Effects Of Type And Quantity Of Flours Used On The Quality Of Frozen Fish Balls

JIRAWAN YAMPRAYOON, POONSAP VIRULHAKUL and SOMKIAT PUNTHURA

Fishery Technological Development Division
Department Of Fisheries
Bangkok, Thailand

Abstract

Fish balls were produced from thread-fin-bream based surimi. Three types and quantities of flours were used in this study: tapioca flour, Purity 4 and National Frigex. Three, 5 and 8% were added during kneading. The cooked fish balls were then frozen by nitrogen tunnel and stored at -18°C in order to determine their quality during storage. Samples were removed to determine total viable count (TVC), total volatile base (TVB), gel strength, drip loss, moisture and protein content and for sensory assessment. The addition of 8% National Frigex reduced drip loss up to 50% compared to control samples (fish balls without addition of flour) and gave better results than the use of tapioca flour. Type and quantity of modified starches did not affect general appearance, surface, succulence, texture, glossiness and flavour of the fish ball samples. The samples stored more than 60 days caused outer surface dryness and reduced glossiness resulting in unacceptability by the panelists.

Introduction

Fish balls are popular minced fish-based products in the Southeast Asian region especially in Thailand and Singapore. Good quality fish balls should possess white colour, no fish smell and soft-but-elastic texture.

Fish balls are perishable, thus they must be stored at low temperature in order to retard bacterial growth. Yamprayoon, Suwansakornkul and Kiatkungwalkrai (1980) studied the quality of fish balls during storage at various temperatures; the results revealed that the samples could be kept for 1 and 7 days at 30°C and 4°C respectively. However, the texture of fish balls stored at between -9°C and -18°C became sponge-like and dry because of an expansion of ice crystals during frozen storage which subsequently damaged the texture of the products. When the frozen products were thawed, dramatic drip loss could occur (Lawrence, *et al*, 1986).

Freezing is known to be the best method of preserving food since it inhibits bacterial growth. However, an important problem always encountered is the subsequent damage of food texture. The quality of frozen food depends on the rate of freezing. The size of the ice crystals is directly related to freezing methods. If slow freezing is employed, it causes the formation of very large and sharp ice crystals resulting in damaged texture of the products. The most rapid freezing method is the use of liquid nitrogen (Love, 1968).

In the past, flours were used in fish balls to thicken the texture and as a source of carbohydrate, but they are now used extensively as stabilizers, texturizers, water or fat binders and emulsifiers. They also increase gel strength and freezing-thaw stability of the products if appropriate modified

---

Note: This paper was presented at the Seminar by Mrs Jirawan.

starches are added at proper content (Luallon, 1985).

The objectives of this study are to determine the appropriate type and quantity of flours to be used in frozen fish balls and to study the quality of frozen fish balls during storage.

Materials And Methods

Frozen surimi made of threadfin bream containing 4% sorbital and 4% sucrose as cryoprotectant was used to produce fish balls.

Various types and quantities of flours were added, as follows:

- 0, 3, 5 and 8% tapioca flour
- 0, 3, 5 and 8% of National Frigex (modified tapioca starch, freeze thaw stability 7-8 cycle), purchased from National Starch and Chemical Corporation, and
- 0, 3, 5 and 8% of Purity 4 (modified tapioca starch, freeze thaw stability 3-4 cycle), purchased from National Starch and Chemical Corporation.

Therefore, there were 10 treatments to be studied.

The frozen surimi was thawed at room temperature for two hours and then cut into pieces by a silent cutter. The following flow chart shows the fish ball production process (Chart 1).

The fish balls were frozen in a nitrogen tunnel. The temperature of nitrogen during spraying was -170°C, tunnel temperature was between -50°C and -60°C and freezing time was 10-12 min per sample.

Two hundred grams of frozen fish balls were packed in a 7" x 9" polypropyrene bag and stored in a freezer at -18°C to study their quality during frozen storage.

Chemical and microbiological analyses:

- The fish balls prior to freezing and after freezing at week 0 and week 10 were analyzed for protein content (AOAC, 1980) and total viable count TVC (ICMSF, 1978).

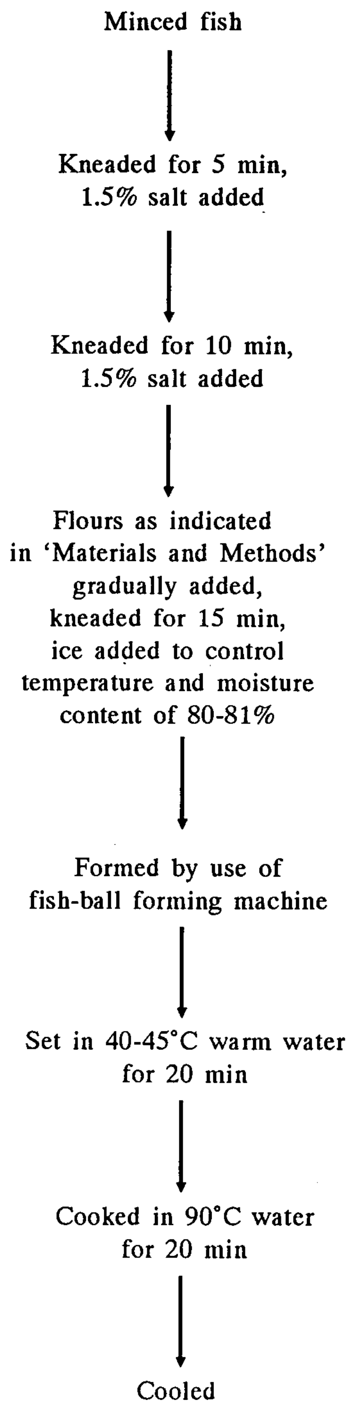

Chart 1. Fish ball production method and procedure.

The samples were removed every fortnight to determine

- Total volatile bases (Uchiyama, 1978).
- Moisture content (AOAC, 1980).
- Gel strength (MFRD, 1979).
- Drip index (Jiang, N.D.).

Sensory Assessment : Eight members of a trained sensory panel were asked to describe the appearance, texture and flavour of the fish ball samples using the hedonic scale.

Statistical Analysis : Results for individual treatments were pooled for statistical analyses using a statistical analysis system (SAS) of Bar *et al* (1976). Analysis of variance and Duncan's New Multiple Range Test were performed with significance accepted at 5% level of probability ($P \leq 0.05$).

Results And Discussion

Tables 1 and 2 show effects of the type of flours on the frozen fish balls during storage. It was found that tapioca flour, Purity 4 and National Frigex did not affect TVB value, protein and moisture contents and gel strength of the samples but that they did affect drip loss. The drip loss was significantly affected ($P \leq 0.05$) by flour type. The frozen fish balls containing National Frigex had the lowest drip loss after thawing (Fig.1). This indicates that flours which have been modified are better than normal flours in this aspect.

For sensory evaluation, eight trained panelists judged that flour type did not affect general appearance, gel strength, outer surface, succulence, texture, glossiness, cut surface and flavour of the samples but did affect hardness.

The hardness of samples containing tapioca flour and Purity 4 were not significantly different but they were found to be harder than the sample containing National Frigex. Flour types did not affect the flavour of fish ball samples as shown by the scores, nor did the TVC which possessed the average of 6.9×10^3 colonies/gram sample.

Tables 1 and 2 show that the flour contents used viz. 0, 3, 5 and 8%, did not affect moisture content since during the fish ball processing, the moisture content was adjusted to maintain 80-81%. Protein contents were reduced in the fish balls containing more than 5% flours but remained constant in the samples containing no more than 3% flours.

The higher the content of flours added, the less the drip loss (Fig.1). It can be concluded that 8% flour gave the best result. Presumably, the flour molecules were attached to the myofibrillar protein molecules after the heating process, resulting in an increase of capability to retain water after thawing. This is in accordance with the study of Jiang (N.D.).

In the sensory evaluation, the percentages of flours used did not significantly affect texture and cut surface score of the samples. The samples containing flours showed better attributes ie, outer surface smoothness, glossiness and succulence than the samples without additional flour; however, levels of the flours added did not significantly affect the score given by the panelists. The samples with additional flours were judged harder but less elastic than the control. Types and contents of flours added did not affect elasticity score; nor did the results given by Rheometer (Table 1). Possibly the flours used contained quite the same amylose. Amylose in flours gives elasticity to food products, hence different amylose content will affect the products' texture (Laullen, 1985). The samples containing flours were more acceptable in flavour than the control sample; presumably, the flours have masked or reduced fish smell.

TVC were not significantly different at any levels of the flours added.

The frozen fish balls stored at -18°C and sampled fortnightly for about 75 days showed no significant difference in gel strength measured by Rheometer (Table 1 and Fig. 2). There were contradictory to sensory assessment results which showed the fish balls kept for more than 40 days were scored as significantly different ($P \leq 0.05$) from the samples kept for 60 and 75 days (Fig. 3). The drip loss of the fish balls before freezing and after freezing and storage for 2 days up to 75 days were significantly different. The longer the storage time, the higher the drip loss after thawing (Fig. 1). The addition of modified starches helped

Table 1. Pooled mean TVB, protein, moisture, drip loss, gel strength and TVC against type and quantity of additional flours and storage time of frozen fish balls.

Treatment	TVB (mg%)	Protein (%)	Moisture (%)	Drip Loss (%)	Gel Strength g/cm	Total Viable Count (colony/g)
Type of Flour						
- Tapioca flour	3.35±0.78^{a}	11.09±1.35^{a}	80.58±1.18^{a}	9.98±3.12^{a}	452.01±145.00^{a}	6.9x10^{3}±10.30^{a}
- Purity 4	3.33±0.73^{a}	11.24±1.22^{a}	80.17±1.13^{a}	7.97±3.24^{b}	450.01±139.82^{a}	6.6x10^{3}±9.80^{a}
- National Frigex	3.41±0.77^{a}	11.21±.211^{a}	80.13±1.28^{a}	6.88±3.45^{c}	449.57±139.60^{a}	7.1x10^{3}±9.80^{a}
Quantity of flour						
- 0 %	3.59±0.76^{a}	11.78±2.02^{a}	81.03±1.41^{a}	11.05±2.92^{a}	665.67±76.47^{a}	3.1 x10^{3}±11.20^{a}
- 3 %	3.17±0.60^{bc}	11.42±0.96	80.56±0.79^{a}	9.20±2.87^{b}	395.40±68.02^{b}	3.9 x10^{3}±10.80^{a}
- 5 %	3.37±0.87^{ac}	10.93±0.72^{b}	80.36±0.86^{a}	7.10±2.88^{c}	360.86±69.92^{b}	3.1 x10^{3}±10.12^{a}
- 8 %	3.77±0.72^{a}	10.59±0.41^{b}	81.23±0.88^{a}	5.72±3.06^{d}	378.63±61.56^{b}	3.1 x10^{3}±11.16^{a}
Storage Time (Days)						
- 0	2.83±0.66^{a}	11.53±0.98^{a}	79.93±0.68^{a}	4.80±2.13^{a}	459.17±142.32^{a}	2.35x10^{3}±9.23
- 2	3.07±0.44^{ab}	11.01±0.88^{a}	81.35±1.18^{a}	6.30±1.75^{b}	412.61±106.30^{bc}	1.22x10± 9.21
- 15	3.28±0.59^{bc}	-	81.83±1.16^{a}	6.45±2.15^{b}	443.42±173.17^{ac}	-
- 28	3.50±0.78^{c}	-	79.76±0.39^{a}	8.75±3.47^{c}	450.92±158.72^{a}	-
- 42	3.30±0.61^{c}	-	80.00±0.97^{a}	10.31±3.63^{d}	440.28±152.27^{a}	-
- 60	4.19±0.82^{e}	-	79.92±0.66^{a}	10.36±3.42^{d}	476.53±120.38^{a}	-
- 75	3.39±0.57^{c}	11.00±0.94^{a}	79.28±0.67^{a}	10.82±2.83^{f}	468.22±139.26^{a}	6.6 x10^{3}±8.24

a, b, c, d, e, f: Means in the same variable with different superscripts are different ($P \leq 0.05$).

Table 2. Pooled mean sensory score against type and quantity of additional flours and storage time of frozen fish balls.

Treatment	Score								
	Outer Surface	Gel Strength	Hardness	Appearance	Succulence	Texture	Glossiness	Cut Surface	Flavour
Type of Flour									
- Tapioca flour	3.08 ± 0.73^{a}	3.73 ± 0.71^{a}	3.39 ± 0.92^{a}	3.87 ± 1.12^{a}	3.17 ± 0.75^{a}	3.95 ± 0.58^{a}	3.08 ± 0.73^{a}	3.23 ± 0.71^{a}	3.36 ± 0.49^{a}
- Purity 4	3.10 ± 0.73^{a}	3.73 ± 0.71^{a}	3.28 ± 0.83^{ac}	3.89 ± 1.11^{a}	3.13 ± 0.76^{a}	3.91 ± 0.59^{a}	3.10 ± 0.73^{a}	3.73 ± 0.71^{a}	3.38 ± 0.49^{a}
- National Frigex	3.15 ± 0.73^{a}	3.77 ± 0.72^{a}	3.20 ± 0.78^{bc}	3.88 ± 1.11^{a}	3.07 ± 0.72^{a}	3.94 ± 0.56^{a}	3.15 ± 0.73^{a}	3.77 ± 0.72^{a}	3.37 ± 0.48^{a}
Quantity of flour									
- 0 %	2.82 ± 0.66^{a}	8.13 ± 1.17^{a}	2.90 ± 0.89^{a}	3.75 ± 1.10^{a}	2.89 ± 0.65^{a}	3.86 ± 0.61^{a}	2.82 ± 0.66^{a}	3.68 ± 0.77^{a}	3.23 ± 0.48^{a}
- 3 %	3.19 ± 0.70^{b}	7.84 ± 0.96^{b}	3.56 ± 0.84^{b}	3.89 ± 1.11^{b}	3.20 ± 0.73^{b}	3.92 ± 0.54^{a}	3.19 ± 0.70^{b}	3.75 ± 0.72^{a}	3.42 ± 0.49^{b}
- 5 %	3.21 ± 0.77^{b}	7.79 ± 1.07^{b}	3.50 ± 0.76^{b}	3.94 ± 1.11^{b}	3.27 ± 0.80^{b}	3.98 ± 0.57^{a}	3.21 ± 0.77^{b}	3.77 ± 0.69^{a}	3.41 ± 0.48^{b}
- 8 %	3.21 ± 0.71^{b}	7.84 ± 1.17^{b}	3.21 ± 0.74^{c}	3.94 ± 1.12^{b}	3.14 ± 0.77^{b}	3.98 ± 0.58^{a}	3.21 ± 0.71^{b}	3.79 ± 0.66^{a}	3.42 ± 0.99^{b}
Storage Time (Days)									
- 0	3.57 ± 0.50^{a}	8.62 ± 0.75^{a}	3.90 ± 0.63^{b}	4.68 ± 0.47^{a}	3.44 ± 0.79^{acd}	4.53 ± 0.46^{a}	3.57 ± 0.80^{a}	4.49 ± 0.50^{a}	3.60 ± 0.40^{a}
- 2	3.69 ± 0.49^{ac}	8.10 ± 0.65^{c}	3.67 ± 0.68^{c}	4.81 ± 0.58^{ab}	3.58 ± 0.50^{a}	4.28 ± 0.56^{b}	3.69 ± 0.49^{a}	3.89 ± 0.55^{b}	3.64 ± 0.48^{a}
- 15	3.17 ± 0.58^{b}	8.20 ± 0.94^{c}	3.46 ± 0.78^{dc}	4.54 ± 0.58^{ac}	3.30 ± 0.60^{ce}	3.90 ± 0.45^{ch}	3.17 ± 0.58^{b}	3.97 ± 0.60^{b}	3.31 ± 0.46^{b}
- 28	3.17 ± 0.58^{b}	8.29 ± 0.94^{c}	3.46 ± 0.78^{d}	4.54 ± 0.58^{ac}	3.30 ± 0.60^{de}	3.90 ± 0.45^{dh}	3.17 ± 0.58^{b}	3.97 ± 0.60^{b}	3.31 ± 0.46^{b}
- 42	2.91 ± 0.81^{d}	8.21 ± 1.06^{c}	3.08 ± 0.79^{e}	3.79 ± 0.61^{d}	2.88 ± 0.72^{be}	3.82 ± 0.39^{ehi}	2.91 ± 0.82^{d}	3.56 ± 0.54^{c}	3.32 ± 0.51^{b}
- 60	2.78 ± 0.71^{d}	6.90 ± 0.91^{d}	3.17 ± 0.80^{e}	2.51 ± 0.42^{e}	2.83 ± 0.82^{b}	3.72 ± 0.45^{fi}	2.78 ± 0.72^{e}	3.47 ± 0.58^{c}	3.22 ± 0.01^{b}
- 75	2.47 ± 0.53^{e}	6.88 ± 0.90^{d}	2.29 ± 0.37^{f}	2.28 ± 0.30^{f}	2.54 ± 0.58^{f}	3.39 ± 0.49^{g}	2.47 ± 0.53^{f}	2.88 ± 0.33^{d}	3.22 ± 0.41^{b}

a, b, c, d, e, f, g, h, i: Means in the same variable with different superscripts are different ($P\leq0.05$).

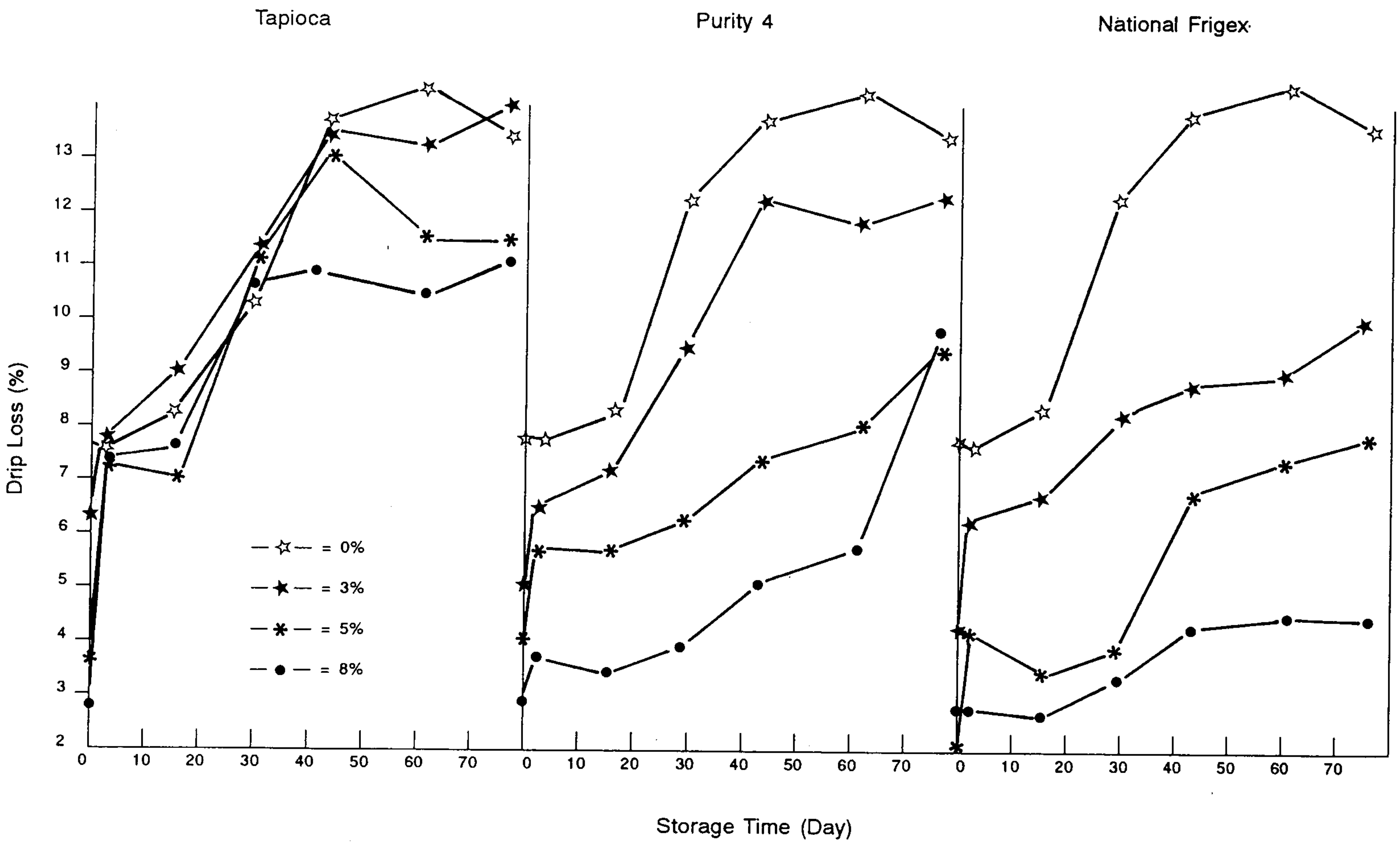

Fig. 1. Effect of type and quantity of flour on drip loss of fish balls during frozen storage.

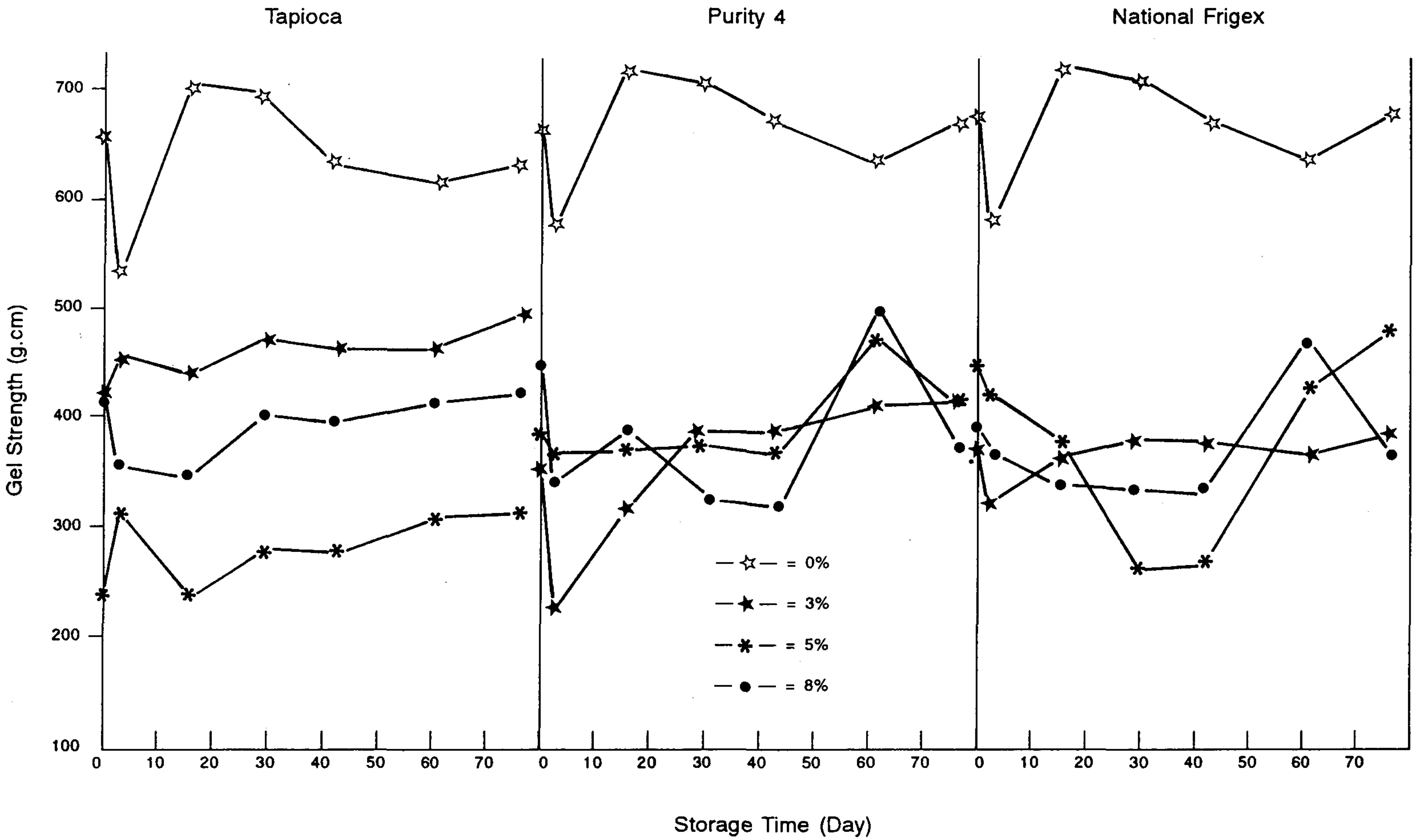

Fig. 2. Effect of type and quantity of flour on gel strength of fish balls during frozen storage (rheometer scores).

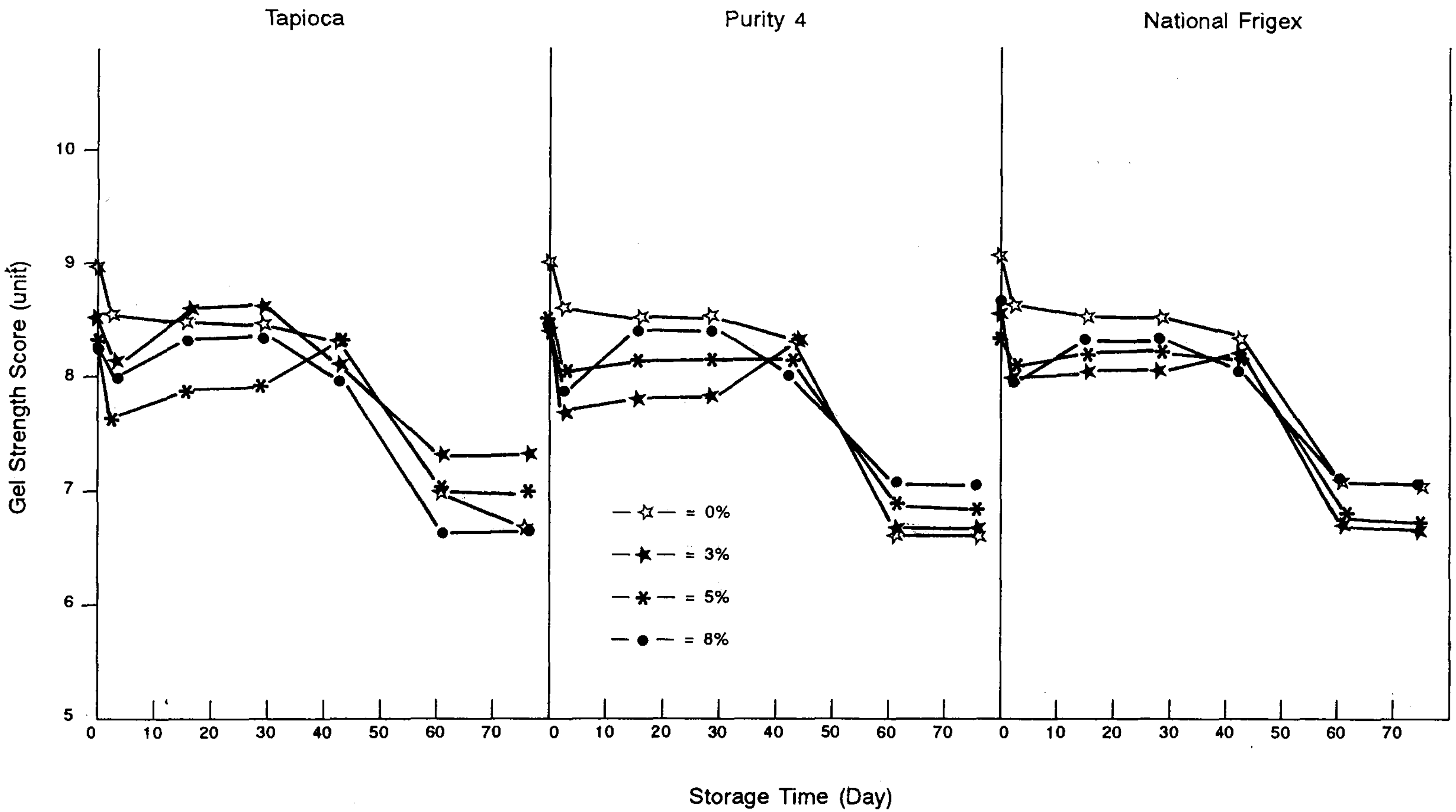

Fig. 3. Effect of type and quantity of flour on gel strength of fish balls during frozen storage (organoleptic scores).

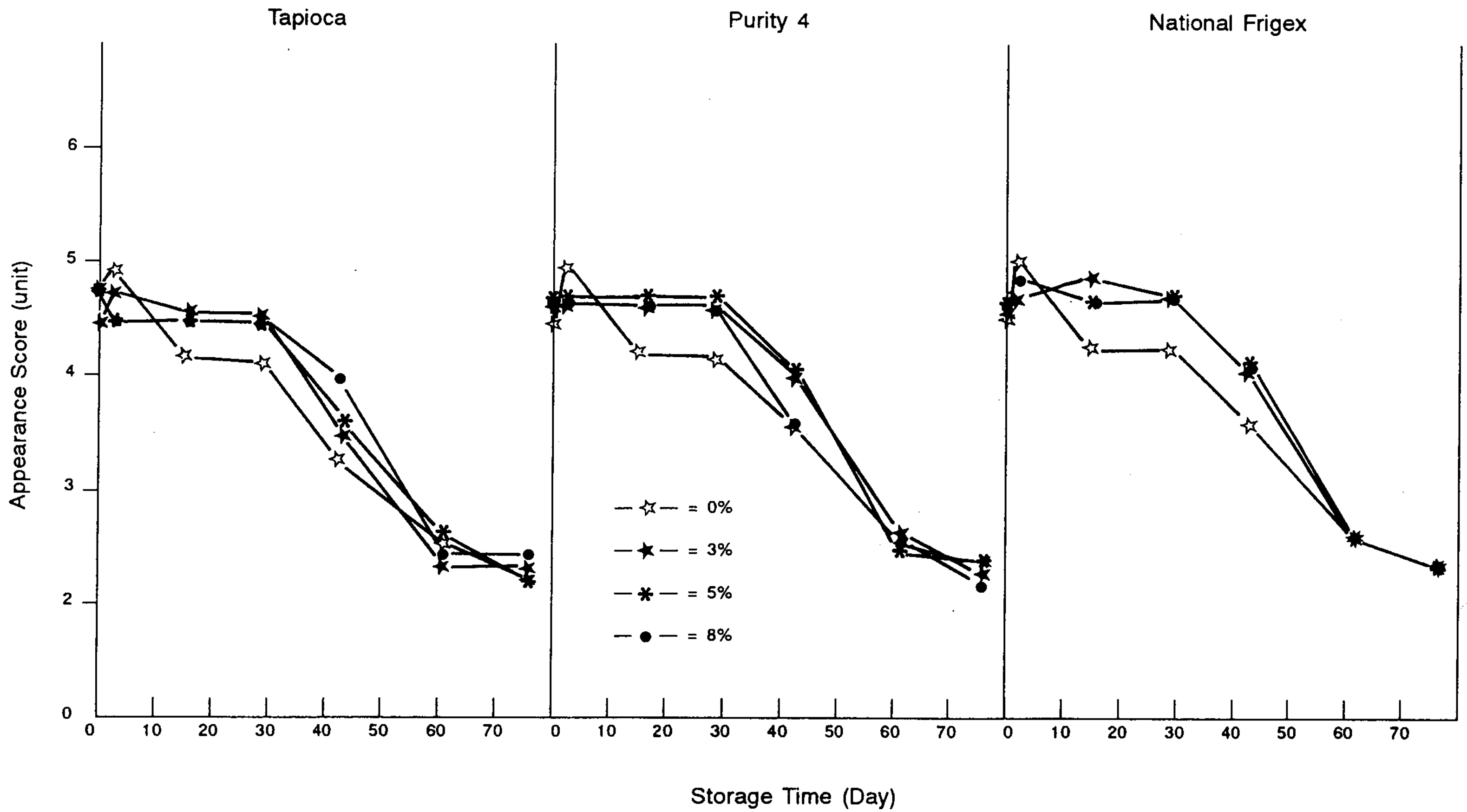

Fig. 4. Effect of type and quantity of flour on appearance of fish balls during frozen storage.

reduce drip loss during storage to a level lower than that experienced with the use of normal tapioca flour. The findings are consistent with Sorensen's (1976) study, in which he concluded that freezing would affect drip loss in minced fish during frozen storage.

Sensory assessment of the frozen fish balls showed that the samples before freezing and the samples kept for two days after freezing were not significantly different in general appearance, outer surface, glossiness and succulence. It was found that the scores awarded on outer surface, general appearance, succulence and glossiness by the panelists decreased as the storage time increased. Fig. 4 shows that the fish balls with additional tapioca flour, Purity 4 and National frigex of different levels during storage were awarded decreasing appearance scores as storage time proceeded and the scores were obviously low if stored for more than 42 days. The samples kept for 60 days were found to be dry, not glossy and unacceptable. The cut surface of the frozen fish balls was found to be rough and not shiny compared with samples that had not undergone freezing; however, the scores still fell into the acceptable range throughout the storage period. Storage time did not affect the flavour of the samples as shown by the acceptability scores. These were between 3.2 and 3.6 (judged acceptable) throughout the storage period (Table 2).

Conclusion

Quality values of frozen fish balls (eg, drip loss and texture damage) can be improved by the addition of appropriate modified starches with freeze-thaw stability. In this study, fish balls with additional 8% National Frigex, reduced drip loss up to 50% compared with the samples without additional flour. They also showed better results than samples with additional tapioca flour (unmodified starch). The type and quantity of the modified starches added did not significantly affect general appearance, outer surface, succulence, texture, glossiness and flavour of the frozen fish balls during storage, but the products with additional flours had smoother outer surfaces and superior glossiness and succulence to samples without additional flour. Frozen fish balls which were stored for more than 60 days showed outer-surface dryness and dullness and were judged unacceptable by the panelists.

A.O.A.C. 1980. Official method of analysis. 13rd ed. Washington Dc : Association of Official Analytical Chemists.

Bar, A. J., Goodnight, J.H., Sall, J. P. and Helwing, J. T. 1976. A user's guide to the statistical analysis system. Raleigh, N.C., SAS Institute Inc., Raleigh.

International Commission on Microbiological Specifications for Food (ICMSF). 1978. Microorganisms in food (1) the significance and method of enumeration. 2nd ed. Toronto: University of Toronto.

Jiang, S. T. (N.D.) Effect of modified starch on the quality of frozen minced fish products. National Taiwan of Marine Science Technology. Keelung, Taiwan, 23p.

Lawrence, R., Consolation F. and Jelen, P. 1986. Formation of structured protein foods by freeze texturization. Food Technology 3 : 77-82

Love, R.M. 1968. Ice formation in frozen muscle *In* Hawthorne, J.(ed.) Low temperature biology of foodstuffs. Pergamon Press, Oxford, 105-124.

Luallon, T. E. 1985. Starch as function ingredient. Food Technology. 1 : 59-63.

Sorensen, T. 1976. Effect of frozen storage on functional properties of separated fish mince. Proceeding of the Conference on the Production and Utilization of Mechanically Recovered Fish Flesh (Minced Fish). Keay, J. N. (ed.) Aberdeen Escocia : Torry Research Station. 56-65.

Southeast Asian Fisheries Development Center. 1979. Marine Fisheries Research Development, Annual Report. Singapore.

Uchiyama, H. 1978. Analytical method for estimating freshness of fish. Training Department, South East Asian Development Center (SEAFDEC). 10-12.

Yamprayoon, J., Suwansakornkul, P., and Kiatkungwalkrai, P. 1980. Study to determine shelf-life of fish ball at different temperature. Annual Report, Fishery Technological Development Division, Department of Fisheries, Bangkok, Thailand: 75-89.

Discussion

A comment was made that samples to which no starch had been added had better gel strength, while samples with starches had lower gel strength but demonstrated reduced drip losses. A question was raised as to whether there was a balance between saving on the drip loss and loss of gel strength due to addition of starch. Mrs Yamprayoon said that the starch increases the hardness of the fish balls and that this was reflected in an increase in the gel strength by rheometer measurement. However, the panelists were able to judge the difference between springiness and hardness caused by the starch.

On the comment that commercial processors in Thailand are already producing frozen fish balls and when asked what type of starch was used in the industry and why tapioca flour was chosen for the study, Mrs Yamprayoon answered that only one processor is producing frozen fish ball in Thailand and that the type of flour used was not known; hence the need for this study. Tapioca flour is cheap and is available locally, and so was chosen for the study.

In response to a question on colour differences between frozen and thawed fish balls, it was stated that both samples had the same colour.