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Effect of packaging on the storage quality of fishburger

(Kesan pembungkusan terhadap kualiti penyimpanan burger ikan)

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Key words: fishburger, packaging, storage quality

Abstract

The effect of packaging on the storage quality of fishburger was studied. Three types of packaging used were low density polyethylene (LDPE) bags; polystyrene (PS) trays overwrapped with LDPE film; and polypropylene (PP) semi-rigid containers. Results from analyses of thiobarbituric acid number (TBA), trimethylamine (TMA), total volatile basic nitrogen (TVBN), salt soluble protein (SSP), moisture content; and sensory evaluation showed that fishburgers in all the packagings were acceptable up to 18 weeks storage at –20 ± 2 °C. Fishburgers in polypropylene (PP) semi-rigid containers had the best quality followed by samples in low-density polyethylene (LDPE) bags and polystyrene (PS) trays wrapped with LDPE film.

Introduction

Today's consumers have less time to prepare meals and are becoming more dependent on pre-prepared packaged, convenience foods. Packaging plays a very important role in preserving the quality of products. Packaged foods may suffer chemical, physical and microbiological damage. The most common type of damage is caused by air and more especially by oxygen. Too little or too much moisture is also a common problem of foods. The sources for oxygen and moisture are from the food itself or the atmosphere. Thus, it is important to select packaging materials which restrict, to tolerable levels, the movement of these substances through the package.

Most battered and breaded fish products are sold frozen to ensure a longer shelf life. The factors influencing the quality of frozen breaded fish products are moisture loss, oxidation, rancidity, changes in odour and flavour, loss of volatile flavours, enzymatic activity, loss of vitamins, and protein denaturation (Asean-Canada Fisheries 1994). Therefore, packaging materials should be used to minimize these deteriorative changes throughout storage.

Materials commonly used in the packaging of frozen battered and breaded fish products are plastics and paperboard. The packaging forms commonly used are PP/PS trays overwrapped with PE/PP film; cellophane/PE bags inside a paperboard boxes; wax-coated paperboard boxes; PE-coated paperboard boxes; microwavable paperboard/PET/aluminium foil trays inside a PE-coated paperboard boxes; and bags made of PE film (Asean-Canada Fisheries 1994).

This study was conducted to investigate the effect of LDPE bags; PS trays overwrapped with LDPE cling film, and PP semi-rigid containers on the storage quality of battered and breaded fishburgers.

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Materials and methods

Materials

Fresh *Selaroides leptolepis* (yellow-striped trevally) was purchased from the wet market. Other materials used include mixed vegetables (diced carrots, corn kernels and green peas), potato starch, vegetable oil, fish flavour, salt, pepper, garlic powder, cinnamon powder, monosodium glutamate, wheat flour, corn flour and bread crumbs. Clear low density polyethylene bags (15 cm x 25 cm LDPE bag, 0.08 mm of thickness), polystyrene (PS) tray, low density polyethylene cling film (LDPE, 0.015 mm), and polypropylene (PP) semi-rigid containers were purchased from Lam Seng Plastics Industries Sdn. Bhd. (Malaysia).

Table 1. Formulation of fishburger

Ingredient	%
Paste	
Surimi	63.0
Vegetables mixture	16.0
Potato starch	6.0
Iced water	6.0
Palm oil	3.0
Fish flavour	3.0
Salt	1.2
Pepper	0.5
Garlic powder	0.5
Spices	0.4
Monosodium glutamate	0.2
Cinnamon powder	0.2
Batter	
Wheat flour	30.0
Corn flour	10.0
Water	60.0

Preparation of surimi

The fish were gutted manually, washed and then fed to a mechanical deboner (15 cm horizontal type, Taiwan), the size of the drum perforation being 3 mm. The minced fish meat was washed twice in diluted saline at concentration of 0.2% and 0.3% respectively for 15 min. The ratio of minced meat to iced saline water (10–15 °C) was 1:4. The minced meat was washed by stirring for 5 min. When settled, the water was decanted and drained through a nylon mesh. Excess water was spun off until the final moisture content was 80–82%. The washed minced meat was then thoroughly mixed with 2.5% sucrose, 2.5% sorbitol and 0.2% sodium tripolyphosphate. The paste was packed as 1 kg blocks in clear LDPE bags (0.08 mm thick), blast frozen at –25 °C and stored at –20 ± 2 °C for preparation of fishburger.

Preparation of fishburger

Fishburgers were prepared according to the formulation developed by Siah and Yu (1998). The semithawed surimi was ground with a food processor (National, model MK-5070N). The ground surimi was then mixed with ingredients as shown in *Table 1* (Kenwood, Model SM-210). Mixed paste weighing approximately 65 g was formed using a burger former (Safe World Enterprise Sdn. Bhd., Malaysia). In order to facilitate handling, the fishburgers were blast frozen to –25 °C before battering and breading. Five pieces of breaded fishburgers were then packed into each type of packaging. LDPE bags were tied up with cellophane tape, PS trays overwrapped with LDPE cling film (PS trays +LDPE film) using a Heat Sealing Machine (Model701-U, Japan), and PP semi-rigid containers were heat sealed using a foot-operated impulse heat sealer. The fishburgers were stored at –20 ± 2 °C for 18 weeks and analyses were carried out at week 0, 2, 4, 6, 8, 10, 12, 14, 16 and 18.

Chemical analyses

The rancidity development was determined by thiobarbituric acid (TBA) number test according to the method of Tarladgis et al. (1964). Triplicate aliquots of homogenate were used for determination of TBA number which is expressed as mg of malonaldehyde per kg of sample. Trimethylamine (TMA) and total volatile basic nitrogen (TVBN) were determined using Conway's Method as described by Ng (1987). Salt soluble protein was determined according to Lim (1987).

A 10-g sample was blended with 200 ml 0.5 M KCl phosphate buffer solution with the homogenizer for 4 min and left to stand in iced water for 2 h. The blended sample was centrifuged at 9,000 rpm at 5 °C for 20 min. A sample of 20 ml supernatant was pippeted for digestion according to Kjeldahl method.

Moisture content

Moisture content was determined according to AOAC (1984). Minced samples weighing 2.5 g were dried in dry crucibles in convection oven at 105 °C for 16 h, cooled and weighed. The samples were reheated, cooled and weighed until constant weight was obtained. Calculation was based on wet basis.

Sensory evaluation

Sensory evaluation was performed by 15 experienced panellists. Fishburgers were fried in hot oil (175 °C) for 4 min and then cooled down at room temperature for 3 min. The panellists were asked to evaluate the taste, texture, colour, juiciness and overall acceptance of the fried burgers using a 9-point Hedonic Scale (Kosmark 1986) with 1 designating extremely unacceptable and 9 extremely good.

Statistical analysis

Data from three replications were analysed statistically using the Analysis of Variance Method at 5% level (ANOVA). The Duncan Multiple Range Test (DMRT) was used to determine significant differences. The statistical program used was the Statistical Analysis System (SAS).

Results and discussion

Thiobarbituric acid (TBA) number

The TBA number of fishburgers showed significant differences (p <0.05) among PS trays + LDPE film and PP semi-rigid containers *(Figure 1)*. Fishburgers packed in PS trays + LDPE film had the highest increase in TBA, followed by fishburgers in LDPE bags. Samples in PP semi-rigid containers had the lowest increase. Results obtained reflect the characteristics of the packaging materials used. According to Asean-Canada Fisheries (1994), LDPE has a higher oxygen transmission rate (7,500 cc/m^2/day), compared with PP (2,320 cc/m^2/day). PS has a lower transmission rate (1,500 cc/m^2/day), but PS + LDPE film packaging showed the highest rate of rancidity due to the highly permeable characteristics of LDPE film especially the cling film used which had a thickness of 0.02 mm only.

As storage time increased, TBA increased significantly. At 0 week, the TBA

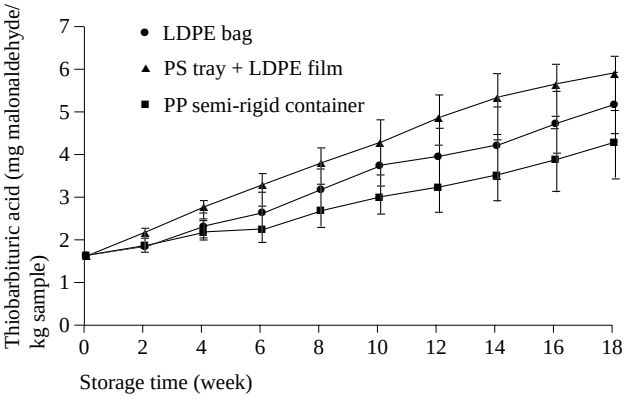

Figure 1. Changes in thiobarbituric acid number of fishburgers during storage

value in all samples was 1.63 mg malonaldehyde/kg sample. At the 18th week, TBA in LDPE bag was 5.18; 5.91 for fishburgers in PS trays + LDPE film; and 4.29 for samples in PP semi-rigid containers. The increase in TBA is due to oxidative rancidity. Frozen storage does not stop oxidation of lipids. Fish, with a higher degree of unsaturated lipids than most other foods, are more susceptible to oxidative rancidity (Kurade and Baranowski 1987). According to the same authors, lipid oxidation in fish is also influenced by factors such as the amount of lipids, their susceptibility to autoxidation; the level of microsomal associated lipid oxidation system present, level of heme compounds, and the presence of metal ions.

Although the TBA values increased significantly throughout storage, sensory panellists rated taste and overall acceptability at an acceptable level (score more than 5) at 18th week of storage *(Table 2)*.

Trimethylamine (TMA)

Trimethylamine oxide (TMAO) is a natural component in muscles and many organs of marine fish and invertebrates (Connell and Shewan 1980). Since many microorganisms reduce TMAO to the fishy smelling component trimethylamine (TMA), the TMA content is often used as an indicator of staleness (Babbitt et al. 1972).

The effect of packaging and storage time on the formation of TMA is shown in *Figure 2*. Overall, fishburgers packed in PP semi-rigid containers had the lowest level of TMA followed by LDPE bags and PS trays + LDPE film.

TMA levels in the samples also increased significantly ($p < 0.05$) with increase in storage time from week 0 to week 18. The TMA level of 1.02 mg% at week 0, increased to 4.21 mg% for samples in LDPE bags, 4.56 mg% for PS trays + LDPE film, and 3.67 for PP semi-rigid containers at week 18. However, this was considered as acceptable to sensory panellists *(Table 2)*.

Total volatile basic nitrogen (TVBN)

The type of packaging materials had significant effect on the formation of TVBN *(Figure 3)*. Samples in PP semi-rigid containers had the best stability, followed by samples in LDPE bags. Samples in PS trays + LDPE film showed least stability.

TVBN levels increased significantly throughout the storage period. At week 0, TVBN level was 2.32 mg% and increased to 5.62 mg% for samples in LDPE bags, 6.30 mg% for PS trays + LDPE film, and 5.40 mg% for fishburgers in PP semi-rigid containers at week 18. The amount of TVBN increases as spoilage progresses due to bacterial activities. Eskin et al. (1971) and Chichester and Graham (1973) reported that

Table 2. Colour, taste, texture, juiciness and overall acceptability of fishburger

Storage time (weeks)	LDPE bag	PS tray + LDPE film	PP semi-rigid container
Colour acceptability			
0	8.24a A	8.20a A	8.22a A
2	8.19a A	8.21a A	8.20a A
4	8.12ab A	8.15ab A	8.14ab A
6	8.10ab A	8.13ab A	8.15ab A
8	8.11ab A	8.09ab A	8.10ab A
10	8.09ab A	8.04b A	8.09ab A
12	8.05b A	8.06b A	8.07b A
14	8.02b A	8.03a A	8.04b A
16	8.00b A	8.06b A	8.04b A
18	8.05b A	8.06b A	8.04b A

(cont.)

Table 2. *(cont.)*

Taste acceptability			
0	7.43a A	7.49a A	7.40a A
2	7.36ab A	7.42a A	7.32ab A
4	7.18b A	7.20ab A	7.23b A
6	7.00b A	6.89b A	6.93c A
8	6.82bc A	6.81b A	6.84cd A
10	6.73c A	6.75bc A	6.71d A
12	6.66c A	6.69c A	6.68d A
14	6.51d A	6.49d A	6.53e A
16	6.42de A	6.40d A	6.44ef A
18	6.28e A	6.31e A	6.29f A
Texture acceptability			
0	7.24a A	7.26a A	7.25a A
2	7.08ab A	7.04 b A	7.11ab A
4	7.00b A	6.94b A	7.03b A
6	6.97bc A	6.79c B	6.98b A
8	6.92c A	6.72c B	6.94bc A
10	6.88c A	6.66cd B	6.87c A
12	6.80cd A	6.43d B	6.83c A
14	6.63d A	6.14e B	6.61d A
16	6.47e A	5.91ef B	6.49de A
18	6.32f A	5.78f B	6.34e A
Juiciness			
0	7.36a A	7.38a A	7.37a A
2	7.28a A	7.28a A	7.30a A
4	7.14ab A	7.08ab A	7.21ab A
6	7.06b AB	6.94b B	7.15ab A
8	6.92bc B	6.72c C	7.08b A
10	6.78c B	6.58d C	6.92bc A
12	6.71c B	6.52d C	6.88bc A
14	6.63d B	6.41de C	6.76c A
16	6.60d B	6.35e C	6.72c A
18	6.34e B	6.21f C	6.64d A
Overall acceptability			
0	7.28a A	7.26a A	7.28a A
2	7.23a A	7.24a A	7.25a A
4	7.18a A	7.14a A	7.16a A
6	7.03a A	7.08a A	7.01a A
8	6.69b A	6.69b A	6.68b A
10	6.47b A	6.41b A	6.43b A
12	6.33bc A	6.32bc A	6.34bc A
14	6.26c A	6.23c A	6.26c A
16	6.23c A	6.21c A	6.20c A
18	6.15d A	6.16d A	6.16d A

a–f = Means bearing the same letter within the same column are not significantly different at 5% level
A–C = Means bearing the same letter within the same row are not significantly different at 5% level

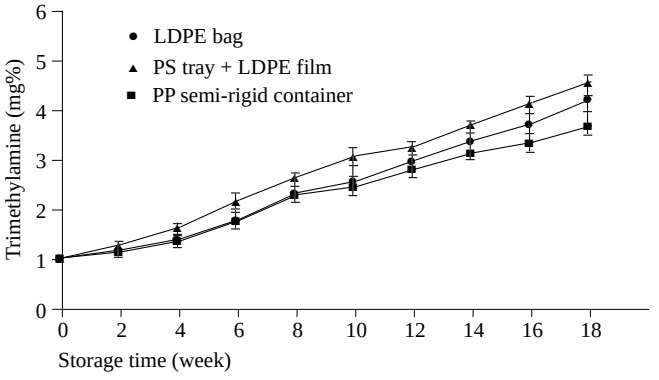

Figure 2. Changes in trimethylamine of fishburgers during storage

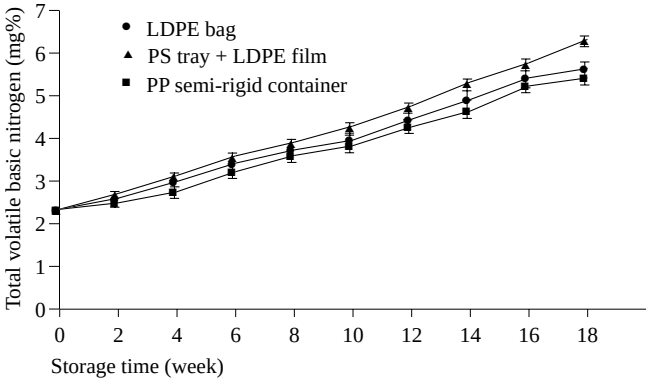

Figure 3. Changes in total volatile basic nitrogen of fishburgers during storage

metabolites from enzymatic changes in the fish contribute to bacterial growth. The main spoilage process involve bacterial metabolism of low molecular weight compounds in fish muscle to yield a variety of unpleasant flavour and odour compounds. Microbial degradation of amino acids can yield volatile bases such as diamines, cadaverine and putrescine as well as ammonia and the monoamine histamine (Eskin et al. 1971; Tabor and Tabor 1976; Mietz and Karmas 1977). The fishburgers were acceptable up to 18 weeks of storage and the TVBN level did not exceed 20 mg% as recommended by Connell (1980).

Salt soluble protein (SSP)

Results showed that types of packaging used had significant effect on the extractability of myofibrillar protein *(Figure 4)*. There was a decrease in the levels of SSP during frozen storage at –20 ± 2 °C. At week 0, the SSP level for all samples were 17.22 mg%, and it decreased significantly throughout the storage period to 15.20 mg% for sample in LDPE bags; 14.87 mg% for PS trays + LDPE film; and 15.31 mg% for PP semi-rigid containers. Protein was denatured during frozen storage and this may affect gel properties. The level of SSP is an important indicator of quality. Sorensen (1976) has shown that to ensure satisfactory binding in heat-gelled products, a minimum level of 8.5–11 mg% SSP is required.

Moisture content

After 18 weeks of storage, samples in PS trays + LDPE film had the lowest moisture content (78.57%), followed by samples packed in LDPE bags (78.82%), and samples in PP semi-rigid containers had the highest level (79.06%) *(Figure 5)*. Results

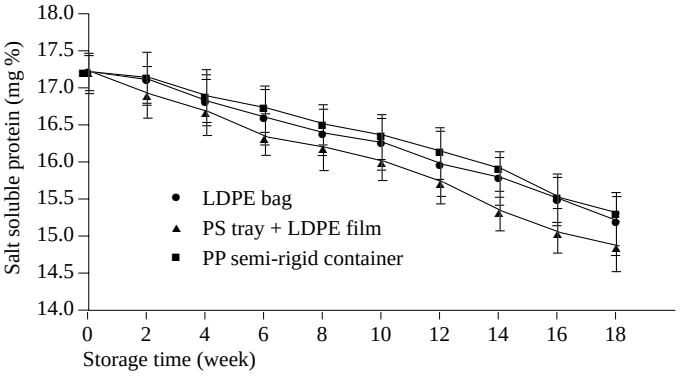

Figure 4. Changes in salt soluble protein of fishburgers during storage

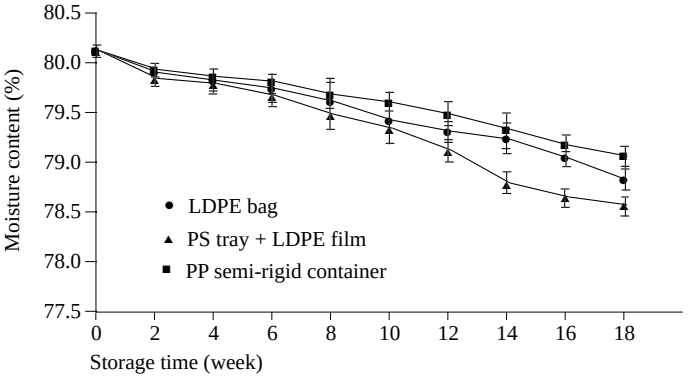

Figure 5. Changes in moisture content of fishburgers during storage

agreed with the moisture vapour transmission rate of the packaging materials used. According to Asean-Canada Fisheries (1994), PP has a transmission rate of 6–10 g/ml/day, LDPE has 18–23 g/ml/day, and PS 78-132 g/ml/day. Results from sensory evaluation also showed that scores for juiciness decreased with increase in storage time.

Sensory evaluation

In terms of taste, colour and overall acceptability, there were no significant differences for the three types of packaging material used, but texture and juiciness were significantly different *(Table 2)*. For these two attributes, panellists gave the lowest score for fishburgers packed in PS trays + LDPE film.

There was a significant effect of storage time on the sensory qualities of fishburgers. The scores for all sensory attributes decreased significantly. The highest decrease was for fishburgers packed in PS trays + LDPE film and the least for PP semi-rigid containers packed fishburgers. Overall, all samples were acceptable after 18 weeks (scores more than 5).

Conclusion

Fishburgers in PP semi-rigid containers showed the best storage quality, followed by fishburgers in LDPE bags while fishburgers in PS trays + LDPE film showed the lowest quality. Fishburgers in all three types of packaging were acceptable by panellists after 18 weeks of storage at –20 ± 2 °C.

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Abstrak

Kesan pembungkusan terhadap kualiti penyimpanan burger ikan telah dikaji. Tiga jenis pembungkus yang digunakan ialah beg polietilena ketumpatan rendah (LDPE); dulang polistirena (PS) dengan balutan filem polietilena ketumpatan rendah (LDPE); dan bekas polipropilena (PP) separa tegar. Keputusan yang diperoleh daripada ujian nilai asid tiobarbiturik (TBA), trimetilamina (TMA), jumlah nitrogen meruap (total volatile basic nitrogen, TVBN), protein larut garam (SSP), kandungan lembapan, dan penilaian rasa menunjukkan bahawa burger ikan di dalam semua jenis pembungkus masih boleh diterima selepas 18 minggu penyimpanan pada suhu –20 ± 2 °C. Burger ikan di dalam bekas PP separa tegar mempunyai kualiti penyimpanan yang paling baik, diikuti dengan sampel yang dibungkus di dalam beg LDPE, dan sampel di dalam dulang PS dengan balutan filem LDPE.

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