

## **Effect of cereal fibre on the physico-chemical quality and sensory acceptability of instant fish crackers**

(Kesan serat bijirin terhadap mutu fiziko-kimia dan penerimaan sensori keropok segera)

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Keywords: fishery product, fish snack, high fibre product, oat fibre, wheat fibre, instant fish crackers

### **Abstract**

The effect of adding fibre from wheat and oat on moisture, protein, fat, total dietary fibre (TDF), instrumental texture, instrumental colour and sensory responses of instant fish crackers was studied. The product was prepared by mixing fish meat, starch and other ingredients into a smooth paste, stuffed into casing, cooked, sliced and deep-fried in hot oil until crispy. Adding fibre had no significant effect ( $p > 0.05$ ) on the moisture and protein contents of the product. Addition of fibre from both cereals also had significantly increased ( $p < 0.01$ ) the total dietary fibre content (TDF), decreased ( $p < 0.05$ ) the fat content and significantly increased the hardness value of the product. The mean sensory responses for all attributes decreased significantly ( $p < 0.05$ ) at 5% fibre addition but the product with both fibres remained acceptable up to 8% fibre addition. Instant fish crackers enriched with oat fibre contained 16.0% TDF, 25% fat and 9% protein and the wheat fibre-enriched instant fish crackers contained 16.0% TDF, 28% fat and 8% protein.

### **Introduction**

The modern consumers of today require healthy foods. Deep-fried crispy snacks from tapioca, bananas, rice and fish such as fish crackers, prawn crackers, squid crackers and fish chips are popular in Malaysia. These snacks are rich in carbohydrate, protein and fat. Fish products are good source of protein but lack of fibre. The addition of fibres to fishery products will not only improve the functionality of minced fish products such as surimi products, but also create new functional foods with health benefits (Borderias et al. 2005).

Dietary fibre is the edible parts of plants or analogues carbohydrates that are resistant to digestion and absorption in the human small intestine with complete or partial fermentation in the large intestine (AACC 2001). These includes polysaccharides, oligosaccharides, lignin and associated plant substances. Different plants have different amounts and kinds of fibre such as pectin, gum, mucilage, cellulose, hemicelluloses and lignin. Pectin and gum are water-soluble fibres. Fibres in cell walls are water insoluble. These include cellulose, hemicelluloses and lignin. Such

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fibres increase faecal bulk and speed up the passage of food through the digestive tract (Chen et al. 1998). Wheat bran contains higher insoluble fibre than oat bran (Chen et al. 1998; Yanniotis et al. 2007).

Dietary fibres promote positive physiological effects to human health such as laxation, blood cholesterol reduction and/or blood glucose reduction. Soluble fibre is known for its blood cholesterol lowering effect and insoluble fibre is known to reduce the risk of digestion-related diseases such as colon cancer. Whitehead (1986) and Anderson (1991) reported that an increase of intake of fibre-rich food decreases the risk of colon cancer and reduces the cholesterol level in the blood.  $\beta$ -Glucan from oat is known to reduce the risk of colon cancer and the absorption of glucose in the digestive system (Pomeranz 1988; Potty 1996).

Fibre has the capacity to retard fatty acid absorption and interfere with cholesterol absorption in the bloodstream (Gallaher and Schneeman 1986), hence it could be useful in the treatment of obesity. According to the American Dietetic Association, the current recommended fibre intakes for adults range from 25 to 30 g/day or 10 to 13 g/1,000 Kcal, and the insoluble/soluble ratio should be 3:1 (Borderias et al. 2005). In Europe, daily consumption is recommended at 20 g/person, but in developing countries the range is 60–120 g/day.

Several workers reported the effect of various fibres from different sources such as wheat bran, beet fibre, oat fibre, barley bran and psyllium husk on the quality of high fibre bread (Laurikainen et al. 1998; Sidhu et al. 1999; Wang et al. 2002) and sausages (Cengiz and Gokoglu 2005). However, not many studies on the addition of fibres to fishery products including expanded deep-fried snacks have been reported (Sanchez-Alonso et al. 2007).

Currently, fibres used in the fishery products are mainly in the form of soluble fibres from seaweeds and tubers added for

their functional properties such as high water holding capacity, thickening or gel-forming properties but not to the dietary fibre in those products (Borderias et al. 2005). Kappa-carrageenan had been reported to present better water holding capacity than iota-carrageenan and prevented syneresis in fish gels during freezing/thawing (Da Ponte et al. 1985).

The eating quality of these expanded fried snack foods such as instant fish crackers depend on their crunchiness or linear expansion. The expansion and structure of these products depend on starch gelatinization (Mendonca et al. 2000). The authors reported that the addition of fibre in the form of bran resulted in premature rupture of gas cells which reduces the overall expansion of expanded snack. Yanniotis et al. (2007) also reported that the addition of pectin and wheat fibre decreased the radial expansion and increased the hardness of extruded cornstarch.

The addition of fibre to popular Malaysian traditional fish snack such as fish crackers is envisaged to have a good impact on our health. Traditionally, fish crackers is made by mixing fish meat and starch, formed, cooked, sliced and dried before being deep-fried for consumption. Deep-fried fish crackers contain 8–12% protein and 30–35% fat.

Cereal fibres such as wheat and oat, which have a great proportion of insoluble fibre, contribute towards physiological advantages such as the chewing mechanism, stimulation of intestine function and influence on intestine transit period (Chen et al. 1998; Bollinger 2000). These fibres contain mostly cellulose that have high water and fat binding capacity which are optimal ingredients for achieving high yields and reduced cost (Sanchez-Alonso et al. 2007). The content of 1–3% fibre in certain foods can also reduce lipid retention when these foods are fried (Ang 1993).

Therefore, the aim of this study was to evaluate the effect of adding oat and wheat fibres on the physical, chemical and sensory

acceptability of a deep-fried puffed fish snack, instant fish crackers (IFC).

## Materials and methods

### Raw materials

Fresh fish, red bigeye snapper (*Priacanthus macracanthus*), was purchased from a local fish landing complex. The fish was gutted, cleaned and mechanically deboned to obtain the meat. Fish meat was mixed with 2% sucrose and 0.2% sodium tripolyphosphate in a pestle grinder (Safeworlds, Taiwan) before being packed into 5 kg blocks and blast frozen to  $-20\text{ }^{\circ}\text{C}$  using a blast freezer and kept frozen at  $-18\text{ }^{\circ}\text{C}$  in a cold room until the experiment was conducted. Different batches of about 200 kg fish were purchased for each experiment.

Resistant starch (Nevolose) with 30% total dietary fibre was purchased from National Starch and Chemical (M) Sdn. Bhd. Shah Alam. Polyvinylidene chloride casing was purchased from Mark Aids Sdn. Bhd. Petaling Jaya. Tapioca starch, corn starch, sago flour, wheat flour, cooking oil, spices, salt, sugar and other ingredients were purchased locally.

Two commercial cereal fibres namely oat and wheat fibres were used in this study. Oat fibre (Snowite 300–58) with 94% total dietary fibre and <5% total soluble fibre was purchased from Spectrum Ingredients Pte. Ltd., a distributor in Singapore. This fibre measures about 325  $\mu\text{m}$  long and 58  $\mu\text{m}$  wide. The water absorption capacity is 3.7 g per gramme fibre. Wheat fibre (Vitacel, WF 200) was purchased from Mark Aids Sdn. Bhd. Petaling Jaya. It has 94.5% insoluble fibre, and 2.5% soluble fibre with average fibre length of 250  $\mu\text{m}$  and average fibre thickness of 25  $\mu\text{m}$  (according to the manufacturer). The water absorption capacity is 3.3 g per gramme fibre.

### Preparation of the samples

**Product formulation** Instant fish crackers were prepared using the standard formulation developed earlier (Che Rohani et al. 1997). This basic formulation consisted

of 33.0% fish meat, 36.7% starch, 1.2% salt, 3.0% egg white, 24.5% cold water, 0.8% leavening agent, 0.5% sugar and 0.3% spice mix.

In the first experiment, oat fibre was used as the source of fibre. Fibre was added in the range of 3–10% based on the total weight of fish meat and starch in the formulation. Lots were formulated as follows: control without added fibre (C); 3% fibre (Fib 3); 5% fibre (Fib 5); 8% fibre (Fib 8); 10% fibre (Fib 10). All formulations contained 0.5% resistant starch (Nevolose), added to improve the slicibility of the oat fibre-enriched samples which became slightly tacky without the incorporation of resistant starch. In the second experiment, wheat fibre was used and the levels of fibre addition were similar as above. However, resistant starch was not added to any of the formulations in this experiment.

**Product preparation** Fish meat was mixed with salt, starch and other ingredients to form a smooth and viscous paste using an ice-jacketed pestle grinder (Safeworlds, Taiwan), keeping the temperature of the mix below  $15\text{ }^{\circ}\text{C}$ . The final paste was stuffed into polyvinylidene chloride casing using a sausage stuffer (Dick's, Germany). They were hand-linked, steamed for 45 min in BCS Combi cooker (Henny Penny, USA) to gelatinize the starch, cooled in a chiller overnight, then sliced into 2 mm thickness using a mechanical slicer (Giant Foods, China). The cracker slices were deep-fried at  $150\text{ }^{\circ}\text{C}$  for 3 min, then at  $180\text{ }^{\circ}\text{C}$  for another 3 min in two separate electrical fryers (Pitco Frialator, USA). The samples were then cooled and packed in aluminium bags for evaluation.

Randomized complete block design was applied in this study and all experiments were conducted in two replicates.

### Sample evaluation

The samples were evaluated for protein, fat, moisture, total dietary fibre, instrumental colour, instrumental hardness (breaking

strength), and sensory responses. The moisture, protein and fat contents of all samples were analysed using AOAC methods (AOAC 1990). Total dietary fibre was determined using AOAC method 985.29 (AOAC 2000).

The instrumental hardness analysis was conducted using a Shimadzu EZ-Test Texture Analyzer (Shimadzu, Tokyo, Japan). Measurement of the samples was carried out at room temperature using a cutting test probe with a 20 N load cell applied at a crosshead speed of 50 mm/min. The hardness value was in Newton (1 N = 0.1 kgf).

The colour of the samples was measured using a Minolta Chromameter CR-300 (Japan) for CIE 1976 L\* a\* b\* colour space with standard illuminant D<sub>65</sub> according to manufacturer's guidelines. L\* is the parameter that measures lightness, +b\* the tendency towards yellow and +a\* the tendency towards red.

The sensory attributes of samples were evaluated by 15 trained panellists using a 5-inch horizontal line labelled at both ends. Panellists indicated their responses by marking a slash on the line provided for each attribute (Stone et al. 1974; Che Rohani et al. 2000). The attributes evaluated were crunchiness (0 = very hard, 5 = very crunchy), colour (0 = dark, 5 = yellowish/whitish), taste (0 = not acceptable, 5 = very acceptable) and overall acceptability (0 = dislike very much, 5 = like very much).

The panellists were served with three digit-coded samples and were asked to mark their responses for each sample. Samples receiving sensory responses of less than 2.5 were considered as not acceptable to the panellists.

### Data analysis

Each stage of the experiments was replicated twice. Data were analysed using SAS program (SAS Inst. 2001).

## Results and discussion

### *The influence of fibre on the physical and chemical properties of instant fish crackers*

The effect of oat and wheat fibres on the chemical properties of instant fish crackers (IFC) is shown in *Table 1*. The moisture content in fibre-fortified IFC did not differ significantly ( $p > 0.05$ ) compared to the control samples. The IFC fortified with oat fibre had slightly higher moisture content ranging from 2.2% (C) to 2.5% (Fib 10), while those fortified with wheat fibre had slightly lower moisture content which ranged from 1.2% (C) to 1.7% (Fib 10). This was probably due to the higher initial moisture content in the oat fibre as well as its higher hydration property, hence retained more moisture after frying. The initial moisture content in the oat and wheat fibres used in this study was 10.5% and 6.7% respectively.

The water binding capacity of oat fibre is higher than wheat fibre (Figuerola et al. 2005; Rosell et al. 2009). Rosell et al. (2009) reported that oat fibre had a water binding capacity of 4.79 g water per gramme solid compared to 4.15 g water per gramme solid by wheat fibre. They concluded that hydration property of fibre depended not only on the shape and particle size but also on the chemical structure of the fibre.

The oat fibre used in this study had longer particle size (325  $\mu\text{m}$ ) than the wheat fibre (250  $\mu\text{m}$ ), hence retained more water after frying. According to Ang and Miller (1991), water retention capacity of cellulose increases as fibre length increases. Water retention capacity of fibre varies 2–5% depending on the fibre source (Esposito et al. 2005; Figuerola et al. 2005).

Fibre concentrate from grapefruit was reported to have the highest water retention capacity compared to concentrates from other fruit pomaces and peels used in their study (Figuerola et al. 2005). According to Rosell et al. (2001), the differences in the amount of water absorbed by the fibre is mainly caused by the number of hydroxyl

Table 1. Mean composition of moisture, protein, fat and total dietary fibre in instant fish crackers fortified with oat fibre and wheat fibre (n = 40)

Samples composition/ oat fibre addition	Composition (mean $\pm$ s.d), g in 100 g product			
	Moisture	Protein	Fat	Total dietary fibre
<b>Oat fibre</b>				
0%	1.75 $\pm$ 0.29a	9.44 $\pm$ 0.86a	31.93 $\pm$ 2.04a	5.03 $\pm$ 0.31e
3%	2.22 $\pm$ 0.20a	9.70 $\pm$ 0.72a	31.24 $\pm$ 1.68a	10.51 $\pm$ 0.49d
5%	2.35 $\pm$ 0.77a	9.89 $\pm$ 0.53a	25.90 $\pm$ 0.97b	12.10 $\pm$ 0.27c
8%	2.42 $\pm$ 0.24a	9.20 $\pm$ 0.67a	24.82 $\pm$ 0.58b	15.92 $\pm$ 0.45b
10%	2.55 $\pm$ 0.33a	8.99 $\pm$ 0.23a	23.72 $\pm$ 1.42b	17.40 $\pm$ 0.35a
CV	8.97	4.50	3.50	2.91
<b>Wheat fibre</b>				
0%	1.15 $\pm$ 0.30a	7.35 $\pm$ 0.10b	31.09 $\pm$ 1.68a	2.52 $\pm$ 0.44e
3%	1.17 $\pm$ 0.22a	7.97 $\pm$ 0.36ab	28.10 $\pm$ 2.03ab	5.80 $\pm$ 0.49d
5%	1.30 $\pm$ 0.08a	7.65 $\pm$ 0.06b	26.15 $\pm$ 2.90b	9.83 $\pm$ 1.00c
8%	1.15 $\pm$ 0.46a	7.95 $\pm$ 0.47ab	28.15 $\pm$ 1.17ab	16.03 $\pm$ 0.68b
10%	1.70 $\pm$ 0.33a	8.38 $\pm$ 0.15a	19.15 $\pm$ 2.50c	17.90 $\pm$ 0.36a
CV	8.28	3.22	6.52	10.41

Means followed by a different letter within the same column are significantly different ( $p < 0.05$ )

group that exist in the fibre structure and that allows more water interaction through hydrogen bonding.

The fat content in the C samples from experiment 1 (oat fibre) and 2 (wheat fibre) was 32.0% and 31% respectively. The protein content in oat and wheat fibre-fortified IFC was about 9% and 8% respectively (Table 1). The seasonal variation in the fish composition might have contributed to this slight difference in IFC protein and fat contents since the raw material used in this study was obtained at different time of harvest.

The TDF in the C sample of experiment 1 was higher (5%) than that of experiment 2 (2.5%). This can be explained by the fact that resistant starch (Nevolose), which is also a source of TDF, was added into the formulation in experiment 1 to ease the process of slicing the cooked dough for frying. Sufficient amount of water is required to gelatinize the starch fully during the cooking process (Gomez and Aguilera 1984), otherwise the crackers will not expand satisfactorily during deep-fat frying.

In this study, the amount of water added during IFC preparation was increased by 3.5 g to every gramme of fibre added to

the formulation regardless of their sources. The authors observed that cooked cracker dough containing oat fibre was very sticky and stuck to the slicer blade during slicing. Nevolose was added to minimize the problem. Similar observation was reported by Sudha et al. (2007) when cereal fibres were added to enrich the wheat flour for biscuit making. However, the problem was not encountered in experiment 2 with wheat fibre.

The addition of both oat and wheat fibres had a significant effect on the fat content in IFC. The fat content decreased significantly ( $p < 0.05$ ) with the increased in fibre addition (Table 1 and Figure 1). The fat content in samples enriched with oat fibre decreased significantly ( $p < 0.05$ ) from 32% in the C sample to 24% in sample with 10% added fibre (Fib 10) while those with wheat fibre decreased significantly ( $p < 0.05$ ) from 31% in the C sample to 19% in Fib 10 sample. Figure 1 shows the decreasing trend in fat content of fibre-enriched IFC. The regression equation for oat fibre enriched samples was  $Y = 32.09 - 1.14 * X$  (adjusted  $R^2 = 0.87$ ) and for wheat fibre enriched samples was  $Y = 31.3 - 1.19 * X$  (adjusted  $R^2 = 0.61$ ).

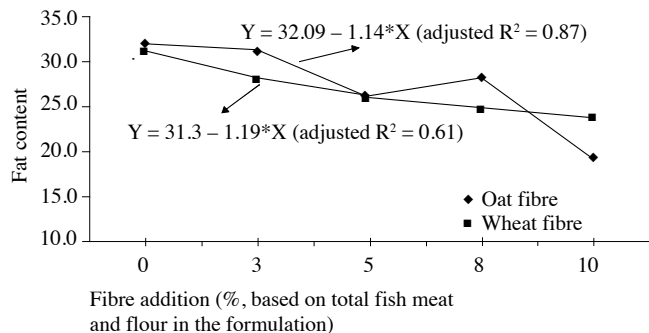


Figure 1. The effect of fibre addition on the fat content in instant fish crackers

A reduction in fat uptake was also reported by Khalil (1999) when pectin and carboxyl methyl cellulose (CMC) were used to coat french fries. The fat uptake was reduced by 40% in french fries coated with pectin and by 50% with CMC. The fat adsorption capacity by the fibres also varies depending on its source (Figuerola et al. 2005). The ability of fibre material, cellulose, to reduce the fat uptake during frying is due to its hydrophilic character (Ang and Miller 1991). Another fibre material, gellan gum added at 0.25% into the formulation of a chickpea Indian traditional deep-fried food called 'sev' had significantly reduced its fat content from 37% in the control sample to 27.9% in the gellan fortified sev (Bajaj and Singhal 2007).

Oil uptake during frying is a surface phenomenon that had been studied by many researchers (Pinthus et al. 1993; Pinthus and Saguy 1994). Deep-fat frying involves mass transfer that influences the moisture removal from the crackers and the absorption of the frying oil into the crackers. The reduction in fat uptake during frying of high fibre IFC can be explained by the decrease in its linear expansion. Fibre has a negative effect on the linear expansion of IFC during frying. Linear expansion resulted in the formation of tiny bubbles within the crackers hence trapping the oil in them. Less expanded products were more compact with less tiny bubbles in them, hence trapping less oil in them (Pinthus et al. 1993; Yanniotis et al.

2007). The linear expansion was greatly reduced at 10% fibre addition.

Debnath et al. (2003) found that chickpea ribbon snack that had been pre-dried before frying absorbed less oil during frying due to the compactness of its microstructure. Therefore, the decrease in fat uptake during frying of IFC was more related to the compactness of IFC microstructures rather than the fibres hydrophilic nature. The fibre-enriched IFC had less oil that can be trapped in the tiny air cells or bubbles in the crackers matrix compared to the control samples which was crispier and had larger air cells. IFC fibre enriched samples were less crispy and required more force to break the pieces as indicated by their lower texture score and higher hardness values as compared to the C samples (Tables 2 and 3). The IFC with 10% wheat fibre hardly expanded on frying and was very hard, thus explained its lowest oil uptake compared to other samples.

The total dietary fibre (TDF) in IFC increased significantly ( $p < 0.05$ ) with fibre addition (Table 1). The TDF content in samples with oat fibre and Nevolose increased from 5% in the C sample to 17% in Fib 10 sample. With wheat fibre, the TDF content increased from 2% in the control to 18% in Fib 10 sample.

Figure 2 shows the increasing trend of total dietary fibre as affected by the fibre addition in the formulation of IFC. The regression equations for TDF increment are

Table 2. Mean instrumental hardness and colour values of instant fish crackers prepared using different fibre sources (n = 150)

Level of fibre addition	Samples enriched with oat fibre				Samples enriched with wheat fibre			
	Hardness values (N)	Colour			Hardness values (N)	Colour		
		L*	a*	b*		L*	a*	b*
0%	13.05 ± 5.63a	64.75a	1.65a	25.77d	12.11 ± 3.36a	61.55b	-0.80a	26.28a
3% level	15.05 ± 6.55ab	62.59ab	2.00a	26.85c	16.73 ± 3.48b	64.62a	-0.09b	28.26b
5% level	18.01 ± 7.72c	64.47a	1.47a	28.58b	17.61 ± 3.71bc	61.64a	2.42d	31.65c
8% level	18.29 ± 6.21c	62.28bc	2.78b	29.41ab	19.53 ± 4.44c	64.45a	1.81c	31.12c
10% level	17.78 ± 6.65cb	60.32c	2.56b	30.09a	22.57 ± 4.26d	60.87b	2.45d	31.32c

Means followed by a different letter within the same column are significantly different ( $p < 0.05$ )

Table 3. Means of sensory scores of the instant fish crackers enriched with oat fibre and with wheat fibre

	Texture	Colour	Taste	Overall acceptability
<b>Oat fibre</b>				
0%	4.1 ± 0.7a	4.0 ± 0.5a	4.0 ± 0.7a	4.1 ± 0.6a
3%	4.2 ± 0.6a	3.9 ± 0.5a	3.9 ± 0.6a	4.0 ± 0.7a
5%	4.0 ± 0.7a	3.6 ± 0.9ab	3.3 ± 0.7b	3.4 ± 0.9b
8%	3.7 ± 0.9ab	3.3 ± 0.8b	3.2 ± 0.9b	3.3 ± 0.8b
10%	3.4 ± 0.9b	3.2 ± 0.8b	3.1 ± 0.8b	3.0 ± 0.9b
<b>Wheat fibre</b>				
0%	4.2 ± 0.6a	4.1 ± 0.6a	4.1 ± 0.6a	4.2 ± 0.5a
3%	4.1 ± 0.6a	4.0 ± 0.5a	4.0 ± 0.5a	4.0 ± 0.5a
5%	3.4 ± 0.9b	3.6 ± 0.5ab	3.6 ± 0.7b	3.4 ± 0.6b
8%	3.4 ± 0.9b	3.7 ± 0.5b	3.5 ± 0.5bc	3.3 ± 0.6b
10%	2.6 ± 0.4c	2.2 ± 0.8c	2.3 ± 0.8c	1.9 ± 0.9c

Means with different letter within the same column are significantly different from each other ( $p < 0.05$ )

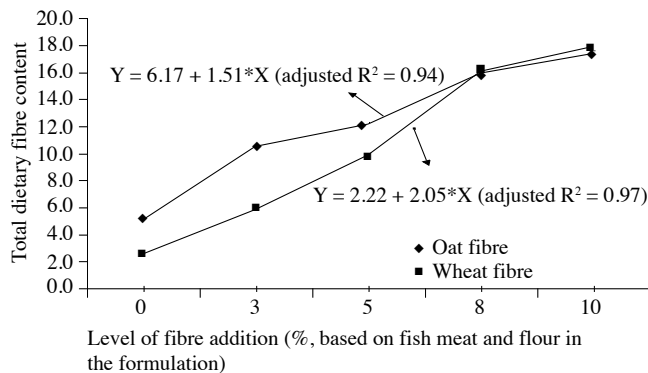


Figure 2. The changes in total dietary fibre content in the instant fish crackers as affected by the level of fibre addition

$Y = 6.17 + 1.51 * X$  for oat fibre enriched samples (adjusted  $R^2 = 0.94$ ) and  $Y = 2.22 + 2.05 * X$  for wheat fibre enriched samples (adjusted  $R^2 = 0.97$ ). The amount of fibre to be added into the formulation to get any intended TDF content can be calculated from these equations.

### ***The influence of fibre on the physical characteristics of instant fish crackers***

Fibre gave significant effect on the colour and texture of the IFC. *Table 2* shows the instrumental breaking strength and  $L^*$ ,  $a^*$ ,  $b^*$  colour of fibre- enriched IFC. The breaking strength or the hardness values increased significantly ( $p < 0.05$ ) with the increase in fibre addition, indicating the products both with oat or wheat fibre became hard and less crispy. The hardness values increased by 38% in IFC fortified with 10% oat fibre and by 83% in product fortified with the same level of wheat fibre. Sudha et al. (2007) and Yanniotis et al. (2007) reported the same increase in textural hardness and breaking strength when cereal fibres were added into baked and extruded snacks respectively. Wheat fibre reduced the cell size and porosity of extruded cornstarch snack resulted in increased hardness (Yanniotis et al. 2007).

The colour of fibre-enriched IFC samples (*Table 2*) was darker than the control as indicated by the significant decrease in lightness ( $L^*$ ) and significant increase ( $p < 0.05$ ) in redness ( $a^*$ ) and yellowness ( $b^*$ ). At levels 5% and below, the wheat fibre gave a nice yellowish colour to the IFC but at higher levels the colour became too dark. The oat fibre-enriched IFC had better colour. Fibre seemed to contribute to the development of brown colour as a result of Maillard reaction during frying. Similar significant decrease in lightness was observed in wheat-based biscuits incorporated with cereal fibres including oat bran and wheat (Sudha et al. 2007).

### ***The influence of fibre on the sensory characteristics of instant fish crackers***

The development of high-fibre crispy and crunchy fish snacks such as IFC poses a great challenge to us. Fibre addition has been reported to negatively affect the sensory properties and overall acceptability of many products such as cookies and fermented sausages (Garcia et al. 2002). Most fibres are known to have a good water retention capacity (Bajaj and Singhal 2007). Colour and texture are two important criteria that determine the acceptability of a food product.

At high levels of fibre addition, the product did not puff on frying and the texture became hard. The addition of oat fibre up to 8% has no significant effect ( $p < 0.05$ ) on the sensorial texture of the product even though the mean score for this attribute decreased slightly (*Table 3*). Oat fibre gave a nutty flavour to the fish crackers which was preferred by the taste panellists. However, at levels more than 5% the textural and colour properties were significantly ( $p < 0.05$ ) affected. The mean score for overall acceptability decreased significantly from 4.1 to 3.4 ( $p < 0.05$ ) after the addition of 5% oat fibre but the results in *Table 3* showed that all samples of IFC enriched with oat fibre up to 10% were still acceptable to the taste panellists. Sample with 3% oat fibre (Fib 3) received comparable mean acceptability score as the control.

*Table 3* shows the mean sensory scores for IFC enriched with wheat fibre. Similar trends as oat fibre enriched samples were obtained. The mean scores for texture, taste and overall acceptability decreased significantly ( $p < 0.05$ ) after the addition of 5% wheat fibre. Only sample with 3% fibre addition received comparable mean scores for texture, taste and overall acceptability as the control. Sample of Fib 10 with wheat fibre was not accepted by the sensory panel for all sensory attributes. This sample was hard, dark in colour and had a bitter taste. The result correlated very well with the



instrumental hardness value and instrumental colour of this sample. The instrumental hardness for this sample was 22.6 N (2.26 kgf).

The changes in texture, colour and taste of fibre-enriched IFC had a negative impact on the overall acceptability of the product. Incorporation of both fibres at levels higher than 5% gave a dry mouthfeel that the overall acceptability of the product was affected. Sudha et al. (2007) also reported similar finding with fibre fortified biscuits. The sensory score for texture, mouth feel and colour decreased with the increase in levels of fibre added to the biscuits. They reported that oat bran can be added up to 30% without affecting the biscuits quality but wheat and barley bran may be used up to only 20%. In this study, instant fish crackers with oat or wheat fibre up to 8% (based on fish meat and starch weight) were still acceptable to the taste panellists.

### Conclusion

Oat and wheat fibres can be incorporated into IFC formulation to produce acceptable fibre-enriched deep-fried snack that contained more than 10% TDF. However, at levels more than 8% the incorporation of both fibres affected the textural, colour and overall acceptability of the product. At 8% fibre addition, IFC enriched with oat fibre and wheat fibre contained 9.0% protein, 25.0% fat, 16% TDF and 8% protein, 28% fat and 16% TDF respectively. These products received means overall acceptability score of higher than 3.0 based on 5-inch unstructured line scale score sheet. Oat fibre gave better product when compared to wheat fibre at the same level of fortification.

Instant fish crackers with up to 3% fibre addition were found to have a sensory quality comparable to product without oat or wheat fibre addition even though the product enriched with wheat fibre was less crispy. Both fibres had also reduced the fat content in fish crackers at 5% fibre addition. The results in this study show that incorporation

of fibre into traditional snack such as fish crackers will help increase the nutritional value of the product.

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### **Abstrak**

Kesan penambahan serat daripada serat oat dan serat gandum terhadap kandungan lembapan, protein, lemak, jumlah serat pemakanan (TDF), tekstur dan warna yang diukur dengan instrumen serta respons sensori keropok segera dikaji. Produk disediakan dengan menggaul isi ikan, tepung kanji serta bahan lain sehingga menjadi pes yang sebatu, diisi ke dalam sarung plastik, dimasak, dihiris dan digoreng sehingga rangup. Penambahan serat tidak memberi kesan yang signifikan ( $p > 0.05$ ) terhadap kandungan lembapan dan protein di dalam produk. Penambahan serat daripada kedua-dua bijirin ini telah meningkatkan kandungan TDF secara signifikan ( $p < 0.01$ ), mengurangkan kandungan lemak di dalam produk secara signifikan ( $p < 0.05$ ) dan meningkatkan nilai kekerasan instrumen bagi produk secara signifikan ( $p < 0.05$ ). Nilai purata respon sensori bagi semua atribut yang dikaji menurun dengan signifikan ( $p < 0.05$ ) dengan penambahan serat pada tahap 5% tetapi produk yang ditambah dengan kedua-dua jenis serat masih diterima baik oleh panel sensori sehingga penambahan 8% serat. Keropok segera yang diperkaya serat oat mengandungi 16.0% TDF, 25% lemak dan 9% protein manakala keropok segera serat gandum mengandungi 16% TDF, 28% lemak dan 8% protein.