cooking step by consumers using different cooking methods. The highest amount of fat uptake of was during the pre-frying step. Black pomfret (*Parastromateus niger*) which was selected for this study, is one of the important commercial marine fish in the Asian countries. Therefore, the objective of this study was to determine the effects of pre-drying procedure by conventional oven on the texture, color and oil uptake in the pre-fried breaded black pomfret (*Parastromateus niger*) fillet.

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MATERIALS AND METHODS

Materials

Fresh black pomfret fish (*Parastromateus niger*) weighting approximately 345±6 g and measuring 21±2 cm in length were purchased from the wholesale wet market (Pasar Brong) in Malaysia in March 2006. The fish was manually filleted. Two fillets were produced of each fish. Each fillet was cut into halves. The fillets were then washed under running tap water and dripped dried for 10 min in a colander. Fillets were randomly selected and packed in polyethylene bags in a pack of six, stored at -20°C and were used within 2 weeks. Sunflower oil (LAM SOON edible oil SDN BHD, Malaysia) for pre-frying and ingredients for breading process was purchased from local supermarket (Seri Kembangan supermarket).

Experimental Design

Five pre-drying treatments i.e., 0, 30, 60, 90 and 120 sec were selected and 12 breaded fillets were used for each pre-drying treatment. The pre-drying durations selected were based on our preliminary studies. Where pre-dried above the highest point used in this study the breaded layer of the fish fillets were highly damaged. After pre-drying, 12 fillets from each pre-drying treatment were pre-fried in sunflower oil. The pre-fried fillets were cooled at room temperature for 10 min and packaged in polyethylene bags and blast frozen at -38°C for 1.5 h in a blast freezer with cooling capacity of 11 KW -40°C (NRS, Malaysia). The frozen fillets were then stored at -20°C for one week. After which, they were final cooked by oven (Fig. 1).

Methods

Breading of Fillets

Batter formulation was prepared according to our previous studies in the Food Processing Laboratory by using 75% wheat flour, 24.5% corn flour and 0.5% salt. All ingredients in the ratio of 1:1.4 (w/w) dry materials and water were mixed thoroughly for 3 min in a kitchen blender (National, Model MX-897 GM Japan). Frozen fish fillets were thawed overnight in the cold room at 4°C. The surfaces of thawed fillets were then dabbed with paper towels before dipping the fillets into the batter and the excess batter was dripped-off for 30 sec. Battered fillets were then coated with breadcrumbs prior to the deep-fat frying.

Pre-Drying

Pre-drying procedures was carried out in a conventional oven (Memmert, UL 40, Germany). The oven temperature was set at 180°C and this was checked by reading the temperature of the built in thermometer. The oven was heated for 45 min to achieve 180°C prior drying. The fillets were placed on the stainless steel rack and dried for 30, 60, 90, 120 sec, respectively. The drying for each drying time was carried out in duplicate. The drying time was controlled by a stopwatch. They were then immediately pre-fried.

Pre-Frying

Three liter capacity deep-fryer (PHILUX, Model Df30AIT) filled with 2 L of the frying oil was used for the pre-frying and the frying oil was used once. Each batch of frying consisted of 24 fillets. The temperature of the frying oil was set at 180±2°C and monitored with a metal thermometer. The fillets were fried for 30 sec in sunflower oil.

Final Cooking

Final cooking was carried out at 180°C in a combination oven (Combi-CPC61, Model RATONAL) in a dry mode (no moisture) for 7 min. Once the fillets were cooked, they were cooled at room temperature for 10 min.

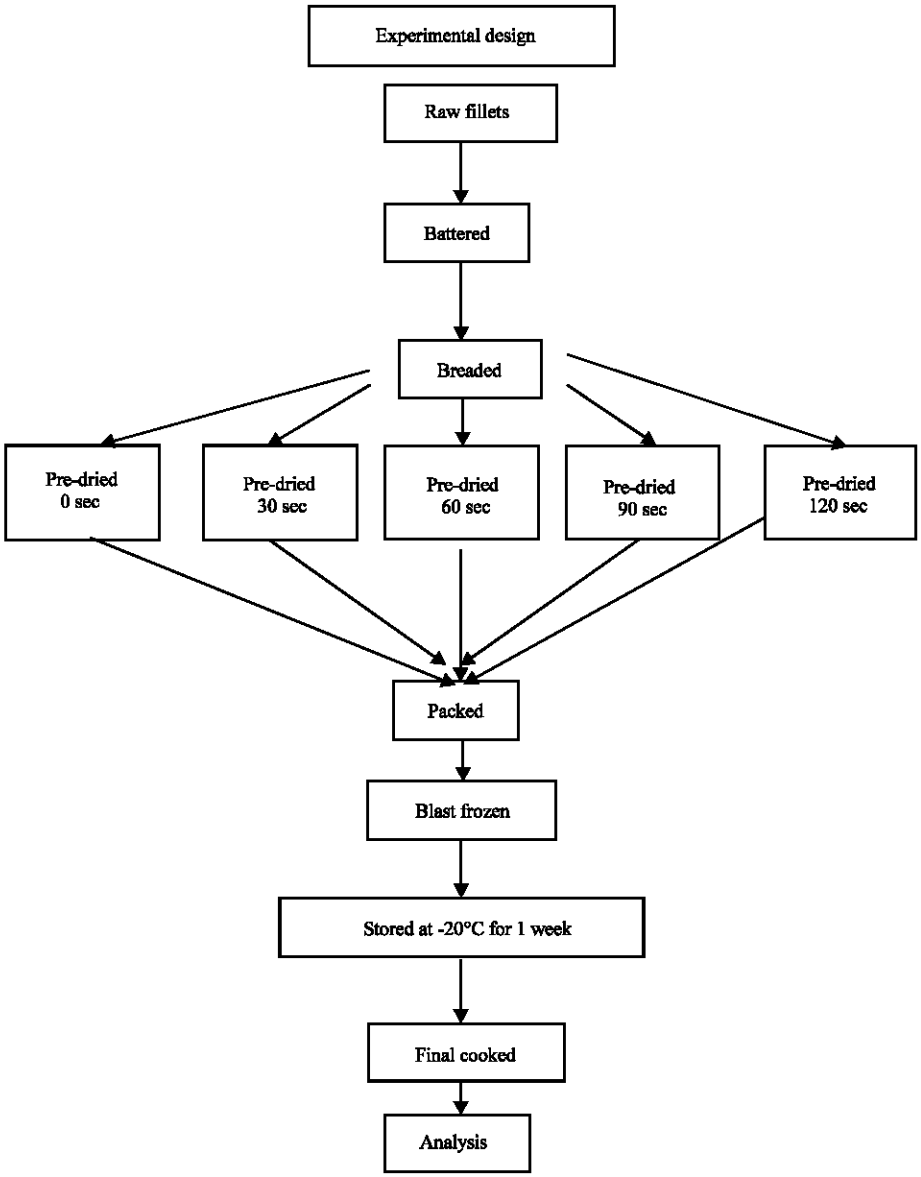

Fig. 1: Flowchart of experimental design

Moisture and Fat Content Determinations

Moisture and fat content were determined according to standard methods (AOAC, 1990).

Texture Profile Measurement

Texture Analyzer TA-XT2 was used to determine the texture profile of the samples according to the manual provided by the manufacture. A cylindrical plunger P/0.5 (12.5 mm diameter) and HPD/90 platform was used for the analysis. The load cell was 30 kg. The pre and post test speed were 2 mm sec^{-1}. The plunger was pressed into the fillets at a constant speed of 1 mm sec^{-1} until it reached

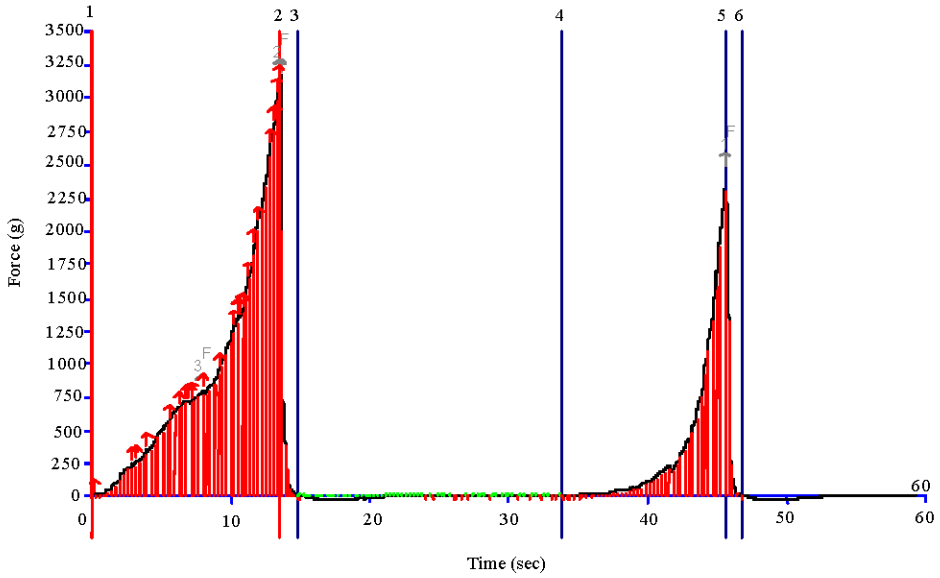

Fig. 2: An example of a TPA curve of the fried breaded fillet, Hardness: F2 (Force), Fracturability: F3 (Force), Adhesiveness: Area 3:4. (Force), Springiness: Time difference 4:5/Time difference 1:2, Chewiness: Force 2×(Area 4:6/Area 1:3)×(Time diff 4:5/Time diff 1:2), Cohesiveness: Area 4:6/Area 1:3, Resilience: Area 2:3/Area 1:2

80% (approximately 14.5±0.8 mm as indicated by the analyzer) of the sample height (Anna *et al*., 2003). The texture of the completely cooked samples was evaluated after cooling off the samples at 10 min at room temperature (17°C). Six breaded fillets measuring approximately 11±0.5 cm in length, 4±0.8 cm wide and 1.5±0.4 cm high were used for each treatment. The measuring unit was g sec^{-1}. Two measurements were performed in the middle (about 3 cm of each) and on the surface of each fillet and mean values were used in the data analysis. The contact area of each measurement was 126.86 mm. An example of TPA curve is shown in Fig. 2.

Color Measurement

Color of the samples was measured using a Minolta Chroma Meter (CR-300 Minolta, Japan). The color readings were expressed by CIE (L* a* b*) system (Rafael *et al*., 2004). L*, a* and b* indicates whiteness/darkness, redness/greenness and blueness/yellowness, respectively. The maximum value for L* is 100, which would be a perfect reflecting diffuser. The minimum for L* would be zero, which would be black. The a* and b* axes have no specific numerical limits. Positive a* is red and negative a* is green. Positive b* is yellow and negative b* is blue. Six breaded fillets were used for each treatment and the L* a* b* values were measured directly on three different positions on both sides of the fillets.

Statistical Analysis

The statistical analyses were performed using MINITAB version 14 software (MINITAB Inc., Pennsylvania, USA). One-way ANOVA was used for comparison of the data between different pre-drying times in samples ($p<0.05$).

RESULTS

Fat and Moisture Content

The changes of the fat and moisture content of final cooked samples are shown in Table 1. As indicated the moisture content in all pre-dried samples increased, while fat content decreased as compared to the control (0 sec). The amount of moisture content was correlated positively ($R^2 = 0.91$) with the pre-drying time (Table 1). However, the correlation between the fat content and the pre-drying time was found to be negative.

Effects of Pre-Drying on the Texture Profile of Breaded Fillets

Pre-drying significantly ($p<0.05$) changed the hardness and the adhesiveness of the breaded fillets. Hardness of the fillets increased with increasing pre-drying time. This increase was not significantly ($p>0.05$) different between the control (0 sec) and the 30 sec pre-dried samples and between the 60 and 90 sec pre-dried samples. The maximum increase (about 33%) of hardness value was found in 120 sec pre-drying. Strong positive correlation ($R^2 = 0.97$) between the pre-drying time and hardness was observed (Table 2).

Effects of Pre-Drying on the Color of the Breaded Fillets

No significant ($p>0.05$) differences were found in L* and a* values among the pre-dried samples as compared to the control. However, significant increase ($p<0.05$) was found in b* values between the control and all the samples (Table 3).

Table 1: Effects of pre-drying on the fat and moisture contents of final cooked breaded fillets (g/100 g)

	Pre-drying time (sec)				
Compositions	0 (Control)	30	60	90	120
Moisture	53.7±0.1a	55.6±0.9a	58.5±0.9c	59.87±0.6c	59.0±0.6c
Fat	8.5±0.2a	7.9±0.4a	7.5±0.5c	6.20±0.1d	7.2±0.2c

Values with letters in the same row are significantly ($p<0.05$) different. Values are Mean±SD

Table 2: Effects of pre-drying on the texture profile the final cooked breaded fillets

	Pre-drying time (sec)				
Parameters	0 (Control)	30	60	90	120
Hardness[1]	1676±108a	1687±157a	1880±365c	1985±462c	2182±122d
Adhesiveness[2]	-118±25a	-87±15a	-78±24c	-93±30c	-84±32c
Springiness	0.89±0.05a	0.86±0.02a	0.85±0.04a	0.84±0.04a	0.83±0.05a
Chewiness	546±98a	546±90a	541±120a	598±150a	595±105a
Cohesiveness	0.38±0.03a	0.38±0.03a	0.37±0.01a	0.38±0.01a	0.36±0.03a
Resilience	0.05±0.00a	0.05±0.00a	0.05±0.00a	0.05±0.00a	0.05±0.00a

1, 2 g sec^{-1} force, Values with letters in the same row are significantly ($p<0.05$) different. Values are Mean±SD

Table 3: Effects of pre-drying on the color of the final cooked breaded fillets

Colour	Pre-drying time (sec)				
evalution	0 (Control)	30	60	90	120
L*	62.3±2.9a	59.5±0.8a	61.9±2.0a	60.7±3.3a	60.5±3.0a
a*	14.8±2.9a	16.4±2.5a	15.5±1.8a	15.4±0.8a	16.3±4.0a
b*	57.8±1.5a	60.0±1.2b	61.0±1.2b	60.9±3.4b	61.5±1.5b

Values with letters in the same row are significantly ($p<0.05$) different. Values are Mean±SD

DISCUSSION

As shown in Table 1, as the pre-drying time increased, the oil content for the same frying time decreased. Effects of pre-drying on the increasing the moisture content and reducing the oil uptake in the cooked breaded fillets can be explained by the crust formation during pre-drying and the changing in the microstructure on the surface of the fillets. In agreement with our results, Lamberg *et al*. (1990) and Moyano *et al*. (2002) reported that the pre-drying process decreased the initial moisture content of potato pieces and was an efficient way to reduce the fat uptake in the final fried product. Krokida *et al*. (2001) declared that the drying time before frying has negative effect on the equilibrium oil content of fried potatoes. They concluded that reduction in oil uptake of pre-dried apple slices is mainly due to crust development and surface changes occurring during the drying step. Crust microstructure development (mean pore size, connectedness and permeability) has a marked effect in oil absorption. In fact, oil absorption is essentially a surface-related phenomenon resulting from the competition between drainage and suction into the porous crust once the food is removed from the oil bath and begins to cool and therefore crust permeability is of paramount importance. A comparison on the microstructure of fried ribbon snacks samples (frying temperature 175°C and frying time 45 sec) without pre-fry drying and with pre-fry drying for 90 min showed clearly indicates the compactness of microstructure due to pre-fry drying. This results in less oil absorption during frying (Sukumar *et al*., 2003). The highest of oil reduction (26%) was obtained in this study at 90 sec of pre-drying time as compared to the control (0 sec).

Pre-drying process also affected the texture properties of the breaded fish fillets. The hardness of the samples was found higher in pre-dried samples as compared to the control. This increase can be related to the crust formation on the surface and reduction the fat uptake in the fillets. Franco and Pedro (2005) found that pre-drying significantly increased the hardness in blanched fried potato as compared to the non-pre-dried fried potato.

Pre-drying process did not significantly change the L* (lightness) and a* (redness) values. L* is a critical parameter in the frying industry and is usually used as a quality control factor; therefore, an adequate control of this indicator is of great importance (Mariscal and Bouchon, 2008). High L* values are mainly associated with non-enzymatic browning reactions. These reactions can occur between reducing sugars and amino acids and also between ascorbic acid, dehydroascorbic acid and other degradation products from ascorbic acid oxidation, which enter into Maillard-type browning reaction (Belitz *et al*., 2004).

CONCLUSION

Conventional oven pre-drying process can affect the quality of the pre-fried and oven cooked breaded fish fillets. Pre-drying prior to pre-frying resulted in a significant ($p<0.05$) reduction of the moisture loss and consequently the reduction of the fat uptake in the final cooked samples. Ninety seconds of pre-drying can be recommended since the lowest moisture loss and fat uptake was observed at this pre-drying time. The pre-dried samples were harder than the non pre-dried samples. Pre-drying did not affect the color attributes of the samples.

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