

Production of Two Types of Pocket-Forming Flat Bread by the Sponge and Dough Method

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ABSTRACT

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Two types of flat bread (thin and thick) were produced from straight-grade flour by the traditional straight dough (SD) and sponge and dough (SPD) methods using 50 and 60% sponges. Quality of the resulting bread was evaluated with respect to specific volume, crumb distribution between layers, moisture content, overall sensory quality, and rate of staling. The results showed that the method of production has a significant effect ($P < 0.05$) on the specific volume of the crumb-rich thick flat bread but not on the almost crumb-free thin type. The study showed that breads produced

with the SPD method were superior to those produced by the SD method with respect to their overall quality and resistance to staling, and that using 50% sponge gave bread with superior overall sensory quality to that obtained using 60% sponge. The results indicate that the Structograph can be used to follow the staling of these breads. Nonetheless, using the SPD method has some drawbacks, mainly longer fermentation time, and more space, mixing, and labor requirements that are expected to limit its use in commercial production of flat bread types.

Wheat bread is the staple food in the Middle East (Ayoub and Knight 1991), it contributes ≈ 53 and 65% , respectively, of the total calorie and protein intake by Jordanians and up to 90% of the calorie intake by some other peoples of the Middle East (Amr 1988). Flat breads, many of them are known today as “Arabic” breads (Cornell and Hoveling 1998), are among the oldest forms of bread and are the most popular types in the Middle East. They are gaining great acceptance even in other parts of the world (Abu Gholi 1999).

The most common type of flat bread in the Middle East consists of two separate layers, which makes it suitable for sandwich preparation due to its pocket-forming property, as opposed to the other single-layer, or crumb-rich nonpocket-forming types. Pocket-forming bread types constitute $\approx 60\%$ of the total bread produced in Jordan (Amr 1988) and they are usually available in two forms: the traditional thick flat bread, also known as pita, and the thin type known as “Lebanese” bread.

Loaves of the typical thick type are usually small in diameter (≈ 12 – 25 cm), relatively thick (0.50 – 1.0 cm), and have a considerable amount of crumb, a feature that results in ideal pocket formation suitable for preparation of sandwiches prepared from foods containing liquid sauces, as the crumb has the advantage of liquid-absorbing ability. The presence of a substantial amount of crumb in this bread makes it easier to chew than the thin type, which makes it preferred by the elderly and children. Traditionally, this bread type is produced manually or semiautomatically and baked in hearth ovens, although fully automated production is getting more popular these days, especially in large cities. Typical thin flat bread, on the other hand, is usually up to 45 cm in diameter (although smaller versions are produced too), between 0.2 – 0.3 cm thick, and has almost no crumb. It consists of two paper-thin layers (Amr 1988) that are easily separated when the bread is freshly baked and become hard to separate when the bread is kept overnight. In addition to pocket formation, the whole loaves of this thin type can be rolled easily with the two layers attached, to hold food or spread without the need for pocket formation, in which case a roll is literally formed rather than a sandwich. Here, the crumb is not as desirable a property as in the thick type because the food contained in the roll usually contains small

amounts of liquid. In contrast to the thick type, the thin type is usually produced automatically and baked in continuous ovens at higher temperatures for shorter times. The main differences between the two types, with respect to their production method, are the sheeting and proofing steps. Thick or pita doughs are sheeted less vigorously by widening the gap between the sheeting rolls (5 – 8 mm vs. 2 – 3 mm in thin type) and proofed for a longer time than thin flat bread doughs, a process that allows for more crumb formation later upon baking.

Traditionally, the two bread types have been produced by the straight dough (SD) method in most Middle-Eastern countries. However, due to the rising demand for freshly baked bread, and the wide-spread use of fully automated, large-scale, commercial bakeries, there has been a growing need for baking methods that are more flexible in terms of scheduling and tolerance to variations in ingredients and processing conditions than the traditional SD method currently used by all bakeries. Pressure imposed by the high demand on bakeries for fresh bread to supply the lines of customers made improper mixing and proofing responsible for most of the quality problems encountered in Jordan’s baking industry (Ajo 2002).

The objectives of this work were to study the possibility of adapting the sponge and dough (SPD) method for the production of these two bread types and to compare the quality of the bread obtained by the two methods (SD and SPD) as well as their processing requirements.

MATERIALS AND METHODS

Flour Sample

Straight-grade flour (72 – 78% extraction) was obtained from the local market in 50 -kg polypropylene-knit bags. All flour used in the study was obtained from the same mill, on the same day, from the same batch of wheat.

Flour Characterization

Moisture, ash, protein, falling number, and wet gluten were determined according to Approved Methods 44-15A, 08-03, 46-13, 38-11, and 56-81B, respectively (AACC International 2000). A Glutomatic apparatus (Brabender type 219013, Duisburg, Germany) was used for gluten washing. Falling Number apparatus (Falling Number AB, type 1402, No. 1531, Huddinge, Sweden) was used for falling number determination.

Farinograph Test

Farinograph testing was performed according to Approved Method 45-21 (AACC International 2000) using a Brabender Farinograph (model 810104, Duisburg, Germany) supplied with a

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model 820501 (S300N) mixer. Farinograph parameters were calculated according to the method described by D'Appolonia and Kunerth (1984).

Baking Trials

A lean formula consisting of flour, salt (1.5%), compressed yeast (2%), sugar (2.5% for thin and 2% for thick), and water (55%) was used. In the SD method, all of the flour was mixed with the rest of the ingredients, while in the SPD method, two trials were conducted. In the first one, all the flour quantity was divided equally (50:50) between the sponge and dough stages, and in the other one, the flour was divided 60:40 between the sponge and dough stages, respectively. This regime was followed in the production of the two bread types. Ingredients were mixed in a commercial 50-kg mixer under the supervision of an expert baker, and temperature and humidity were measured in the bakery using a mercury thermometer and a sling Psychrometer (Tayler 1328A).

In the SPD method, sponges were prepared by mixing the specified amounts of flour (50 or 60% of the total flour) with the yeast, and the respective proportions of water, salt, and sugar for 6 min to form a moderately stiff dough. This was moved to a stainless steel bowl, covered, and left to form the sponge at 30°C and 68% rh for 60 min, with punching after 20 and 40 min. After its formation, the sponge was returned to the mixer and the rest of the dough ingredients were added (the remaining flour, water, salt, and sugar). The whole batch was then mixed for 9 min more to attain the optimum consistency and kept in the stainless steel bowl for bulk fermentation for an additional 20 min.

In the SD method, all ingredients were mixed together for 9 min and the dough was left in the mixer bowl for bulk fermentation for 30 min at the bakery conditions of 30°C and 68% rh.

After bulk fermentation, doughs produced by the two methods were divided, rounded, and intermediate-proofed on flour-dusted wooden boards for 20 min for thick bread and 5 min for thin bread, then sheeted mechanically by means of a roller sheeter. The gap between the rolls was narrower for thin bread (2–3 mm) than for thick bread (5–8 mm). The dough sheets were then rested (final proofing) for 20 min for thick bread and 15 min for thin bread on the same wooden boards. Thick bread dough sheets were baked in a hearth oven at 400–450°C for 1–1.5 min, while thin bread sheets were baked in a continuous oven at 500–550°C for 15–20 sec. After baking, the bread was cooled to room temperature with an air fan for 1 hr before quality evaluation.

Day 1

Crust	Score
Brown or black spots ()-----	(5)
Cracks ()-----	(5)
Crispness ()-----	(5)
Crust color ()-----	(5)

Crumb	Score
Color ()-----	(5)
Evenness of cells ()-----	(5)
Smoothness ()-----	(5)
Shine and sheen ()-----	(5)
Ease of chewing ()-----	(10)
Pocket formation ()-----	(10)
Rolling and folding ()-----	(10)
Taste ()-----	(5)

Day 2

Pocket formation (ease of separation) ()-----	(10)
Ease of chewing ()-----	(5)
Rolling and folding ()-----	(5)
Taste and aroma ()-----	(5)
Total score ()-----	(100)

Fig. 1. Sensory evaluation sheet for flat bread.

pH Determination of Dough

The pH of the dough was determined on the doughs at the end of both the sponge and dough stages in the SPD method and at the end of the bulk fermentation stage in the SD method. A dough sample (20 g) was mixed with 80 mL of distilled water with stirring. The pH was read immediately using a pH meter (P107, Consort, Belgium).

Evaluation of Bread Quality

All quality parameters were recorded 1 hr after baking and in duplicate. Specific volume (cm³/g) was determined by the sesame seed displacement method (Amr 1988). Upper layer percent was determined by separating the upper layer and weighing, then dividing by the weight of the whole loaf multiplied by 100. Moisture content of bread was determined according to Approved Method 44-15A (AACC International 2000) using an air convection oven (Memert, type UL50, Germany). Softness of the bread was evaluated using the compression module of the Structograph instrument (model 8 603, Brabender, Duisburg, Germany). Results were interpreted by calculating both the area under the curve using a Planimeter (315 E, Gebr. Wichmann, Germany), and the time the curve takes to reach the peak. The test was performed on 10- × 10-cm sections of the cold loaves containing both upper and lower layers at 1 and 24 hr after baking. Higher readings for either area under the curve or peak time indicate softer bread. The difference in the Structograph reading (% change) for the given parameter between readings from the first and second days was considered as an index of the rate of staling (higher % change indicates higher staling rate).

Sensory Evaluation of Bread

Bread samples were evaluated within 1 hr of baking by 10 panel members. Panelists were chosen from laboratory technicians and teaching staff of both sexes, with an age range of 23–34 years; they were all trained in bread evaluation before recording their results. They were asked to rate the bread on a scale of 1 to 5 for some parameters and from 1 to 10 for others, as shown in the accompanying score sheet where the scores of 5 or 10 were excellent and 1 was poor (Fig. 1).

Parameters evaluated on the first day included presence of spots and cracks on the crust, crust color, and crispness, as well as crumb color and evenness of crumb cells, smoothness, shine, and sheen of the interior of the loaves, freedom of the upper layer from crumb, ease of chewing, pocket formation, presence of flour lumps, and ease of rolling and folding. On the second day, loaves from the same treatments were evaluated for pocket formation, ease of chewing, and ease of rolling and folding. The test was conducted at room temperature (≈25°C) and water was provided to the panelists for mouth washing.

Statistical Analysis

Data was analyzed using the Statistical Analysis System (SAS Institute, Cary, NC). Analysis of variance (ANOVA) of the different treatments was done using a randomized complete block design (RCBD) followed by the least significant difference (LSD) test. Correlation coefficients (*r*) between the different dough and bread quality parameters were calculated using the same package.

RESULTS AND DISCUSSION

Flour Characterization

Straight-grade flour (74–80% extraction rate [JISM 1992]) is used in the production of the thin bread and most of the thick flat bread in Jordan, while patent-grade flour (up to 73% extraction [JISM 1992]) is used mainly for the production of some of the thick bread and other types of bread. In this experiment, straight-grade flour from the same batch was used in the production of the two types of bread. The farinograph absorption (58.8%) of this

flour is lower than that required for pan bread production. Yet, it is ideal for flat bread as it facilitates handling and machining of the dough in the absence of the pan that holds the dough in place during proofing and baking (Amr 1988). Its protein content is 12.2%, which is also ideal for flat bread production (Qarooni et al 1988), while the falling number (470 sec) is considered too high for pan bread production, although it is suitable for the production of the freshly consumed flat bread where crust drying and cracking is not a major problem. Malting of flour for production of these types of bread is not a common practice in the Middle East bakeries, although it is a standard practice in the production of some other local high-crumb types. The low amount of crumb that characterizes these two flat bread types makes them less sensitive to the low amylase activity of the flour, as it usually has most influence on the crumb properties and, consequently, would be of higher value in the crumb-rich pan bread. This flour has an ash level of 0.6% and a wet gluten level of 28% on an as-is basis.

The farinograph data indicate a medium strong flour (valorimeter value of 82/100) with good stability (25 min), and mechanical tolerance index (40 BU) necessary for the automated production of the thin bread. Other relevant farinograph parameters included arrival time of 2.5 min, peak time of 3.5 min, and departure time of 27.5 min.

Effect of Using Sponge and Dough Method on Dough Properties

The dough produced by SPD method was softer, more shiny, and had better handling properties than that produced by the SD method. This is probably due to the fact that the dough was mixed twice and fermented for a longer time, resulting in more mellowed and conditioned dough as compared with that produced by the SD method. The smell of the dough produced by the SPD method as judged by the baker (especially 50% flour sponge) was superior to that produced by the SD method, which has a positive effect on the aroma of the finished product. It was also observed that the doughs produced by the SPD method had more small air cells than those produced by the SD method due to the double mixing and increase of the air incorporation in the dough that helped produce a bread with a finer grain and softer texture. Sheetting of the doughs prepared by SPD method was easier and gave dough pieces with larger surface area than those prepared by the SD method under the same sheetting conditions. Better modification of the gluten during the longer mixing and proofing times is expected to result in improved extensibility of the dough with the consequent better sheetting and machinability of the dough without the use of any additives.

Effect of Using Sponge and Dough Method on Dough pH

When 50% sponge was used, the pH values of the sponges were 5.27 for thin type and 5.37 for thick type. These values are lower than those of the doughs (5.31 and 5.46) for the same bread types. On the other hand, the pH values of the 60% sponges of thin types were 5.41 and the thick types were 5.31, and those of their doughs were 5.48 and 5.43, respectively. The lower pH levels of the 50% sponge doughs, as compared to 60% sponge doughs, indicate better yeast action in the former. Addition of the same yeast quan-

tity to more flour (60% vs. 50%) is expected to result in less fermentation due to the dilution effect and the buffering effect of the flour (Pylar 1973; Hosenev 1986) on the other.

All pH values of the doughs prepared with the SPD method were lower than those of the doughs prepared with SD method (pH 5.55), which is likely to be due to the shorter fermentation time in the latter. However, the pH of the dough obtained by the two methods is within the suitable range for proper fermentation of yeast (4.8–5.5) (Doescher and Hosenev 1985; Reed and Nagodawithana 1991).

Effect of Using Sponge and Dough Method on Bread Characteristics

Specific volume. In general, the specific volumes of the bread produced by the SPD method were higher than those bread types produced by the SD method for the thin and thick bread types (Table I), which is probably due to more air incorporation in the dough as a result of more mixing. Data in Table I also show that the method of production has no significant effect on the specific volume of the thin bread, yet it has a significant effect ($P < 0.05$) on the specific volume of the thick bread, where the 50% sponge SPD bread had significantly higher specific volume than the same bread produced by the SD or 60% SPD methods. Other workers reported specific volumes of 1.6 cm³/g for thick flat bread produced by the SD method (Yousif et al 1997; Abu Gholi 1999). More mixing also resulted in more subdivision of the air bubbles produced during proofing to give doughs with more, smaller sized bubbles (Hosenev 1986). This action helps produce bread, pan or flat, with more porous, spongy crumb, and finer grain than that produced with the SD method. This effect was more pronounced in the crumb-rich thick bread as its spongy crumb tends to increase the specific volume, while the crust that makes up most of the thin bread contributes little to this parameter. Furthermore, a highly significant negative correlation coefficient ($r = -0.83$, $P < 0.05$ and $r = -0.81$, $P < 0.05$ for thin and thick types, respectively) was found between the specific volume and the rate of staling as expressed by the change in the peak time of the structogram in these types of bread, thus confirming the suggestion that the same factors responsible for the high specific volume in pan bread are also responsible for the low rate of staling (Pylar 1973; Stuteville et al 1988). This seems to hold true even in the low-crumb flat bread.

Crumb distribution between layers. It is desirable to have less crumb attached to the upper than the lower layer in the thick type, and to have as little crumb as possible attached to any of the two layers in the thin type. The upper layer percent (ULP) was used as an indicator of the crumb distribution. Data in Table I show that production method has a significant effect ($P < 0.05$) on the crumb distribution in the thin type, as the ULP of the bread produced by SPD method (both 50 and 60% sponges) was significantly higher than that produced by the SD method. The value obtained for the thin bread produced by the SD method (51%) agrees with that reported by Amr (1988) for the same bread type produced by the same method. On the other hand, the method of production seems to have no significant effect on the crumb distribution as evaluated by this parameter in the thick bread (Table I). The significant effect ($P < 0.05$) exerted by the production method on the crumb distribution in the thin type is most likely to be a result

TABLE I
Characterization of Thin and Thick Flat Bread Produced by Straight Dough (SD) and Sponge and Dough (SPD) Methods^{a,b}

Characteristic	Thin			Thick		
	SD	50% Sponge SPD	60% Sponge SPD	SD	50% Sponge SPD	60% Sponge SPD
Specific volume cm ³ /g	2.49a	2.59a	2.64a	2.10b	2.59a	2.23b
Upper layer (%)	51.40b	53.06a	52.47a	54.90a	54.40a	54.90a
Moisture (%)	26.81b	27.90a	27.84a	32.20c	33.70b	34.53a

^a Values are means of two replicate measurements taken within 2 hr after baking.

^b Values followed by the same letter in the same row and bread type are not significantly different ($P < 0.05$).

TABLE II
Softness Scores as Indicated by Structograph Parameters of Thin and Thick Flat Bread Produced by Straight Dough (SD) and Sponge and Dough (SPD) Methods^{a,b}

	Thin Bread						Thick Bread					
	Peak Time (min)			Area (PU)			Peak Time (min)			Area (PU)		
	SD	50% SPD	60% SPD	SD	50% SPD	60% SPD	SD	50% SPD	60% SPD	SD	50% SPD	60% SPD
First day	9.25b	10.25a	10.50a	1,900c	1,911b	1,921a	11.50b	12.25a	12.00a	2,146c	2,210b	2,253a
Second day	8.50b	10.00a	10.00a	1,798c	1,898b	1,905a	10.25c	12.00a	11.50b	2,096c	2,200b	2,230a
% Change	8.10a	2.44c	4.70b	5.37a	0.68b	0.80b	10.86a	2.00c	4.16b	2.33a	0.45c	1.02b

^a Area under curves was measured using a Planimeter (PU = Planimeter unit = 10² mm).

^b Values of peak times or areas, within the same row and bread type, followed by the same letter are not significantly different ($P < 0.05$).

TABLE III
Mean Overall Quality Scores^a of Thin and Thick Flat Bread Produced by Straight Dough (SD) and Sponge and Dough (SPD) Methods^b

	Thin			Thick		
	SD	SPD 50%	SPD 60%	SD	SPD 50%	SPD 60%
Quality score	80.4c	88.2a	85.4b	77.6c	87.0a	78.6

^a As assigned by 10 panelists (scores out of 100).

^b Values within the same row and bread type followed by the same letter are not significantly different ($P < 0.05$).

of the longer fermentation time followed in the SPD method, which results in more conditioning of the dough and in higher yeast activity and gas production, thus more crumb attachment to the upper layer than in the same bread produced by the SD method. The production method had a less significant ($P < 0.05$) effect on the ULP in the crumb-rich thick type due to the high amount of crumb in the bread regardless of the production method. In other words, the effect of the SPD method was so small that it was detected only when the comparison was made with the low-crumb bread. Again, having more crumb attached to the upper layer is not a desirable property in the thin type, especially when consumed overnight.

Bread moisture. Table I shows that the two bread types produced by the SD method have significantly ($P < 0.05$) lower moisture content than those produced by the SPD method, and that no significant difference was found between the moisture content of the 50 and 60% sponge SPD breads in the thin type. However, the 50% sponge SPD bread had significantly ($P < 0.05$) lower moisture content than the 60% sponge SPD bread in the thick type. The Jordan Standard of Identity for these two bread types states that their moisture content determined 1 hr after baking should not exceed 32% (JISM 1981). The moisture content of the thick breads produced by both the SD and SPD methods is around this level, except in the 60% sponge bread that was slightly above the specified level due to its higher crumb content that retains more moisture because the thick SPD bread is higher in moisture than its SD counterpart, although its dough is prepared with the same water absorption. It can be inferred that SPD method helps produce bread with more moisture, even in the thin type that is baked at higher temperature. However, the moisture level in this bread can be brought down by reducing the absorption further, thus confirming earlier recommendations by Hallab et al (1974) to the effect that Arabic bread (thick flat) absorption should be less than the farinograph absorption measured at the 850 BU line.

The thinner dough sheets of the thin type result in better heat transfer during the high-temperature baking process, with the result of moisture in this bread falling within the limits specified by the standard (JISM 1981) as compared with the thick type which had higher moisture.

Staling. Structograph readings using the compression module of the instrument were taken on the first and second day after baking. On the first day, both bread types produced by SPD method (50 and 60% sponges) showed significantly ($P < 0.05$) higher

peak times than those produced by the SD method (Table II), thus indicating softer breads. But no significant differences were observed between the 50 and 60% sponge breads with respect to their peak times. On the second day, the same pattern was observed in the low-crumb thin type, but differences were more apparent between the high-crumb thick breads, where the 50% SPD bread exhibited significantly ($P < 0.05$) higher peak times (softer) than each of the 60% SPD and SD breads. The results of the second day seem to give a better picture of the softness of the bread than those of the first day, as more time was allowed for firming. The data indicate that the SPD treatments gave softer breads than those of the SD on both days, thus confirming earlier reports that the SPD method helps delay the staling of pan bread (Pyler 1973; Kilborn et al 1981; Preston and Kilborn 1982).

Data in Table II also show that the area under the curve indicates a similar pattern (SPD bread showed significantly higher readings than SD bread), although the 60% SPD bread showed significantly higher readings than the 50% bread on both days in both types of bread. This perplexing result is probably due to different types of forces influencing these two Structograph parameters, a phenomenon that needs further research.

The rate of staling as indicated by the percent decrease in the peak time was in the order of SD > 60% sponge SPD > 50% sponge SPD with the differences being significant ($P < 0.05$) between each of two successive treatments in both bread types (Table II). The same pattern was observed in the area under the curve in thick bread, however the difference was not significant ($P < 0.05$) between the 50% sponge SPD and the 60% sponge SPD in the thin bread, although each of the two treatments showed significantly ($P < 0.05$) lower staling rate than the SD bread.

Overall Quality of Bread

Data in Table III show that SPD breads had significantly ($P < 0.05$) higher quality scores than their SD counterparts, and that the 50% sponge bread had significantly ($P < 0.05$) higher scores than the 60% sponge bread regardless of the bread type (thin or thick). The data also indicate that the quality of the thin type, as judged by this panel, is superior to that of the thick type, regardless of the method of production, thus implying a shift in consumer preference toward this type of bread which is getting more popular throughout the Middle East. The presence of substantial amounts of crumb attached to the lower layer tends to lower the scores of the thick flat bread, especially when evaluated cold on

TABLE IV
Processing Requirements of Straight Dough (SD) and Sponge and Dough (SPD) Methods Used in the Production of Thin and Thick Flat Bread

	Thin		Thick	
	SD	SPD	SD	SPD
Total time (min) needed to bake a ton of flour (20 batches) ^a	360	373	284	294
Mixing time (min)/batch/ton	9/180	15/300	9/180	15/300
Energy cost (US\$/ton of flour)	0.94	1.57	0.94	1.57
Time needed for fermentation of the first batch (min)	30	80	30	80
Number of mixing bowls needed/batch	1	2	1	2
Labor requirements (man/day of work)	3	3	5	6

^a Batch = 50 kg of flour.

the second day because of the lumpiness and sogginess imparted by the crumb. This is less of a problem in the crumb-free thin flat bread; it gained higher scores on both days, regardless of the method of production. Flat breads have maximum consumer acceptability when they are hot out of the oven or heated to restore freshness when left overnight.

Problems Related to Application of Sponge and Dough Method

The SPD method needs a continuous follow-up to prepare the final dough due to the need for two mixing and fermentation steps. The SPD method requires more mixers, more containers, more energy, and more labor as shown in Table IV. Longer fermentation times can slow production and require better time management, although this problem can be solved partially by adding sugar in the sponge stage instead of the dough stage, which reduces the bulk fermentation time considerably (unpublished data). To apply this method more efficiently, a type of mixer with movable bowls is needed to allow the sponge dough to ferment in it, and then to retain this bowl in the mixer to carry out the second stage of mixing to produce the final dough. These types of mixers may need larger areas in the bakeries and could slow production.

Data in Table IV also show that the SPD method requires more labor than the SD method, particularly for production of the thick type (six vs. five workers/day), while there is no difference between the two methods in their labor requirements for the mechanically produced thin bread, which also requires less labor than the manually produced thick bread. Furthermore, the SPD method requires more total energy (not including that required for the baking step) for the production of one ton than the SD method due to the extra mixing time. However, the superior quality of the bread produced by the SPD method justifies the cost incurred by its application.

CONCLUSIONS

Results of the study indicate that the doughs produced with the SPD method have improved handling properties, sheeting, smoothness, and machinability as compared with those produced by the SD method. Properties of both thin and thick flat types of bread were improved upon using the SPD method, especially in terms of higher moisture retention and reduced staling rate, especially in the thin type as indicated by the compression module of the Structograph instrument. Staling, as evaluated by the change in the structogram peak time over the second day, proceeded at a significantly ($P < 0.05$) slower rate in the 50% sponge SPD bread than its 60% sponge counterpart in both bread types, and only in thick bread when it was evaluated by the change in the area under the peak. Effect of using the SPD method on the specific volume of the bread was apparent only in the crumb-rich thick bread as the crumb contributes more to the specific volume than the crust, while this effect was not significant in the thin type, which is made of two crust layers with little crumb attached to the upper layers.

The results also indicate that a significant increase in the overall quality of the bread produced by SPD method was obtained as

compared with the quality of the bread produced by the SD method, and that the use of 50% sponge helped produce a bread with sensory quality superior to that produced by the 60% sponge. In either case, the quality of the thin type of bread was superior to that of the thick type, as expressed by the panelists. The SPD method, however, requires longer fermentation time, larger work area, and more energy and labor than the traditional SD method which restricts its use to the larger size bakeries.

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