USING SURFACTANTS TO IMPROVE THE QUALITY OF COOKIES MADE FROM HARD WHEAT FLOURS[1]

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ABSTRACT

Several surfactants including sodium stearoyl-2 lactylate (SSL), sodium stearyl fumarate (SSF), and succinylated monoglycerides (SMG) were evaluated for their effectiveness in improving the quality of sugar cookies made from soft and hard red winter wheat (SRW and HRW) flours with two different baking methods. All surfactants tested improved cookie spread and top grain score, more when creamed into a shortening and sugar mixture than when used in powder form. The improving effect varied with surfactants, flours, and baking methods. Consumer acceptability of cookies was evaluated by elementary school pupils. Results indicated that children would have no preference between cookies made from SRW flour and HRW flour treated with 0.5% SSL.

Soft wheat flour is in short supply in the U.S., so its price is high. Although the supply changes yearly, it now seems economically necessary to use hard wheat flour to supplement or replace soft wheat flour in cookies and other soft wheat products. Generally, soft wheat flour has low-protein content, mellow-protein

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quality, low absorption, fine granulation, and less starch damage. Some of the soft wheat flour's characteristics are difficult for hard wheat flour to duplicate. Nevertheless, it also seems scientifically interesting to explore various chemical and physical means to improve the quality of cookies made from hard wheat flour.

Gracza found that farinograms and extensigrams from two fractions of a hard red spring (HRS) wheat flour (produced by air classification) were characteristic of soft wheat flours used in pastries (1), which suggests that fractions of air-classified hard wheat flour could be used in cookies. However, the fractions are costly to produce. We recently found a number of surfactants that increase the spread ratio of regular and high-protein cookies (2). Using such agents in making cookies from hard or soft wheat flour warrants further study.

In the study reported here, we examined whether hard wheat flour could be used to produce acceptable cookies by comparing several hard red winter (HRW) flours with different protein contents and a soft red winter (SRW) flour (a standard, commercially available cookie flour). We also used such dough conditioners as sodium stearoyl-2 lactylate (SSL) and sodium stearyl fumarate (SSF), added in various forms, to improve the quality of cookies made from hard and soft wheat flours by two baking methods.

MATERIALS AND METHODS

SRW flour was provided by the Mennel Milling Company, Fostoria, Ohio. HRW flours were obtained by milling HRW wheats including Eagle, Kirwin, Sage, and Scout varieties with the department's Miag experimental mill as straight grade flours. Protein contents and absorptions of the flours are listed in Table I.

Farinograms were obtained by the constant-dough weight method, using 50-g samples (3). Baking tests were conducted after the cookie baking procedure of Finney *et al.* (4) and the AACC Method 10–50 (3), referred to hereafter as Methods I and II, respectively. Except where otherwise stated, Method I was used throughout the study. Used for each Method I test was 160 g flour. All other ingredients were added at four times the quantity specified by Finney *et al.* in their micromethod III (4). Fine, granular sugar (Jack Frost) and Primex (hydrogenated vegetable oil, Procter & Gamble) were used for all baking tests.

TABLE I
Protein Contents and Absorptions of Indicated Flours (14% mb)

Flour	Protein %	Absorption %
SRW	8.87	55.7
Eagle	11.59	57.6
Kirwin	10.75	61.8
Sage	12.38	63.6
Scout I	8.08	57.9
Scout II	11.74	59.7
Scout III	12.02	60.6
Scout IV	11.70	60.9

The cookie cutter used was 60-mm diam. Six cookies were produced from each test. To calculate the spread ratio (W/T—where W is the average diameter and T the average thickness) the overall width, thickness, and weight of six cookies were measured in cm and g. Cookies' top grain was graded from 1 to 10. Finished cookies that scored below 5 were regarded as unsatisfactory. Most baking tests were repeated at least four times to substantiate results.

Consumer evaluation (acceptability) of cookies, made from the SRW flour and from Eagle flour not treated and treated with SSL, was conducted at a local elementary school with 34–38 Grades 3 and 4 students as tasters. Pupils were given small cookies (prepared using a 30-mm cutter) at about 3:00 P.M. each day. Small cookies made from the same formula under the same conditions were thought to be more suitable than the large ones for the organoleptic evaluation by small children. Each child received two cookies (SRW cookie against Eagle

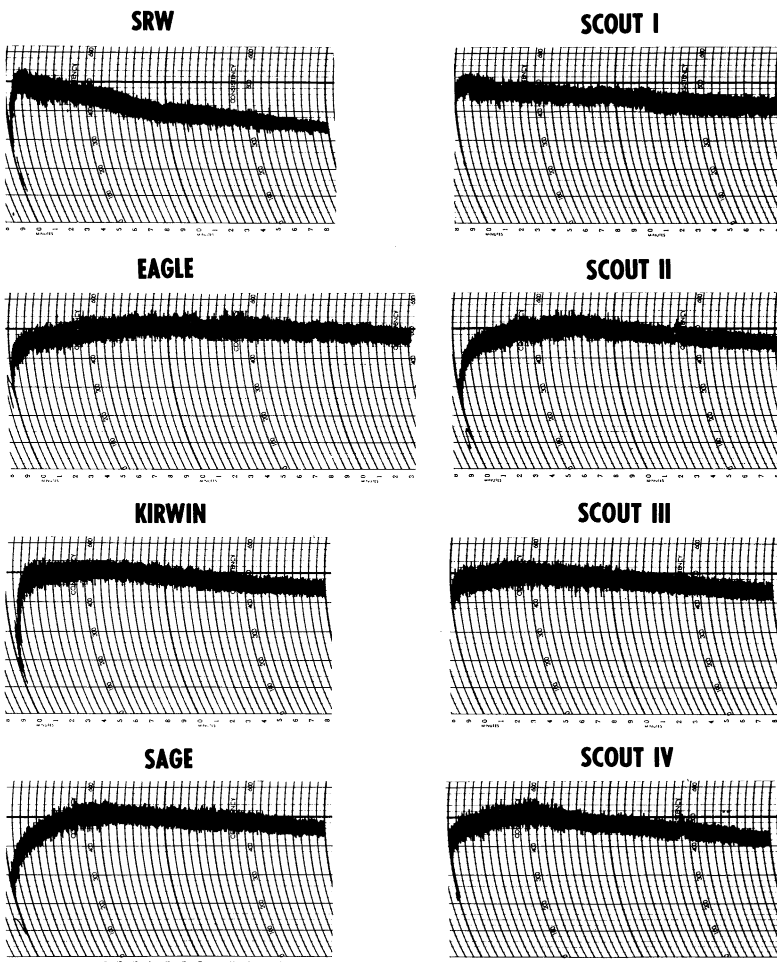

Fig. 1. Farinograms of SRW and HRW flours.

cookie with SSL, or Eagle cookie against Eagle cookie with SSL) identified as O and Δ on a paper plate and was asked to indicate on this evaluation form which one tasted better or acceptable.

A. ______ The cookies are acceptable.
______ The cookies are not acceptable.
• One of the cookies Δ ______ or O ______ is acceptable.

B. ______ I like Δ better than O.
______ I like O better than Δ.
______ I like Δ the same as O.

RESULTS AND DISCUSSION

Farinograms of SRW and HRW Flours

As shown by farinograms in Fig. 1, SRW flour developed and broke faster than HRW flours. SRW flour's absorption was lower than HRW flour's, including Scout I flour, which contained less protein than SRW flour (Table I). The weak dough and low absorption of SRW flour most likely reflect difference in gluten quantity and quality.

Cookies from SRW and HRW Flours Compared

Baking results (Table II) show average weights, diameters, and top grain scores of 36 cookies (6 cookies per test). Because the spread ratio is generally used to estimate cookie quality, the ratio's standard deviation also is listed in Table II to show the variation of cookies prepared by Method I. Cookies made from the SRW flour are superior to those from HRW flours.

Improving Action of Surfactants

As surfactants, particularly SSL, effectively improve the quality of regular and high-protein cookies (2), we used SSL to see if it could improve the baking performance of hard and soft wheat flours in cookies. Also, because succinylated monoglycerides (SMG) (in powder form) were recently reported to improve bread (5), we tested SMG along with SSL in different forms to compare their improving effects (Table III).

SMG in the powder form was more effective than SSL. However, SSL, powdered or creamed, gives a higher cookie spread ratio than SMG in the forms we tested. SSL need not be in powder form to be creamed into a shortening and sugar mixture for cookies.

SSL also effectively improved the spread of cookies made from the SRW flour. However, its effectiveness was less for the SRW flour than for Scout I flour, for spread ratio of the SRW cookies was originally high.

In addition to SSL and SMG, other surfactants [sodium stearyl fumarate (SSF), sucrose tallowate (ST), sucrose monopalmitate (SMP), and sucrose mono- and distearate (SMDS)] were tested. All improved cookie spread, more when creamed into a shortening and sugar mixture than when used in powder form. SSF raised spread ratio of cookies from Scout flour I more than other surfactants (Table IV). Data here on SSL, SSF, and other surfactants in

TABLE II
Average Weight, Width, Thickness, Spread Ratio, and Top Grain of Cookies Made from Indicated Wheat Flours

Flour	Weight g	Width cm	Thickness cm	Spread[a] Ratio	Top Grain Score
SRW	22.36	8.01	0.83	9.65 ± .26	8
Eagle	21.12	8.04	0.98	8.21 ± .14	8
Kirwin	20.71	7.48	1.00	7.48 ± .14	7
Sage	21.37	8.03	0.99	8.11 ± .36	8
Scout I	21.16	7.95	0.98	8.11 ± .17	8
Scout II	20.77	8.09	0.96	8.43 ± .14	7
Scout III	20.86	7.93	0.99	8.01 ± .17	8
Scout IV	20.75	7.75	1.01	7.68 ± .26	7

[a]Mean ± standard deviation.

TABLE III
Effects of SSL and SMG Added in Indicated Form at 0.5% (flour basis) on Average Cookie Spread Ratio

Flour	Surfactant	Spread Ratio
Scout I	O	8.11
	SSL (original)	9.09
	SSL (powdered)	9.71
	SSL (cream-in)	9.86
	SMG (original)	8.75
	SMG (powdered)	9.34
	SMG (cream-in)	9.51
SRW	O	9.65
	SSL (cream-in)	10.60

TABLE IV
Effects of Indicated Surfactants on Average Cookie Spread Ratios

0.5% Surfactant	Spread Ratio
SSF (original)	10.29
SSF (cream-in)	11.02
ST (original)	8.67
ST (cream-in)	9.50
SMP (original)	9.04
SMP (cream-in)	9.22
SMDS (original)	8.78
SMDS (cream-in)	9.18

improving cookie spread confirm work we reported previously (2).

The improving mechanism of the surfactants is not clear. It seems likely that surfactants like SSL and SMP delay gelatinization of flour starch[3]. The delaying action, though temporary, may reduce cookie-dough viscosity (consistency) and allow the cookie to spread before it firms or sets. That idea agrees with Yamazaki's finding that cookie doughs with a fast increase in viscosity spread less during baking than those whose viscosities increase slowly (6). We now are attempting to obtain more precise information regarding the action of surfactants on viscosity changes of cookie dough.

Test-Baking Methods Compared

Method I is better than Method II for making cookies (Table V and Figs. 2a

[3]Kim, Y. J., and Tsen, C. C. Unpublished data.

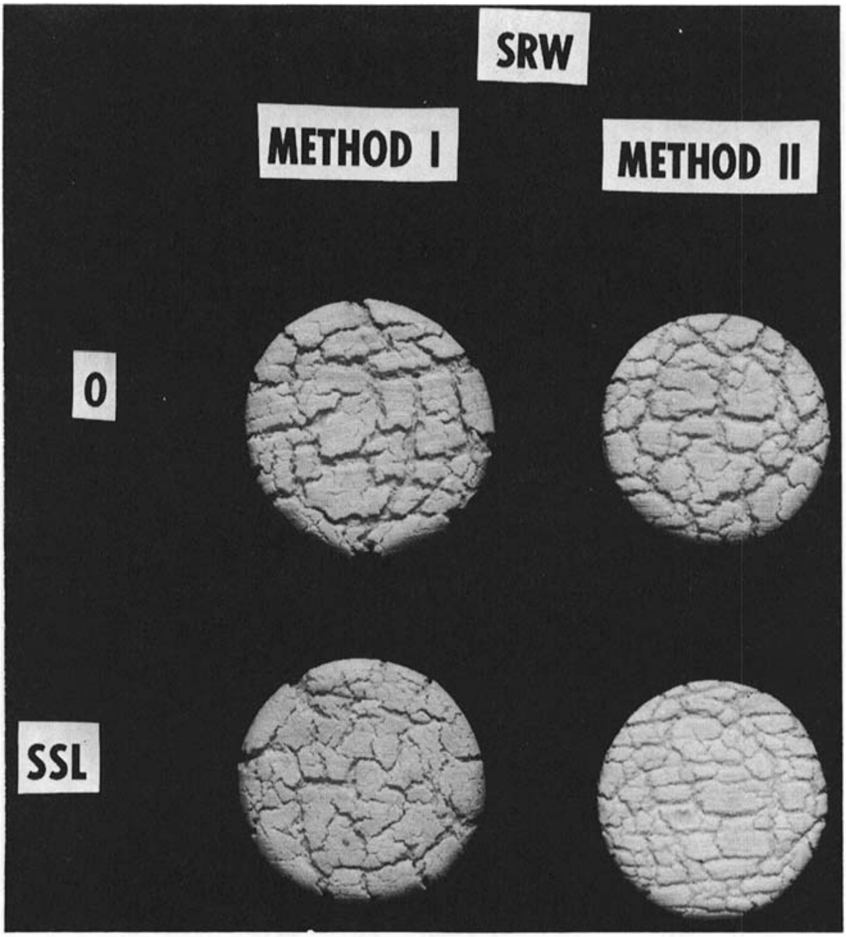

Fig. 2a. Cookies prepared from SRW flour with and without SSL by Methods I and II.

and 2b), which confirms the finding of Finney *et al.* (4). SSL greatly increased the spread ratio of cookies, whether prepared by Method I or II. With Method I, the three hard wheat flours treated with 0.5% SSL all gave cookies with higher spread ratios than soft wheat flour did. However, if soft wheat flour also is treated with SSL, its spread ratio is much higher than that of cookies from hard wheat flours.

Consumer Evaluation

The cookies for testing were all rated acceptable (part A of the evaluation form).

To statistically evaluate data from part B of the form, we used the sign test (7). Chi-square values calculated from the data:

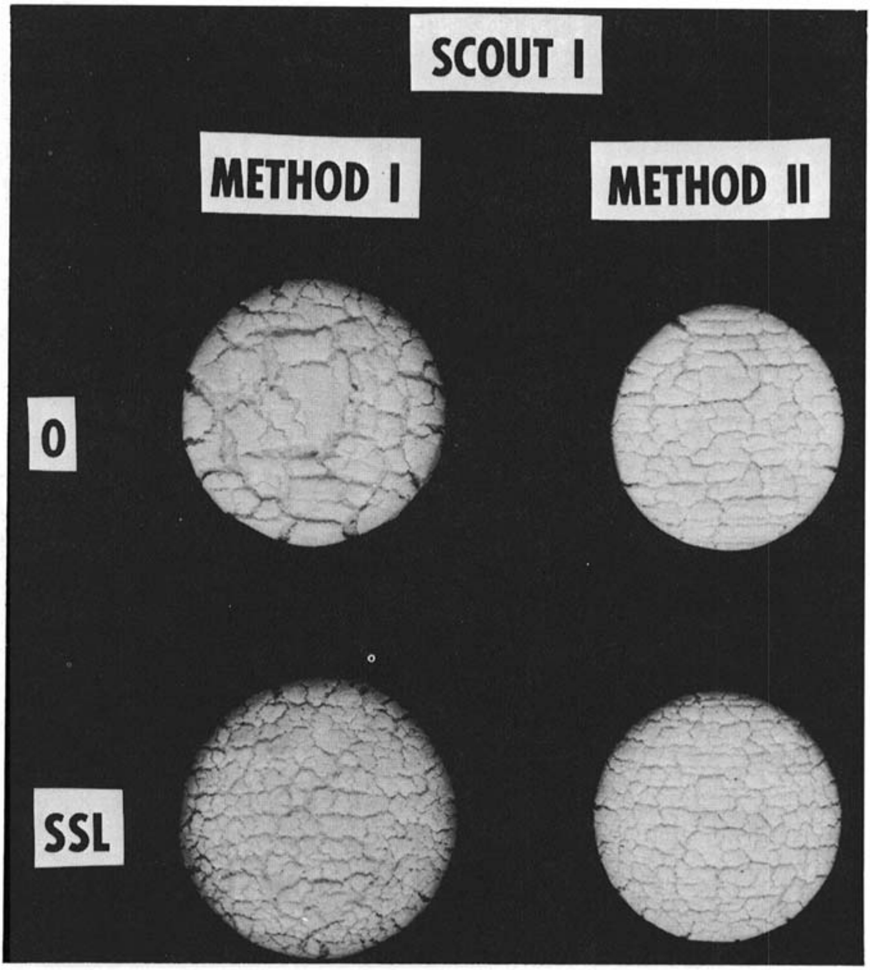

Fig. 2b. Cookies prepared from Scout I flour with and without SSL by Methods I and II.

Survey	*I*	*II*
No. of participants	37	34
No preference	22	18
Preference (a+b)	15	16
a) SRW cookie preferred	10	11
b) Eagle cookie with SSL preferred	5	5
Chi-square value (between blocks)	1.324^{ns}	0.118^{ns}

Preferences did not differ at 5% level. That is, participants did not distinguish between SRW and Eagle cookies with SSL. Within the preference block (15 and 16 in Surveys I and II), chi-square values were 1.667^{ns} and 2.250^{ns} for Surveys I and II, respectively. Again, no difference detected between SRW cookies and Eagle cookies with SSL.

Additional surveys, conducted to ascertain difference in taste between Eagle and Eagle-with-SSL cookies, showed no significant differences. Apparently,

TABLE V
Average Weights, Widths, Thicknesses, Spread Ratios, and Top Grain Scores of Cookies Made from Four Flours with and without SSL by Baking Methods I and II

Method, Treatment and Flour	Weight g	Width cm	Thickness cm	Spread Ratio (W/T)	Top Grain Score
Method I					
No SSL					
Scout I	21.16	7.95	0.98	8.11	8
Scout II	20.77	8.09	0.96	8.43	7
Eagle	21.12	8.04	0.98	8.21	8
SRW	22.36	8.01	0.83	9.65	8
0.5% SSL					
Scout I	22.76	8.33	0.87	9.58	9
Scout II	22.31	8.50	0.83	10.24	8
Eagle	22.34	8.51	0.86	9.89	9
SRW	22.88	8.59	0.84	10.22	8
Method II					
No SSL					
Scout I	22.27	7.59	1.08	7.03	7
Scout II	21.57	7.40	1.09	6.79	7
Eagle	21.43	7.49	1.07	7.00	7
SRW	22.81	8.03	0.92	8.73	8
0.5% SSL					
Scout I	23.21	7.82	0.91	8.59	9
Scout II	21.89	7.65	0.91	8.40	9
Eagle	23.13	7.66	0.92	8.32	8
SRW	22.66	8.04	0.88	9.14	9

even though SSL greatly increases cookie spread and improves top grain score, it has no effect on children's taste preference.

Survey	*I*	*II*
No. of participants	38	36
No preference	21	17
Preference (a+b)	17	19
a) Eagle cookie preferred	5	9
b) Eagle cookie with SSL preferred	12	10
Chi-square value (between blocks)	0.421^{ns}	0.111^{ns}

The chi-square values are 2.882^{ns} and 0.053^{ns} calculated from the block of preference for Surveys I and II.

Acknowledgments

Financial support from C. J. Patterson Company and The International Sugar Research Foundation (ISRF 299) is gratefully acknowledged. Thanks are also given to The Mennel Milling Company for kindly supplying soft wheat flour.

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[Received July 25, 1974. Accepted January 2, 1975.]