Characteristics of White Pan Bread as Affected by Tempering of the Fat Ingredient

I. NOR AINI[1] and C. H. CHE MAIMON[1]

ABSTRACT

Cereal Chem. 73(4):462-465

This study investigated the effect of tempering of four shortening formulations on the baking characteristics of white pan bread. The fats used were palm oil and blends of palm oil (PO) and palm stearin (POS) tempered for two days at 10, 23, and 30°C before being stored at room temperature (23°C). Increasing the level of PO increased the solid fat content (SFC) of the shortenings at each tempering treatment. Increasing the temperature of the tempering treatment decreased the SFC of each shortening. Texture of the shortenings was profoundly affected by increasing the level of POS. Tempering at 23°C of all formulations resulted in a firmer texture than tempering at 10 or 30°C. Shortening tempered at 10°C produced significantly ($P < 0.05$) firmer dough texture than those tempered at 23 or 30°C. Specific volume of bread ranged from 4.11 to 4.43 cm^3/g. Significantly ($P < 0.05$) softer breads were obtained with shortenings tempered at 30°C than with those tempered at 10 or 23°C.

Bakery foods are the major cereal products available to consumers. Among the bakery products, bread has been the principle food in over half of the countries around the world (Chung and Pomeranz, 1983). Compared to other types of baked goods, breads require small amounts of fats (2–4%). Although breads require less fat than other baked goods, the amount of fat used in bread is significant because bread consumption is the largest of all the bakery goods.

Lard has been the fat predominantly used in bread production for years. However, recent trends in the baking industry have been to substitute for animal fats or hydrogenated shortenings with vegetable oils and surfactants (Chung and Pomeranz 1983, Hartnett and Thalheimer 1979). This trend is due to several reasons, such as health, nutrition, availability, and handling and storage, as well as religious considerations of certain group of consumers.

Oils and fats contribute to tenderness of various baked products. In breads, the basic ingredients are flour, liquid, and yeast. Fat, sugar, and salt are added to improve texture and flavor. Proper amount of fat or shortening in bread dough improves the volume, grain, texture, crust tenderness, and keeping quality of the bread and makes the dough more elastic (Sultan 1980).

Characteristics of bread and buns made with lard and vegetable oils have been studied by Kamel (1992). He reported that breads made with palm oil (PO) and lard were of higher specific volumes than those made with canola or soya oils.

The use of PO can be maximized by employing modification processes such as fractionation, blending, interesterification, or hydrogenation. The fractionation process of PO yields the liquid fraction, palm olein, and the solid fraction palm stearin (POS) which is considered a by-product. Palm olein is mainly used as a frying oil. POS, being a less expensive product, is very economical for shortening formulation, and it helps improve plasticity of the shortenings. This article reports work on the effect of tempering of shortenings based on PO and POS in white pan bread.

MATERIALS AND METHODS

The shortening formulations used in this study were: 1) PO, 2) PO:POS 80:20, 3) PO:POS 60:40, and 4) PO:POS 40:60. PO and POS (iodine value 33) were obtained from a local refinery.

Shortening production. Palm oil and blends of PO and POS were melted to 57–60°C, and the blends were prepared by mixing relevant components at appropriate proportions in a 100-kg stainless steel vessel to give a total of 50 kg for each blend. The feed stocks were processed on a pilot plant scale (Schroeder Kombinator type VUK B 01/60-400, Lubeck, FRG). The products were run at a standard pump speed (280 rpm). Speed of cooler I and cooler II was 400 rpm each. Back pressure of the pump was 1.5 kg/cm^2. The average throughput was 65 kg/hr. Refrigerant temperature of cooler I was –0.5°C and that of cooler II was –1.5°C. Temperature of the working unit ranged from 21.6 to 24.7°C. The shortenings were filled into cans.

After production, the shortening samples were divided into three groups. The first group was tempered at 10°C for two days and then kept at 23°C until used. The second group was kept at 23°C throughout the study. The third group was tempered at 30°C for two days and then transferred to 23°C until used.

Slip melting point. Slip melting points of the shortenings were analyzed in triplicate according to the official methods (AOCS 1989).

Fatty acid composition. Fatty acid compositions of the shortenings were analyzed as methyl esters, which were prepared according to a method proposed by Timms (1978). Analyses were conducted on a fused silica capillary column (60 m × 0.25 mm, i.d), at 190°C with Helium as the carrier gas at a flow rate of 0.8 cm^3/min by using a Perkin Elmer Sigma 100 gas chromatograph (Norwalk, CT). Injector and detector temperatures were set at 240°C. Analyses were conducted under isothermal conditions, with a run time of 30 min.

Solid fat content (SFC). After production, SFC of the shortenings were analyzed using a method described by Oh and Berger (1980). During storage at room temperature of 23°C, SFC of the products were also measured directly at 23°C without first melting the samples at 70°C, as in the earlier determination. Measurements were repeated three times on each sample and the results were averaged.

X-ray diffraction. X-ray diffraction analysis was used to determine the polymorphic forms of fat crystals in the shortenings. The camera was an Enraf Nonius model FR 592 (Delft, The Netherlands). The instrument was fitted with a fine focus copper X-ray tube. The sample holders were flat stainless steel plates with a rectangular hole. Short spacing on the X-ray film were measured with a Guiner viewer (Enraf Nonius).

Bread preparation. Bread baking experiments were conducted at 1, 8, and 16 weeks after shortening production. Each set of experiments included each shortening tempered at 10, 23, and

[1]Chemistry & Technology Div., Palm Oil Res. Inst. of Malaysia, Ministry Primary Industries, P.O. Box 10620, 50720 Kuala Lumpur, Malaysia. Fax: 03-8259446.

Publication no. C-1996-0603-05R.

30°C; experiments were conducted daily for four days to include the four shortening formulations: PO, PO:POS 80:20, PO:POS 60:40, and PO:POS 40:60. Duplicates of each treatment were baked each time. Bread was made using the recipe shown in Table I. Bread flour was obtained from a local supplier (Malaysian Flour Mill Bhd., Klang, Selangor). It contained 12.5% protein with potassium bromate added. Dry instant yeast (Saf instant, S. I. Le Saffre, France) was used. Yeast and sugar were dissolved in 100 g of lukewarm water, and the mixture was set aside for 7 min. Salt was dissolved in the remaining lukewarm water. Bread flour (500 g) was placed into a mixing bowl (Hobart model N50, Hobart Troy, OH). Yeast solution and salt solution were added slowly at speed 1 for 1 min. Speed setting was increased to 2, and mixing continued for 30 sec. Shortening was added and the mixture was mixed at speed 1 for 1 min 30 sec. Mixing was continued at speed 2 for 1 min, and the dough was further mixed until smooth (7 min).

The dough was divided into two portions and shaped into balls. The doughs were let to rest for 10 min at ambient temperature (23°C) after which they were flattened with a roller. The flattened doughs were turned over and curled into cylindrical shape. The edges were sealed, and the shaped doughs were placed into non-stick loaf pans measuring 253 × 127 × 64 mm (DuPont, Silverstonne, Britain). Doughs were proved in a bread prover (model 2E, Rodkdersbro, Denmark) for 35 min at a temperature of 38°C and 85% rh. The top surface was brushed with beaten egg before baking. The bread was baked at 200°C for 20 min (Simon rotary oven, Henry Simon, Stockport, England).

Determination of specific bread volume. When the breads had cooled, they were weighed using a balance (model PM 4000, Mettler Instruments Ag, Zurich, Switzerland). Volumes were measured by the rapeseed displacement technique (Griswold, 1962). The instrument was calibrated using a block of wood with a standard volume (500 cm^3). The bread sample was then placed inside the volumeter at the bottom. A knob was pulled out to allow rapeseed to slide down and fill the void space at the bottom portion of the instrument. The volumeter scale is in cm^3 so that the volume of samples can be read directly. The volumes of the breads were divided by their respective weights. Results were expressed as specific volume, in units of cubic centimeters per gram (cm^3/g).

TABLE I
Bread Recipe

Ingredient	g	% flour wt.
Bread flour	500	100
Warm water (45°C)	300	60
Dry yeast	10	2
Sugar	20	4
Shortening	20	4
Salt	5	1

TABLE II
Slip Melting Point and Fatty Acid Composition of Shortenings Used in Breadmaking

	PO:POS[a]			
Shortening Composition	100:0	80:20	60:40	40:60
Slip melting point (°C)	38.3	46.2	47.5	50.1
Fatty acid composition (%)				
C12:0	0.2	0.2	0.2	0.2
C14:0	1.0	1.0	1.0	1.0
C16:0	43.3	45.7	48.4	51.2
C18:0	4.5	4.6	4.8	4.9
C18:1	39.7	38.1	36.0	34.0
C18:2	10.6	9.7	9.0	8.2
C18:3	0.3	0.3	0.3	0.3
C20:0	0.2	0.1	0.1	0.1

[a] Shortening formulations used blends of palm oil (PO) and palm stearin (POS).

Texture

Texture of shortenings. A texture testing machine (model T5K, J. J. Lyod, Southampton, England) was used to measure texture of the shortenings. Measurements were taken at ambient temperature (23°C). Load cell was 5N, speed was 100 mm/min, attachment used was a stainless steel probe of 5/16" dia. with a rounded end. Texture of the shortenings was measured in terms of force required to penetrate the samples to a depth of 1.5 cm. Measurements were done in triplicate.

Dough texture. The same texture testing machine used to measure texture of shortenings was also used to measure dough texture. Dough sample (35 g) was fit into a glass container with 4.3 cm i.d. and 2.6 cm internal depth. The sample was then placed under a 5/16" dia. stainless steel probe with a rounded end. Measurements were taken at ambient temperature (23°C). Speed was set at 100 mm/min. Texture of bread dough was measured in terms of force required to penetrate the samples to a depth of 1.5 cm. Determinations were done in triplicate.

Bread texture. Texture of the bread was measured using the texture testing machine (T5K). Slits were made 2 cm apart with a fabricated utensil and the loaves were cut into 2-cm slices using a knife. The slices were further cut into equal sizes using a stainless steel 4-cm square cutter. The samples for texture measurement were taken from the center portion of the loaves. A compression cage was used to measure compressibility of the bread samples. Load cell was 50 Newtons, speed was 25 mm/min. The force required to compress the sample to a 1-cm thickness (50% compression) was determined. Measurements were taken in triplicate. The remaining loaves were wrapped in polyethylene bags and stored at 23°C until used for the next texture measurements at day 2 and day 4.

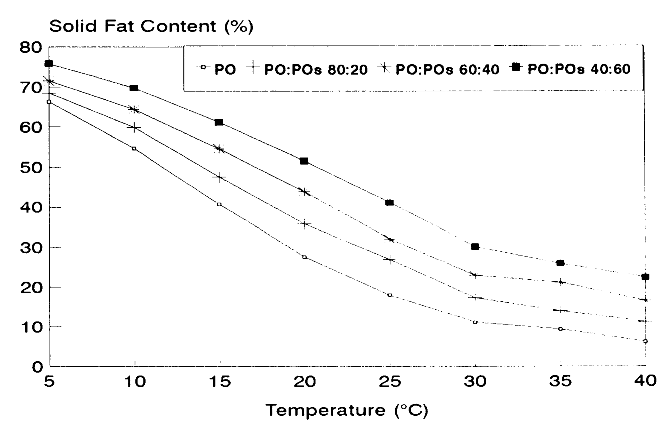

Fig. 1. Solid fat content profiles of shortenings. Shortening formulations used blends of palm oil (PO) and palm stearin (POS).

TABLE III
Solid Fat Content[a] of Shortenings at Storage Temperature of 23°C After Being Tempered at 10, 23, 30°C for Two Days

	Tempering Temperature (for two days)		
PO:POS[b]	10°C	23°C	30°C
100:0	19.4	18.5	15.3
80:20	25.9	25.0	20.6
60:40	31.9	29.8	26.5
40:60	39.3	37.3	36.6

[a] Taken at week 1, 4, and 8; $n = 3$.
[b] Shortening formulations used blends of palm oil (PO) and palm stearin (POS).

Statistical Analysis

The data obtained were subjected to analysis of variance with an IBM mainframe computer. The program used was based on the IBM Scientific subroutine package.

RESULTS AND DISCUSSION

Shortening based on 100% PO had a slip melting point of 38.3°C. Addition of POS increased the slip melting point; the higher the level of POS added, the higher the slip melting point (Table II). All shortenings were rich in C16:0 and C18:0 fatty acids. They contained moderate amount of C18:2. The higher the level of POS in the shortenings, the higher the saturated fatty acids content and the lower the monounsaturate level (C18:1). The differences in fatty acid composition affect the liquid-to-solid fat ratio of the shortenings (Fig. 1). Among the shortenings, PO

TABLE IV
Texture[a] and Polymorphic Forms of Shortenings Tempered at 10, 23, and 30°C for Two Days

		Texture at 23°C		Polymorphic Form	
PO:POS[b]	(°C)	Week 1	Week 16	Week 1	Week 16
100:0	10	3.1	3.2	β′	β′>>β
	23	5.0	5.8	β′	β′>>β
	30	4.0	4.4	β′	β′+β
80:20	10	9.5	8.9	β′	β′>>β
	23	11.5	12.8	β′	β′>>β
	30	8.4	10.6	β′	β′+β
60:40	10	17.4	18.1	β′	β′>>>β
	23	19.6	20.1	β′	β′>>>β
	30	27.1	19.5	β′	β′+β
40:60	10	29.1	31.9	β′>>>β	β′>>β
	23	32.7	38.5	β′>>>β	β′>>β
	30	24.0	31.4	β′+β	β′+β

[a] Expressed in Newtons; $n = 3$.
[b] Shortening formulations used blends of palm oil (PO) and palm stearin (POS).

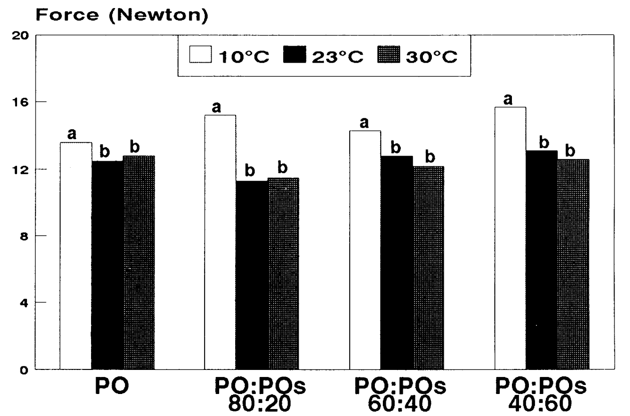

Fig. 2. Texture of bread doughs made with shortenings tempered at 10, 23, and 30°C. Shortening formulations used blends of palm oil (PO) and palm stearin (POS). Different letters indicate significant difference ($P < 0.05$).

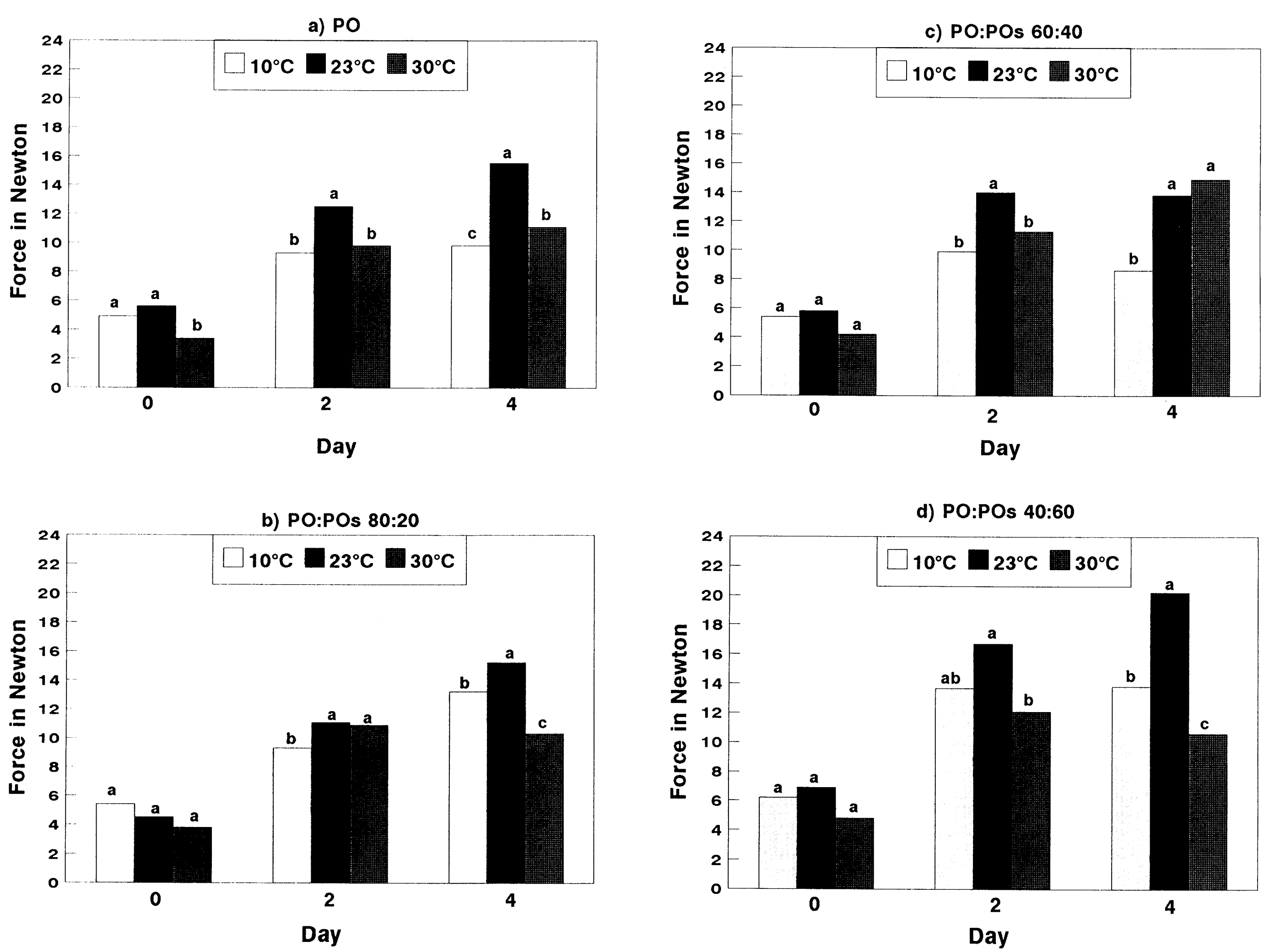

Fig. 3. Changes in texture of bread made with shortening formulations using blends of palm oil (PO) and palm stearin (POS): **a,** PO; **b,** PO:POS 80:20; **c,** PO:POS 60:40; **d,** PO:POS 40:60. Same letters indicate no significant difference ($P < 0.05$). (Data compiled from Table V.)

TABLE V
Compression Test Bread

Shortening[a]	Temp (°C)	Day 0	Day 2	Day 4
PO				
	10	4.9 ± 0.49	9.3 ± 1.98	9.8 ± 0.64
	23	5.6 ± 0.35	12.5 ± 0.49	15.5 ± 0.92
	30	3.4 ± 0.07	9.8 ± 0.07	11.1 ± 2.33
PO:POS 80:20				
	10	5.4 ± 1.70	9.3 ± 3.11	13.2 ± 4.03
	23	4.5 ± 0.07	11.1 ± 0.49	15.2 ± 3.40
	30	3.8 ± 0.71	10.9 ± 3.04	10.3 ± 2.26
PO:POS 60:40				
	10	5.4 ± 1.84	9.9 ± 2.83	8.6 ± 0.07
	23	5.8 ± 1.56	14.0 ± 4.31	13.8 ± 1.84
	30	4.2 ± 0.71	11.3 ± 0.64	14.9 ± 4.31
PO:POS 40:60				
	10	6.2 ± 2.69	13.7 ± 5.59	13.8 ± 5.30
	23	6.9 ± 3.46	16.7 ± 0.78	20.2 ± 2.76
	30	4.8 ± 1.48	12.1 ± 3.68	10.6 ± 1.56

[a] Shortening formulations used blends of palm oil (PO) and palm stearin (POS).

shortening had the lowest solid content at all temperatures. Addition of POS increased the solid content; the higher the percentage of POS, the higher the solids content. The increase in the solid fat content was due to the higher amount of saturates and also the presence of higher melting triglycerides in POS.

Table III shows that increasing the level of POS increased the SFC in the shortening at each tempering treatment. The same table also shows that increasing the tempering temperature of each formulation resulted in a decrease in SFC. This finding is in agreement with that of Moziar et al (1989), who reported that shortening tempered at 10°C had slightly higher SFC than those tempered at 30°C. Moziar et al (1989) also reported that shortening tempered at 23°C isothermal and 10°C for two days had similar types of crystals. However ,they reported that tempering at 0°C resulted in product of harder consistency (texture). On the contrary, our study showed that shortenings tempered at 10°C were significantly ($P < 0.05$) softer than those tempered at 23°C, although they exhibited similar crystal structure (Table IV). It is likely that there are other factors that affect texture besides crystal structure. Further work needs to be done to come up with a good explanation.

Specific volume of bread made with PO, PO:POS 80:20, PO:POS 60:40, and PO:POS 40:60 ranged from 4.11 to 4.43 cm^3/g. The results, however, were not significantly different. It was noted that bread made without the addition of any fat or shortening had a much lower specific volume (3.50 cm^3/g). Thus, the inclusion of PO and PO:POS shortenings in the bread recipe improved the volume of the final baked product.

Texture of bread dough with shortening tempered at 10°C for two days produced bread dough of significantly ($P < 0.05$) firmer texture than shortenings tempered at 23 or 30°C (Fig. 2). Results also indicated that, in general, shortening PO:POS 40:60 produced bread dough of firmer consistency than other shortenings, while PO:POS 80:20 shortening produced the softest bread dough.

Figure 3 and Table V show that PO shortening tempered for two days at 30°C produced significantly ($P < 0.05$) softer breads than shortenings tempered at 10°C or 23°C on the day of baking (day 0). There were increases in firmness of all the breads with time from day 0 to day 4. However, the increase in firmness occurred to a lesser extent in breads made with shortenings tempered at 10 or 30°C for two days than in those made with shortenings tempered at 23°C throughout the study. The force required to compress the breads made with shortenings tempered at 30°C ranged from 3.4 to 4.8 Newtons (on day 0) and increased to 10.3 to 14.9 Newtons (on day 4). With shortenings tempered at 10°C, the breads recorded texture readings ranging from 4.9–6.2 Newtons (on day 0) to 8.6–13.8 Newtons (on day 4). In the case of shortening tempered at 23°C throughout the study, the readings ranged from 4.5–6.9 Newtons (on day 0) to 13.8–20.2 Newtons (on day 4).

It was noted that, in general, the higher the level of POS in the shortening formulation, the firmer was the bread texture. The study suggests that after production, shortenings should be tempered at an elevated temperature for a period of time before being kept at room temperature in order to give good characteristics to the final products. This is especially true for bakery products such as white pan bread where the end product would be softer and have better keeping quality. More work needs to be done to optimize the tempering temperature and time for palm oil shortenings for use in white bread formulations.

ACKNOWLEDGMENTS

We would like to thank the director general of PORIM for permission to publish this article.

LITERATURE CITED

AOCS. 1989. Official and Tentative Methods of the American Oil Chemists Society, 4th ed. Method Cc-25. The Society: Champaign, IL.

CHUNG, O. K., and POMERANZ, Y. 1983. Recent trends in usage of fats and oils as functional ingredients in the baking industry. J. Am. Oil Chem. Soc. 60:1848.

GRISWOLD, R. M. 1962. Evaluating foods by objective methods. Page 525 in: The Experimental Study of Foods. Houghton Mifflin: Boston.

HARTNETT, D. I., and THALHEIMER, W. G. 1979. Use of oil in baked products. I. Background and bread. J. Am. Chem. Soc. 56:944.

KAMEL, B. S. 1992. Characteristics of bread and buns made with lard and vegetable oils of different iodine value. J. Am. Oil Chem. Soc. 69:794.

MOZIAR, C., DEMAN, J. M., and DEMAN, L. 1989. Effect of tempering on the physical properties of shortening. Can. Inst. Food Sci. Technol. J. 22:238.

OH, F. C. H., and BERGER, K. G. 1980. Determination of solid fat content of palm oil by wideline NMR. Page 383 in: Proc. of Intl. Palm Oil Products Technol. in the 80's. E. Pushparajah and M. Rajadurai, eds. Incorporated Society of Planters: Kuala Lumpur.

SULTAN, W. J. 1980. Shortening and their uses. Page 5 in: Practical Baking, 3rd ed. AVI Publishing: Westport, CT.

TIMMS, R. E. 1978. Artifact peaks in the preparation and gas-liquid chromatographic determination of methyl esters. Aus. J. Dairy Tech. 33:4.

[Received October 23, 1995. Accepted April 12, 1996.]