INTERESTERIFICATION OF LARD FOR USE IN BAKED GOODS

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Random and directed interesterification of lard in various sets of time and temperature conditions was carried out. Interesterified lards were used as shortenings for baked goods. Results obtained in laboratory scale investigations were confirmed in a pilot-plant scale.

Table 1

Influence of laboratory interesterification at various sets of temperature and time on physico-chemical properties of lard

Product	Helting Point (°C)	Trisat. Glycer. (%)	Penetration (mm/10) 15°C	20°C	25°C	30°C	35°C	40°C
Untreated lard	45.3	4.2	175	253	270	300	—	—
Random interesterified lard								
0,3% CH_3ONa, 90°C								
0,5 h	41.6	6.9	69	139	163	239	300	—
Directly interesterified lard								
0.3% CH_3ONa, 40°C								
0.5 h	41.7	5.9	51	124	241	271	300	—
1 h	40.9	6.5	49	122	241	212	300	—
3 h	41.5	5.8	55	146	237	288	300	—
5 h	41.3	6.3	58	254	274	283	300	—
0.3% CH_3ONa, 36°C								
0.5 h	41.1	5.9	56	141	235	249	300	—
1 h	41.2	6.8	51	163	234	250	300	—
3 h	44.8	12.1	49	135	124	167	198	300
5 h	45.4	12.1	54	87	111	144	161	300
0.3% CH_3ONa, 33°C								
0.5 h	40.5	5.9	62	107	214	231	300	—
1 h	43.6	8.8	50	104	153	200	300	—
3 h	47.4	10.1	51	72	104	170	300	—
5 h	47.6	15.3	48	75	122	96	300	—

Product	Helting Point (°C)	Trisat. Glycer. (%)	Penetration (mm/10) 15°C	20°C	25°C	30°C	35°C	40°C
0.3% CH_3ONa, 30°C								
1 h	43.4	7.5	111	144	300	—	—	—
3 h	47.0	10.0	62	104	161	184	300	—
5 h	46.9	10.4	46	122	163	217	300	—
0.3% CH_3ONa, 26°C								
0.5 h	44.2	7.3	69	107	214	268	300	—
1 h	45.3	8.5	65	104	153	208	290	300
3 h	46.0	9.7	48	72	104	131	245	300
5 h	44.6	10.8	51	75	122	200	262	300
0.3% CH_3ONa, 23°C								
0.5 h	—	14.5	38	52	75	91	179	300
1 h	46.5	15.9	39	57	63	79	126	300
3 h	47.4	16.4	35	43	49	59	67	251
5 h	47.8	17.2	35	41	51	56	67	256
0.3% CH_3ONa, 30°C (catalyst added after cooling lard to 21°C)								
0.5 h	45.1	9.9	73	143	232	300	—	—
1 h	44.5	10.8	71	137	212	300	—	—
3 h	46.5	11.1	56	125	133	300	—	—
5 h	47.9	13.5	65	84	197	300	—	—
0.3% CH_3ONa, 23°C (catalyst added after cooling lard to 21°C)								
0.5 h	42.7	5.4	187	250	300	—	—	—
1 h	45.0	3.1	186	275	300	—	—	—
3 h	45.0	4.4	237	249	300	—	—	—
5 h	45.0	4.1	167	241	300	—	—	—

Dried, low-fatty acid lard was subjected to random and directed interesterification in the presence of 0.3% CH_3ONa catalyst. Random interesterification was carried out at 90°C for 0.5 h. Catalyst was inactivated with diluted HCl. Directed interesterification was carried out in two ways: in some experiments catalyst was added to fat at 75-85°C and after 15 min of the reaction temperature was decreased to give didected interesterified products. In another experiments reaction was conducted at 23°C, or 30°C with catalyst being added after quick chilling of lard to 21°C to create some amount of of precipitated high and intermediate melting triglycerides. During the course of directed interresterification samples were taken after 0.5, 1, 3.5 h. Catalyst was inactivated with diluted HCl. Table 1 shows changes effected by interesterification in melting point, trisatured glycerides content and consistency of fat. Consistency was measured by a needle penetrometer [1] and trisaturates content by differential cooling curves technique [2].

The least firmness had untreated lard and lard directly interesterified at 23°C with catalyst being added after chilling lard to 21°C. The

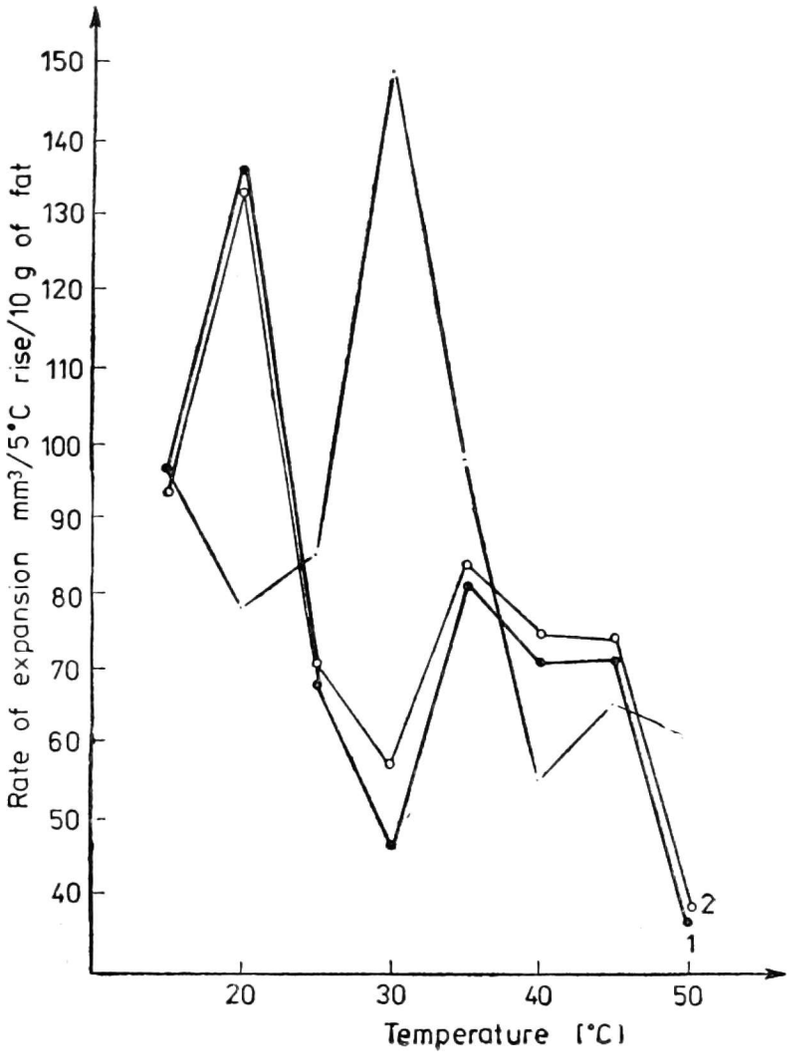

Fig. 1. Differential dilatometric curves. Untreated lard. Random interesterified lard 0.3% CH_3ONa, 90°C: *1* — 0.5 h reaction time, *2* — 1 h reaction time

most firm products were obtained at 23°C when the reaction followed liquid phase interesterification at 75-85°C. Lard interesterified at 40°C was similar to random interesterified one in its melting point and content of trisaturates.

Figures 1-9 present the shapes of differential dilatometric curves of interesterified products. They indicate changes in structure of triglycerides particularly of disaturated-monounsaturated intermediate melting as well as increasing amounts of trisaturated glycerides during the course of reaction.

The influence of interesterified products on properties of baked goods was investigated on yeast-raised bread and biscuit-type cake. Table 2 shows that the general effect was improving the structure of both kinds of baked goods, and flavour of bread. With the exception of lard interesterified at 23°C which gave an excellent biscuit and a poor bread and had the highest amount of trisaturated glicerides there was no marked difference in effects between the interesterified lards tested, in spite of the loaf volumes obtained.

The above results may indicate that in the case of interesterified lard the basic influence on properties of the tested type baked goods

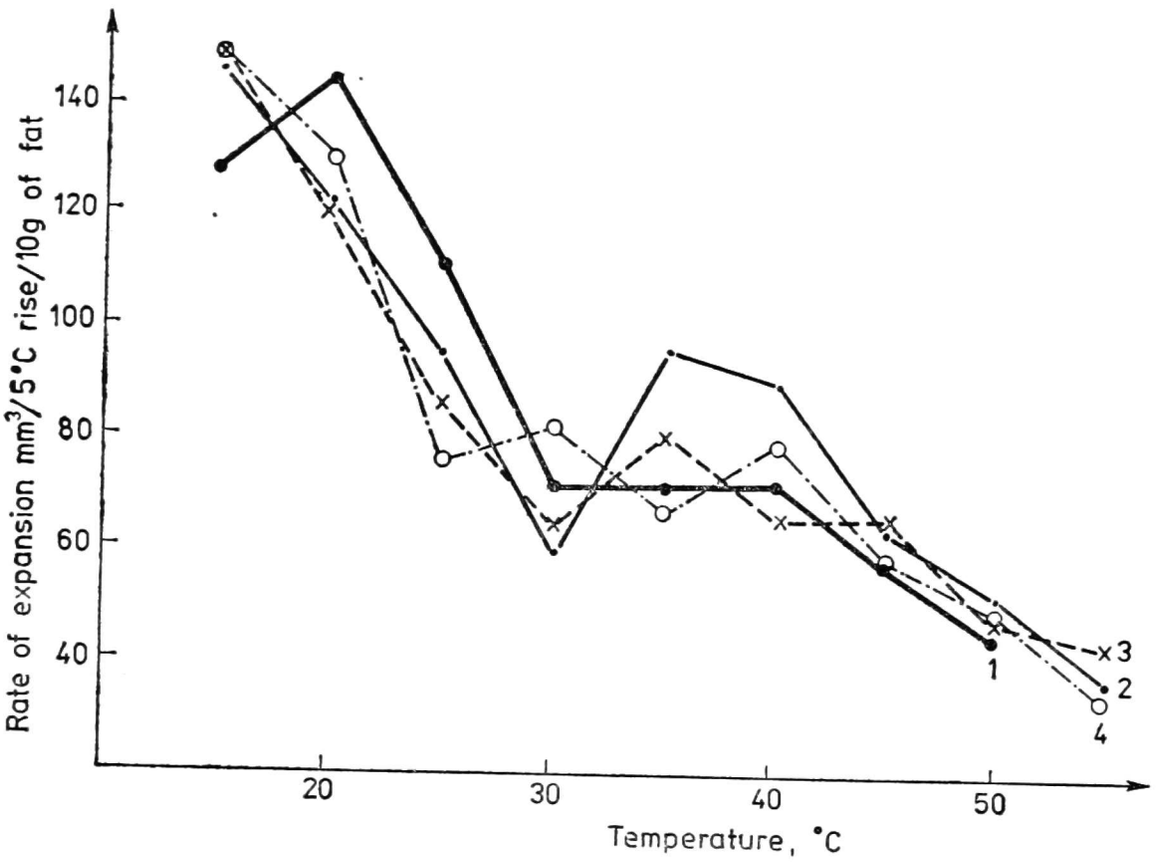

Fig. 2. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 40°C: *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 h reaction time

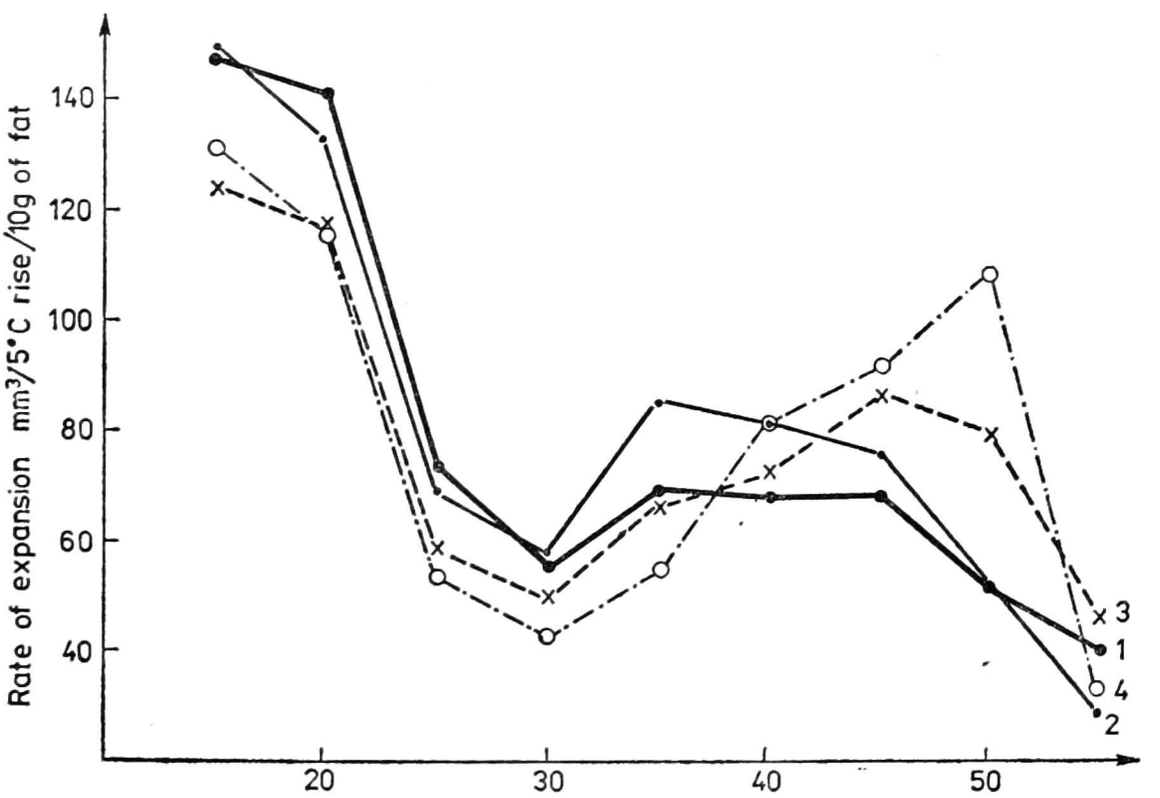

Fig. 3. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 36°C: *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 h reaction time

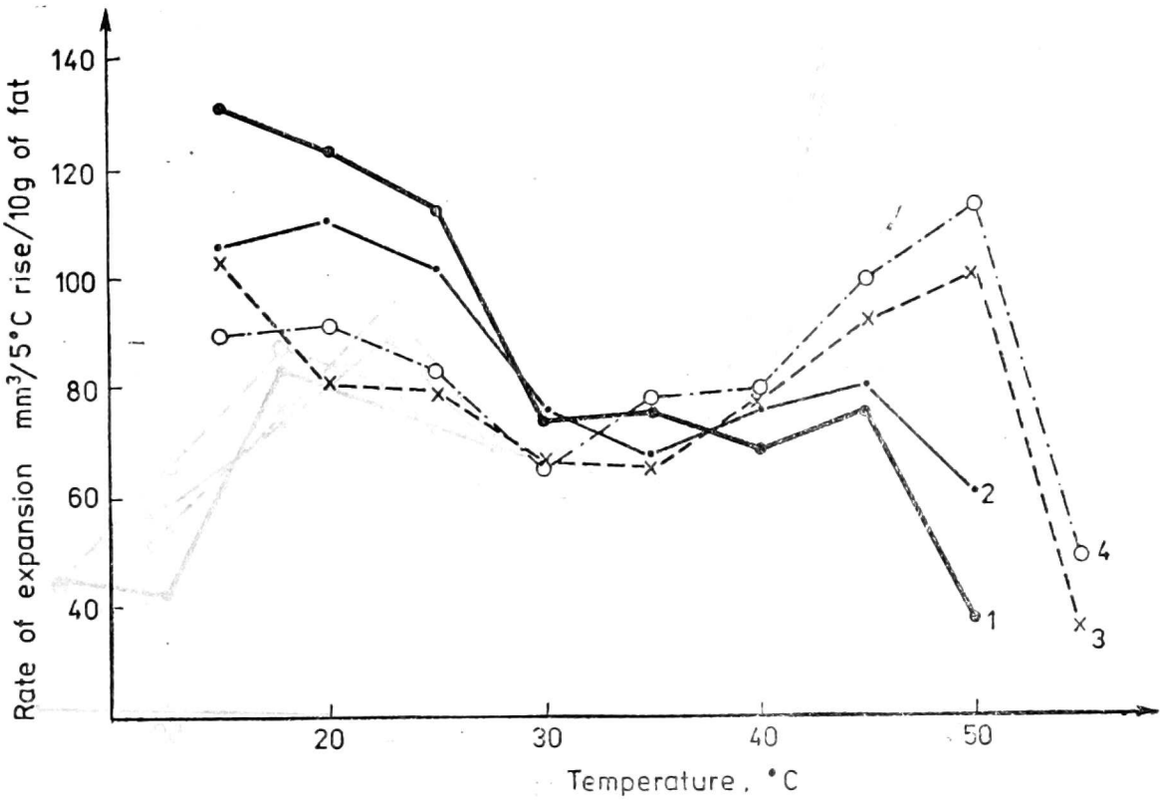

Fig. 4. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 33°C: *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 reaction time

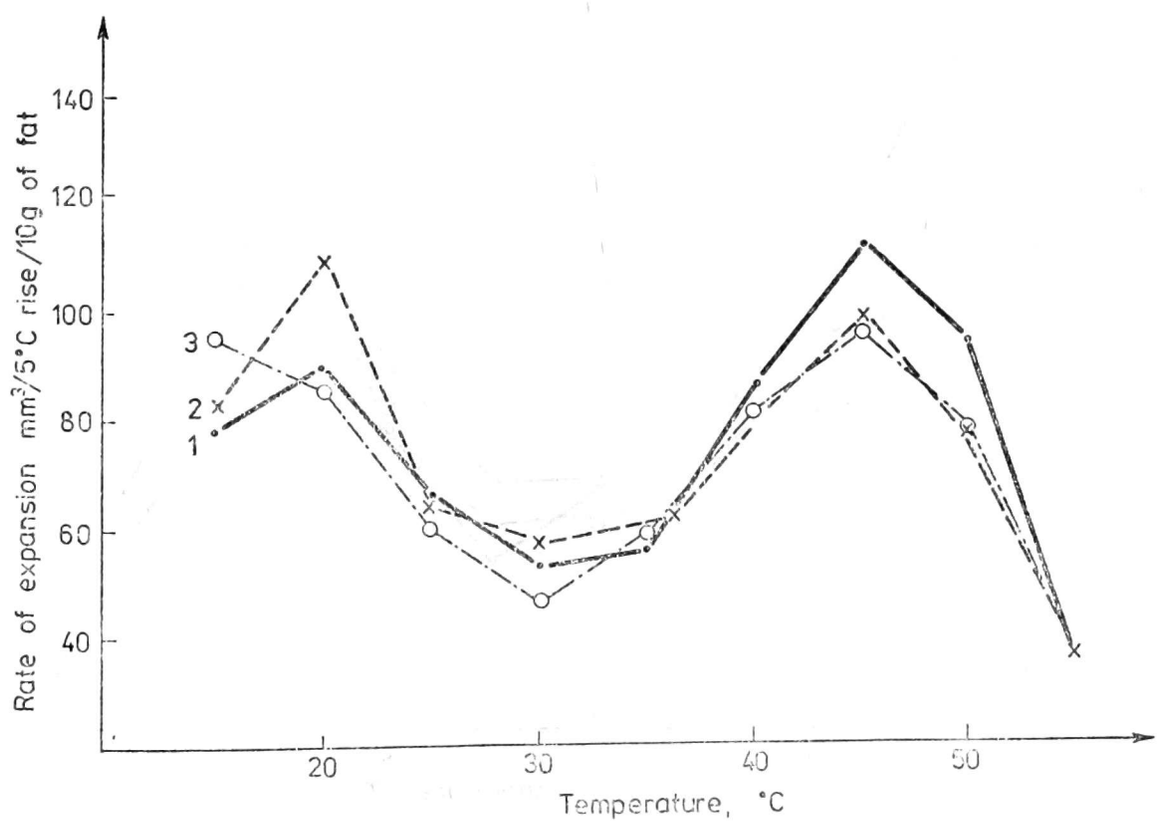

Fig. 5. Differential dilatometric curves. Directly intersterified lard 0.3% CH_3ONa, 30°C: *1* — 1.0 h reaction time, *2* — 3.0 h reaction time, *3* — 5.0 reaction time

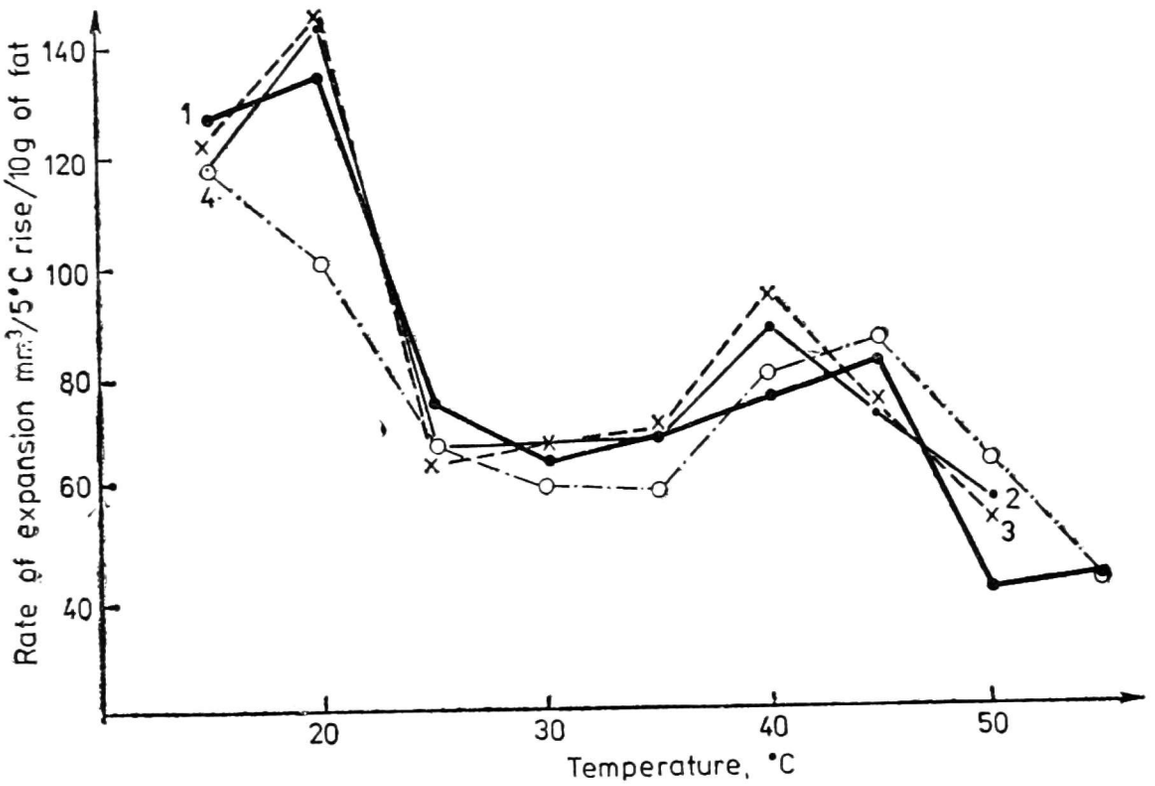

Fig. 6. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 26°C: *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 h reaction time

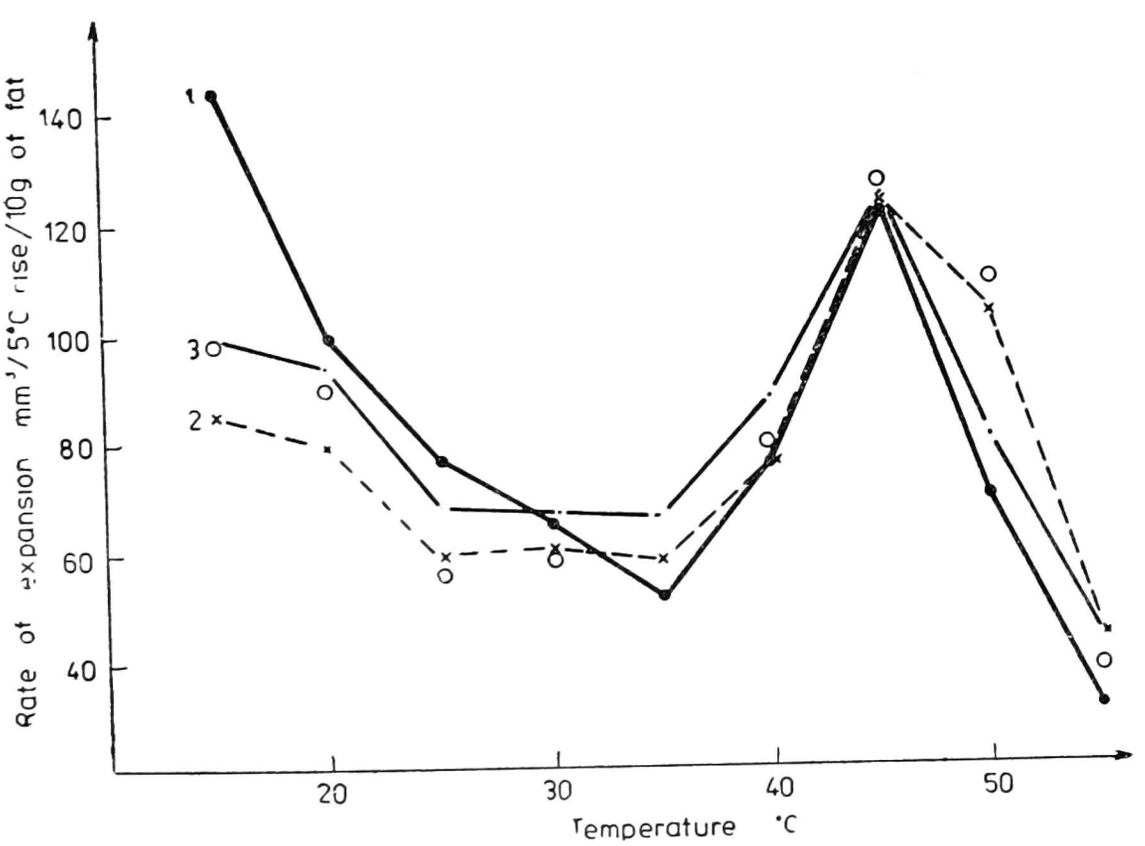

Fig. 7. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 23°C: *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 h reaction time

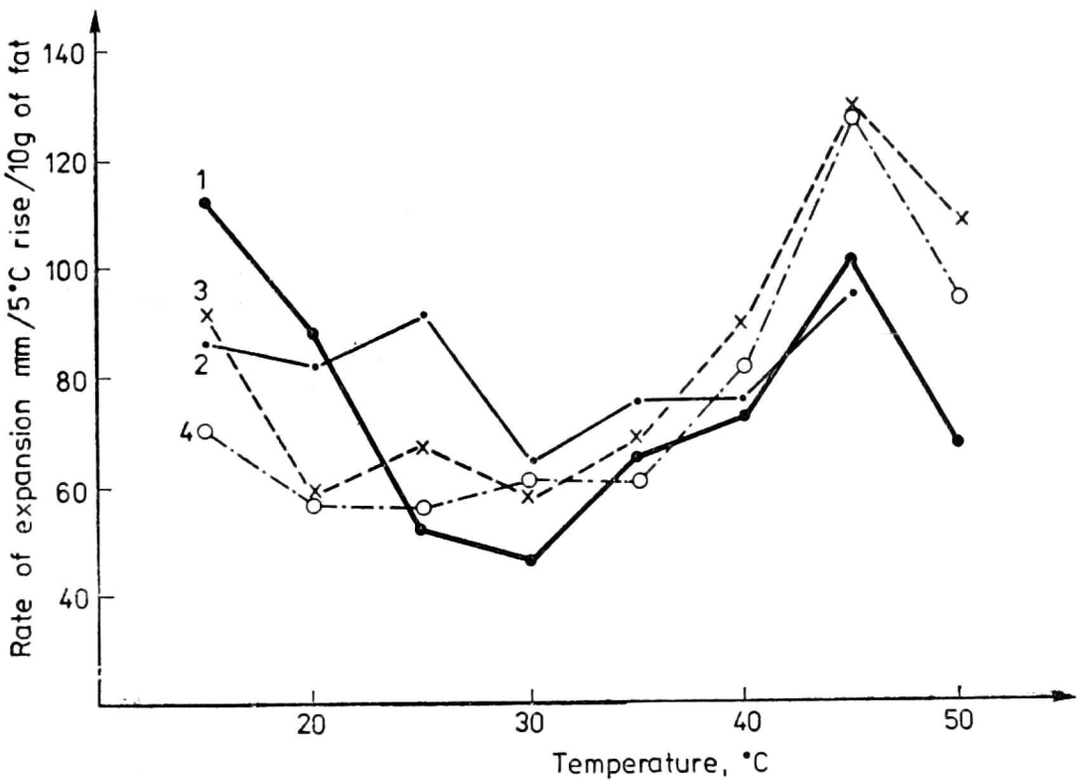

Fig. 8. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 30°C (catalyst added after cooling to 21°C): *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 h reaction time

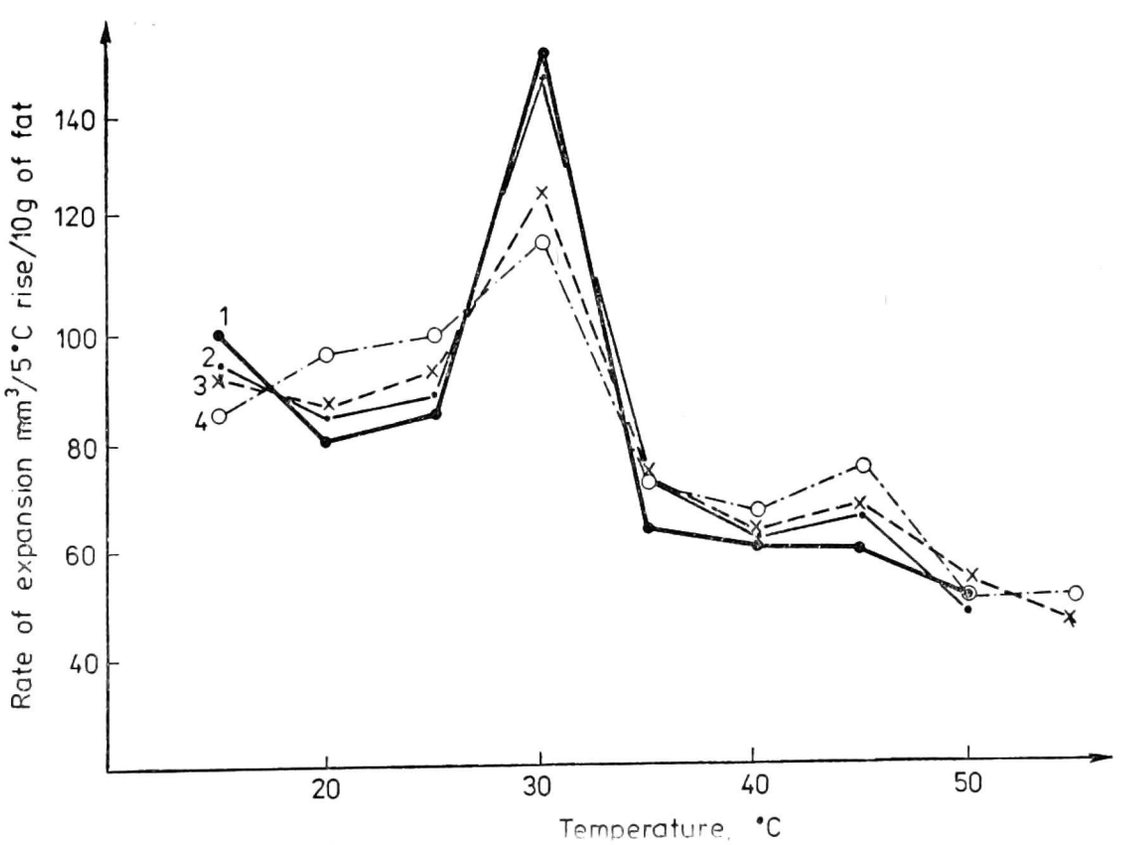

Fig. 9. Differential dilatometric curves. Directly interesterified lard 0.3% CH_3ONa, 23°C (catalyst added after cooling to 21°C): *1* — 0.5 h reaction time, *2* — 1.0 h reaction time, *3* — 3.0 h reaction time, *4* — 5.0 h reaction time

Table 2

Laboratory baking performance tests of laboratory interestierified lards

	Fat-leavened cake		Yeast-raised bread			
	shortness	flavour	cell-structure	fluffiness of crumb	flavour	loaf volume (cm^3)
Margarine	suff. good	good	cells of big and average size, regular, thick-walled	crumb firm	good Specific for rye-wheaten bread	814
Untreated lard	good	good	cells big, average and small, regular, thin-walled	good	v. good Specific for wheaten bread	835
Random int. lard	v. good	good	cells average and small, regular, thin-walled	v. good	v. good Specific for wheaten bread	781
Dir. int. lard			cells average and small, regular,		v. good Specific for	
40 °C, 5 h	v. good	good	thin-walled	v. good	wheaten bread	817
36 °C, 5 h	v. good	good	cells small, regular, thin-walled	highly good	v. good Specific for wheaten bread	851
33 °C, 5 h	v. good	good	cells small, regular, thin-walled	highly good	v. good Specific for wheaten bread	804
30 °C, 5 h	v. good	good	cells big and average, regular, thin-walled	v. good	v. good Specific for wheaten bread	801
26 °C, 1 h			cells average and small, regular, thin-walled	v. good	v. good Specific for wheaten bread	781
26 °C, 5 h			cells average, regular thin--walled	v. good	v. good Specific for wheaten bread	811
23 °C, 5 h	highly good	good	cells average, not regular, thick-walled	poor	good Specific for wheaten bread	886
23 °C, 5 h catalyst added after cooling lard			cells small, regular, thin-walled	v. good	v. good Specific for wheaten bread	818
30 °C, 5 h catalyst added after cooling lard	good	good				

exerts the modified structure of triglycerides obtained in the process. It appears to be valid in a wide range of trisaturated glycerides content, melting point and consistency of interesterified lard shortening.

To verify this assumption a pilot-plant interesterification was carried out at 36°C after rearrangement at 80°C for 15 min and at 27°C after catalyst having been added to lard cooled to this temperature. Resulting directed interesterification process was conducted for 40 min. In Table 3 are given the reaction parameters as well as physico-chemical properties of untreated lard and products of its interesterification. Process at 36°C preceeded by random interesterification at 80°C gave the product of remarkably low melting point with a firm consistency. It had also a bit less amount of trisaturates in comparision with untreated lard. The product obtained at 27°C had melting point and trisaturates content not changed or almost not, but consistency softer (higher penetration). In Table 4 are shown some additional characteristics of interesterified lards after plasticizing, air incorporating and 62 hours' tempering at 21°C.

Samples of both kinds of interesterified lards as well as margarine and untreated lard were used in a pilot-plant scale for biscuit and bread formulations. The results of baking performance tests show Table 5 and 6 confirming results obtained in laboratory experiments. Both types of interesterified lards gave more tender crumb and very good cell structure of bread and additionally had a beneficial influence

Table 3

Interesterification of lard in a pilot-plant scale

Run	Reaction conditions	Melting point (°C)	Trisat. glycer. (%)	Penetration (mm/10)			
				20°C	25°C	30°C	35°C
I	Untreated lard	48.3	8.7	164	202	263	>300
	a) 0.5% CH_3ONa, 36°C 40 min.	42.3	7.0	56	95	194	>300
	b) 0.5% CH_3ONa, 27°C 40 min. (catalyst added after cooling lard to 27°C)	49.5	8.9	203	232	290	>300
II	Untreated lard	48.4	9.1	170	217	245	>300
	a) 0.5% CH_3ONa, 36°C 40 min.	42.7	7.4	64	109	225	>300
	b) 0.5% CH_3ONa, 27°C 40 min. (catalyst added after cooling lard to 27°C)	48.4	8.3	185	250	288	>300

Table 4

Consistency and amount of air incorporated into pilot-plant interesterified lards after plasticizing, air incorporating and tempering

Interesterified lards	Air volume incorporated (%v/v)	Penetration (mm/10)	
		18 °C	21 °C
After plasticizing and tempering:			
Run Ia + IIa (1 : 1)	—	201	>300
Run Ib + II b (1 : 1)	—	>300	>300
After plasticizing, air incorporating and tempering:			
Run I a + II a (1 : 1)	18.0	209	>300
Run Ib + IIb (1 : 1)	31.3	>300	>300

Table 5

Baking performance tests of pilot-plant interesterified lards

Product	Organoleptic properties of bread	Loaf volume (cm^3)
Margarine		
1.5%	—	1400
3%	—	1450
5%	—	1550
Untreated lard		
1.5%	Best porosity at 3% amount of fat. v. good	1505
3%	elasticity. Flavour characteristic for whea-	1506
5%	ten bread.	1540
Directly int. lard		
36 °C, 40 min.		
1.5%	Best porosity at 5% amount of fat. Thin-	1512
3%	-walled, regular cells. Crumb fluffy. At	1570
5%	1.5 and 3% crumb v. soft. V. good elasti-	1670
	city. Flavour characteristic for wheaten bread.	
Directly int. lard		
27 °C, 40 min.		
27 °C, 40 min. (catalyst added after cooling lard to 27 °C)		
1.5%	Best porosity at 5% amount of fat. At 5%	1540
3%	crumb v. fluffy. At 1.5 and 3% crumb v.	1628
5%	soft. Flavour characteristic for wheaten bread.	1700

on loaf volume (though this effect could rise as a result of air incorporation). Use of interesterified lards in biscuit formulation gave improved shortness and structure in comparision with margarine.

Table 6

Baking performance tests of pilot-plant interesterified lards

Product	Organoleptic properties of sweet biscuits
Margarine 4.4%	good shortness, good structure, good flavour
Directly int. lard 36 °C, 40 min. 4.4%	v. good shortness, v. good structure, v. good flavour
Directly int. lard 27 °C, 40 min. 4.4%	v. good shortness, v. good structure, v. good flavour

RESULTS

1. Depending on the conditions of the reaction interesterification of lard gives products of a wide range of physico-chemical properties.

2. Apart from the properties interesterified lard exerts distinctive as well as equal effect on baked goods of the same kind. It is valid in wide range of physico-chemical properties of interesterified lard.

REFERENCES

1. Karpińska B.: Penetrometric investigation of temperature influence on consistency of lard and some products of its interesterification. Roczniki Instytutu Przemysłu Mięsnego, 1969, s. 115.
2. Karpińska B.: Use of differential dilatometric curves in studies on animal fats. Roczniki Instytutu Przemysłu Mięsnego (in printing).

B. Karpińska

PRZEESTRYFIKOWANIE SMALCU DO ZASTOSOWANIA W PRODUKTACH PIEKARNICZYCH

Streszczenie

Przeprowadzono badania nad interestryfikacją smalcu w skali laboratoryjnej i 1/2 technicznej. W skali laboratoryjnej wykonano szereg interestryfikacji obejmujących reakcję niekierowaną i kierowaną. Proces kierowanej interestryfikacji prowadzono tak, aby uzyskać najpierw modyfikację struktury glicerydów w 80°C, a następnie po obniżeniu temperatury zwiększające się ilości trójnasyconych glicerydów, a także w taki sposób, aby w czasie reakcji krystalizowały głównie mie-

szane glicerydy o pośredniej temperaturze topnienia. Uzyskano produkty o różnych temperaturach topnienia, zawartości trójnasyconych glicerydów i penetracji w zależności od warunków prowadzenia procesu. Wyniki badań laboratoryjnych nad wpływem interestryfikowanych smalców na własności pieczywa drożdżowego i kruchego wskazywały, że z wyjątkiem produktu o najwyższej zawartości trójnasyconych glicerydów, pozostałe tłuszcze miały wpływ bardzo podobny. Badania w skali 1/2 technicznej potwierdziły wyniki uzyskane w skali laboratoryjnej.

Б. Карпиньска

ПРЕЭТЕРИФИКАЦИЯ ТОПЛЕНЕГО САЛА ДЛЯ ИСПОЛЬЗОВАНИЯ В ХЛЕБОПЕКАРНЫХ ИЗДЕЛИЯХ

Резюме

Проводились исследования по интерэтерификации сала в лабораторном и полутехническом масштабе. В лаборатории был проведен ряд интерэтерификаций охватывающих неуправляемую и управляемую реакцию. Процесс управляемой интерэтерификации проводился таким образом, чтобы сперва модифировать структуру глицеридов в температуре 80°С, а затем, после снижения температуры, увеличить количество трехнасыщенных глицеридов, а также таким образом, чтобы во время реакции кристаллизировали в первую очередь смешанные глицериды с посредственной температурой таяния. Были получены продукты с разными температурами таяния и с разным содержанием и проникновением трехнасыщенных глицеридов в зависимости от условий ведения процесса. Результаты лабораторных исследований по влиянию интерэтерификации сал на свойства сдобных и ломких хлебных изделий показал, что за исключением продукта с самым высоким содержанием трехнасыщенных глицеридов, влияние остальных жиров было очень сходным. Исследования в полутехническом масштабе подтвердили результаты полученные в лабораторном масштабе.