Replacement of Shortening in Yellow Layer Cakes by Corn Dextrins

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ABSTRACT

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Shortening in a conventional yellow layer cake was replaced by maltodextrin (MD), amylodextrin (AD), octenyl succinylated amylodextrin (OSAD), or mixtures (MD+AD and MD+OSAD). The physical and sensory characteristics of the shortening-free cakes were investigated. The specific gravity and viscosity of the cake batter, and the volume index of the baked cake were significantly reduced by MD, whereas the cake with added AD or OSAD showed a higher volume index than the control cake containing the shortening. An equivalent mixture of MD and AD, or MD and OSAD, however, produced cakes with a volume index and color defined as $\Delta E^*(ab)$ that was similar to the control cake. Sensory evaluation revealed that the cakes containing AD or OSAD had significantly higher firmness than the control, but the cakes containing a mixture of MD and AD had firmness, springiness, and overall flavor scores similar to that of the control cake. According to instrumental texture profile analysis (TPA), MD addition, either alone or mixed with AD or OSAD, reduced firmness, whereas AD addition made the cake significantly firmer. When the shortening-free cakes were stored for eight days at 4°C, TPA revealed greater changes in cake firmness and adhesiveness for MD alone. Cakes made from mixtures of dextrins (MD+AD and MD+OSAD) showed textural change with storage similar to that of the control cake, although the MD+AD cake remained softer than the control.

Fat is one of the important ingredients influencing the sensory characteristics of baked products (Conforti et al 1997). Attempts have been made to replace the fat with other food components in baked products to reduce the total calories as well as to enhance nutritional properties. Among the substituting materials, carbohydrates are widely used in baked products, partly because they have economical advantages over many other fat substitutes (Alexander 1992).

Starch, one of the most economic and abundant carbohydrates in nature, can be modified by various procedures to give the desired physical characteristics for use as a food additive. Most of the structural modifications allowed for food starches can be categorized into two groups: cleavage of the acetal linkages of the anhydrous glucose units, and substitution on the hydroxyl groups on the anhydrous glucose units. Acetal cleavages can be achieved using acids, enzymes, or physical treatments. Under mild conditions, hydrolysis produces solid dextrins such as maltodextrin and amylodextrin.

Maltodextrin is defined as a nonsweet oilgosaccharide of α-D-glucose units with dextrose equivalent (DE) < 20 (Fryer and Setser 1993). It is widely used for partial replacements of fats in a variety of processed foods because of its ability to form a particle gel cream in food systems (Sobczynska and Setser 1991; Alexander 1992).

Amylodextrin, with a DE lower than that of maltodextrin, can be prepared by selective hydrolysis of starch in its amorphous regions under mild conditions with a dilute inorganic acid. The dextrin that is obtained is not fully gelatinized (Chun et al 1997). Therefore, amylodextrin is normally composed of crystalline particles in starch, whereas maltodextrin is obtained as an amorphous powder or syrup. Amylodextrin gelatinizes more readily at lower temperature ranges than the corresponding native starch, and produces a thin paste that readily forms a gel due to the rapid association of the short linear amylodextrin chains (Kainuma and French 1971; Komiya and Nara 1986; Stanley and Harris 1995). When an aqueous dispersion of amylodextrin is homogenized at a high shear rate, the amorphous portion is collapsed to form small crystalline particles. These particles align with other dextrin chains to form a stable matrix that behaves like a fat particle with an emulsified creamy texture (Stanley and Harris 1995).

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Starch substitution can be made on the hydroxyl groups by ester or ether linkages with functional groups. Octenyl succinylation is one of the common substitution reactions for starch to impart an emulsification capacity or dry flowability to the starch (Trubiano 1986). With this substitution, the starch also has more paste viscosity and storage stability than the corresponding starch. For amylodextrin, octenyl succinylation has been used to produce a fat replacer in mayonnaise (Cho et al 1999). It provided good emulsification properties and stability in the system. No studies have been reported on the use of amylodextrin as a fat replacer in cakes.

In this study, the shortening of a conventional yellow layer cake was fully replaced with maltodextrin, amylodextrin, octenyl succinylated amylodextrin, or mixtures, and the changes in physical and sensory characteristics of the shortening-free cakes were investigated.

MATERIALS AND METHODS

Starch and Maltodextrin

Corn starch and maltodextrin (MD) (DE 10) were donated by Samyang Genex Co. (Seoul, Korea) and Shindongbang Co. (Kyungki-do, Korea), respectively.

Preparation of Amylodextrin and Octenyl Succinylation

Corn amylodextrin (AD) was prepared by refluxing the starch dispersion in 2% HCl-ethanol solution (1:2, w/v) for 30 min (Chun et al 1997). Octenyl succinylated amylodextrin (OSAD) was prepared by the method of Caldwell et al (1953). Corn amylodextrin (200 g, db) was dispersed in 1% Na_2SO_4 solution (400 mL), and 2-octen-1-ylsuccinic anhydride (6 g, Aldrich Chemical Co., Milwaukee, WI) was added dropwise while stirring the mixture. The mixture was adjusted to pH 10.0 using 1*N* NaOH during the reaction. After the anhydride addition, the mixture was continuously stirred at room temperature for 1 hr. The reaction mixture was neutralized with 2*N* HCl, and then washed three times with distilled water (400 mL × 3). The OSAD residue was filtered (Whatman No. 1 filter paper) then dried in a convection oven at 40°C overnight.

Preparation of Yellow Layer Cake

The cake formulas used in this study include wheat flour (Daehan Co., Seoul, Korea), sucrose (Daehan), shortening (Crisco, Cincinnati, OH), eggs, salt, baking powder (a mixture of sodium bicarbonate and pyrophosphate) (Jenico Co., Seoul, Korea), nonfat dried milk, and sucrose ester (HLB 15, Il Shin Emulsifier Co., Seoul, Korea). Six different formulas with different dextrins were used for the cake preparation using a modified single-stage mixing method (Table I). The control contained 50% shortening based on the flour weight. The rest of the formulations contained one of the three dextrins

(MD, AD, and OSAD) or a combination of equal amounts of MD and other dextrins (MD+AD or MD+OSAD) for the equivalent weight replacement of shortening.

Date:

Name:

Springiness: Degree of return to its original size and shape after 50% compression without failure between thumb and forefinger.

Weak *control* Strong

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Moistness: Amount of moisture perceived on the surface of the product when in contact with the upper lip.

Dry *control* Wet

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Firmness: Force required to compress completely when placed in the mouth.

Soft *control* Firm

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Adhesiveness: Force required to remove sample from molars

Weak *control* Strong

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Overall flavor: Aromatics associated with the ingredients used.

Weak *control* Strong

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Aftertaste: Describe residual taste after swallowing the sample.

Fig. 1. Score card used for sensory evaluation of yellow layer cakes.

Dry ingredients were blended 1 min at speed no. 2 (KitchenAide mixer K5SS, MI) using wire whip. Remaining ingredients were added and mixed at speed no. 2 for 30 sec. The batter was scraped down and mixed at speed no. 10 for 4 min. Batter (280 g) was poured into a lightly greased pan (15 cm diameter) and baked at 170°C for 37 min in an electric oven (HSDO 2002, Han Young Bakery Machinery Co., Seoul, Korea).

Physical Properties

The specific gravity of cake batters was measured using a measuring cup according to Campbell et al (1979). Batter viscosity was measured using the line-spread test with a consistometer (Kyunggin, Inc., Seoul, Korea) (McWilliams 1993). Mean value was taken from four measurements. Batter pH was measured with a homogenate of 20 g of batter in 80 mL of distilled water (Fondroy et al 1989).

For the baked cakes, plastic measuring templates (Approved Method 10-91, AACC 2000) were used to determine the indices of volume, symmetry, and uniformity. The cake was cut vertically through the center, and the template was placed on the center of the cross-sectional area aligned with the baseline of the template. The color of the cake crumb was measured with a color difference meter (Color JC801, Color Techno System Co., Tokyo, Japan) for L^* (lightness), a^* (redness), b^* (yellowness), and $\Delta E^*(ab)$ values. The instrument was standardized with a white tile (C/2, L = 98.63, a = 0.19, b = –0.67).

Sensory Evaluation

Seven panelists, trained over two weeks, evaluated the sensory properties of the cakes. During the training, the panelists were informed about the purpose of the test and provided with suggested terms and references. Definitions and evaluation methods for each sensory attributes that were developed by the panelists are described in Fig. 1.

TABLE I
Formulation of Yellow Layer Cakes[a]

	Amount (% flour weight basis)					
Ingredients	**Control**	**MD**	**AD**	**OSAD**	**MD+AD**	**MD+OSAD**
Cake flour	100.0	100.0	100.0	100.0	100.0	100.0
Nonfat dried milk	8.0	8.0	8.0	8.0	8.0	8.0
Baking powder	5.0	5.0	5.0	5.0	5.0	5.0
Sucrose ester	1.5	1.5	1.5	1.5	1.5	1.5
Sugar	110.0	110.0	110.0	110.0	110.0	110.0
Salt	2.0	2.0	2.0	2.0	2.0	2.0
Whole eggs, fresh	55.0	55.0	55.0	55.0	55.0	55.0
Water	72.0	72.0	72.0	72.0	72.0	72.0
Shortening	50	. . .	. . .	. . .	. . .	. . .
MD[b]	. . .	50.0	. . .	. . .	25.0	25.0
AD[c]	. . .	. . .	50.0	. . .	25.0	. . .
OSAD[d]	. . .	. . .	. . .	50.0	. . .	25.0

[a] Cakes in which shortening was replaced with maltodextrin (MD), amylodextrin (AD), octenyl succinylated amylodextrin (OSAD), mixture (1:1) of maltodextrin and amylodextrin (MD+AD), and mixture (1:1) of maltodextrin and octenyl succinylated amylodextrin (MD+OSAD).
[b] Dextrose equivalent of MD = 10.
[c] Degree of polymerization of AD ≈ 4,000.
[d] Degree of substitution of OSAD = 0.013.

TABLE II
Physical Properties of Shortening-Free Yellow Layer Cake Batters and Cakes[a]

	Batters[b]			Cakes[c]		
	Specific Gravity	**Spread (cm)**	**pH**	**Volume Index**	**Symmetry Index**	**Uniformity Index**
Control	0.91a	5.03e	7.17b	14.50b	1.00a	0.40a
MD	0.61e	5.51d	7.25a	12.13c	–1.93c	0.07a
AD	0.84b	6.17a	7.17b	18.47a	1.53a	0.33a
OSAD	0.87b	5.77c	7.13b	17.77a	1.53a	0.20a
MD+AD	0.66d	5.93b	7.14b	18.03a	–0.13b	0.13a
MD+OSAD	0.75c	5.95b	7.15b	17.80a	0.20b	0.27a

[a] Cakes in which shortening was replaced with maltodextrin (MD), amylodextrin (AD), octenyl succinylated amylodextrin (OSAD), mixture (1:1) of maltodextrin and amylodextrin (MD+AD), and mixture (1:1) of maltodextrin and octenyl succinylated amylodextrin (MD+OSAD). Mean values of three replicates.
[b] Values followed by the same letter in the same column are not significantly different ($P < 0.05$).
[c] Values followed by the same letter in the same column are not significantly different ($P < 0.01$).

Three replicates were made using a randomized block design (SAS Institute, Cary, NC). The cakes, including the control, were served to the panelists for evaluation within 1 hr after baking. The crumb was cut into 2-cm^3 pieces and served on plates randomly numbered with three digits. The panelists evaluated each attribute using 15-cm unstructured line scales (Fig. 1). The control was used as a reference on the scale. The attributes evaluated included firmness, adhesiveness, springiness, moistness, and overall flavor.

Textural Properties During Storage

Texture profile analyses (TPA) were preformed with the fresh and stored cakes using a rheometer (COMPAC-100, Sun Scientific Co., Tokyo, Japan). For the fresh samples, the test was done within 3 hr of baking, and the stored samples were evaluated at different storage periods from one to eight days at 4°C. For the storage, the samples were wrapped with polyethylene film and kept in a sealed plastic bag to prevent moisture loss. The specimens for the TPA test were prepared by cutting the cake into 2-cm^3 pieces. Springiness, hardness, adhesiveness, cohesiveness, and gumminess were measured from repeated compressions at 50% strain. The measurements were performed at a maximum weight of 2 kg and a speed of 240 mm/min using a cylinder probe (15 mm diameter).

TABLE III
Color Values of Cake Crumbs[a,b]

	*L**	*a**	*b**	Δ*E*(ab)*
Control	74.80b	–1.85b	15.88b	29.08b
MD	71.86d	–0.78a	20.68a	34.31a
AD	75.63b	–0.93a	12.67d	26.63c
OSAD	77.51a	–0.91a	13.25cd	25.33d
MD+AD	73.21c	–0.83a	13.71c	29.24b
MD+OSAD	72.41cd	–0.64a	13.49c	29.83b

[a] Cakes in which shortening was replaced with maltodextrin (MD), amylodextrin (AD), octenyl succinylated amylodextrin (OSAD), mixture (1:1) of maltodextrin and amylodextrin (MD+AD), and mixture (1:1) of maltodextrin and octenyl succinylated amylodextrin (MD+OSAD).
[b] Values followed by the same letter in the same column are not significantly different ($P < 0.01$). Mean of three replicates.

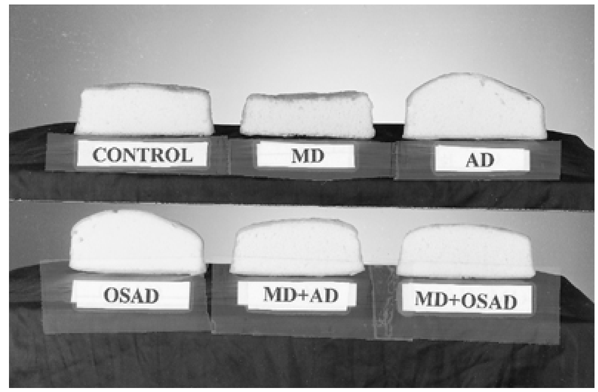

Fig. 2. Photographs of shortening-free yellow layer cakes. Original cake containing shortening (control), and cakes containing maltodextrin, (MD) amylodextrin, (AD), octenyl succinylated amylodextrin, (OSAD), and mixtures (1:1) of MD+AD and MD+ OSAD.

TABLE IV
Sensory Characteristics of Yellow Layer Cakes[a,b]

	Firmness	Springiness	Moistness	Adhesiveness	Overall Flavor
Control	6.13c	8.87c	10.54b	7.50cd	8.59b
MD	6.52c	3.81d	13.09a	11.88a	10.51a
AD	9.67ab	10.69ab	7.64c	8.30c	7.80b
OSAD	9.94a	11.30a	7.30c	6.40d	6.11c
MD+AD	6.58c	8.57c	10.27b	9.71b	8.83b
MD+OSAD	8.16b	10.02b	8.22c	8.23c	7.49b

[a] Cakes in which shortening was replaced with maltodextrin (MD), amylodextrin (AD), octenyl succinylated amylodextrin (OSAD), mixture (1:1) of maltodextrin and amylodextrin (MD+AD), and mixture (1:1) of maltodextrin and octenyl succinylated amylodextrin (MD+OSAD). Mean values of three replicates.
[b] Values followed by the same letter in the same column are not significantly different ($P < 0.01$).

TABLE V
Textural Properties of Cakes[a,b] During Storage at 4°C

	Days of Storage					
	0	1	2	4	6	8
Firmness (dyne/cm^2)						
Control	164.61b	169.78c	179.41b	205.77b	200.86c	181.14c
MD	85.72c	96.19d	133.25c	159.59c	151.60d	206.81b
AD	219.72a	220.17b	247.60a	292.27a	278.03b	306.61a
OSAD	236.89a	257.91a	263.83a	299.06a	307.07a	287.32a
MD+AD	73.90c	72.40e	89.74e	88.77d	107.49e	99.87d
MD+OSAD	88.88c	102.22d	113.59d	104.23d	125.55de	118.13d
Springiness (%)						
Control	83.02b	78.49bc	78.47c	76.12b	75.76b	78.28a
MD	74.26c	75.76c	75.19d	69.94c	74.67b	66.03b
AD	88.80a	87.78a	83.80ab	81.30ab	78.81ab	76.24a
OSAD	90.55a	88.81a	85.35a	86.18a	80.34a	79.51a
MD+AD	82.51b	80.74b	78.86c	76.41b	75.00b	67.29b
MD+OSAD	83.61b	82.63b	81.09bc	79.66b	77.56ab	78.29a
Adhesiveness (g)						
Control	–2.22ab	–4.33b	–4.78c	–6.56c	–6.44c	–6.67b
MD	–4.00c	–5.78c	–9.22d	–10.67d	–8.78d	–11.56c
AD	–1.56a	–2.00a	–2.56a	–2.67a	–3.44a	–3.22a
OSAD	–1.22a	–2.00a	–2.89ab	–2.67a	–3.11a	–2.78a
MD+AD	–2.22ab	–3.11a	–4.00bc	–4.89b	–5.00bc	–4.00a
MD+OSAD	–2.67b	–2.44a	–3.56ab	–4.00b	–4.11ab	–4.00a

[a] Cakes in which shortening was replaced with maltodextrin (MD), amylodextrin (AD), octenyl succinylated amylodextrin (OSAD), mixture (1:1) of maltodextrin and amylodextrin (MD+AD), and mixture (1:1) of maltodextrin and octenyl succinylated amylodextrin (MD+OSAD). Mean values of three replicates.
[b] Values followed by the same letter in the same column are not significantly different ($P < 0.01$).

Statistical Analysis

Three replicates were completed, and data were analyzed by a randomized block design. Analysis of variance (ANOVA) was performed to test the differences among treatments (SAS). When a significant difference was found among treatments, Duncan's multiple range tests were performed to determine the differences among the mean values.

RESULTS AND DISCUSSION

Physicochemical Properties

Physical properties of the cake batters and cakes where the shortening was replaced with MD, AD, OSAD, and mixtures are given in Tables II and III. The control batter had significantly higher specific gravity than all the batters containing the dextrins.

The line spread values (Table II) measured with the consistometer were inversely related to the viscosity of the cake batter. All the values determined with the fat-free cake batters were significantly higher at 5.51–6.17 than the control (5.03), indicating that the control cake batter was more viscous. The MD-containing batter was more viscous than any of the AD or OSAD-containing batters.

Batter pH is also affects the sensory properties and texture of cake products (Pyler 1973). The MD cake exhibited a slightly higher pH value than the other cakes, but this difference may not be great enough to affect the cake quality.

Compared to the control (14.50), the fat-replaced cakes had significantly higher volume indices at 17.77–18.47, with the exception of the MD cake (12.13). The retention of leavening gas during baking is highly associated with batter viscosity (Bath et al 1992). Results for cake volume suggest that the dextrins used as fat replacers may have increased air incorporation into the cake batter despite the low batter viscosity. The low specific gravity and relatively high viscosity of the MD cake batter could have allowed more air to be incorporated. But the low cake volume indicates that the membranes around the air cells were readily collapsed by gas expansion during baking. Although the AD cake batter was less viscous than the MD batter, AD became swollen or gelatinized during baking providing additional viscosity. This might have given enough strength for the cake to hold the expanded air cells, resulting in the high volume indices. Additionally the long linear chains of amylodextrin associate readily there by setting the cake shape quickly. It is notable that this positive effect in cake volume was not further improved by octenyl succinylation (Table II). The shapes of the control and shortening-free cakes are shown in Fig. 2.

The symmetry index of the MD cake was negative (–1.93) indicating that the cake had a concave crust surface (Fig. 2) as expected from the high specific gravity of the batter and lower volume index of the cake. The AD or OSAD cakes exhibited higher indices than the control cake, although differences were not significant. However, indices were found with the MD+AD and MD+OSAD cakes compared with the control cake (Table II). There was no statistical difference in uniformity indices among the cakes, indicating that the shortening-free cakes were as uniform as the control cake.

Crumb color characteristics of the cakes are shown in Table III and Fig. 2. The L^* value of the OSAD cake was significantly higher than the control cake whereas all the MD-containing cakes (MD, MD+AD, and MD+OSAD) exhibited significantly lower values. This can also be observed in the photographs where the MD-containing cakes appeared darker than the control and AD cakes (Fig. 2). The control had a significantly lower value for a^* (–1.85) than all of the dextrin-containing cakes. The b^* value, which represented the yellowness, was highest for the MD cake (20.68) in agreement with the photographs (Fig. 2). With the exception of the MD cake, all other fat-free cakes showed significantly lower yellowness values than the control. The $\Delta E^*(ab)$ values of the MD cake were significantly higher than the control whereas the AD or OSAD cake were significantly lower. But when the mixed dextrins (MD+AD or MD+OSAD) were used, the value became similar to that of the control. The greater darkness and yellowness of the cake containing MD was possibly caused by browning reactions during baking.

Sensory Evaluation

The effect of the shortening replacement by dextrins in yellow layer cake on the sensory characteristics of the cake is summarized in Table IV. Firmness was substantially increased by replacing the shortening with the equivalent amount of AD, OSAD, or MD+OSAD. With MD or the mixture of MD and AD, however, the cake remained as soft as the control. For springiness, the replacement of shortening with MD resulted in a substantial reduction of the cake springiness (3.81 vs. 8.87), whereas with AD, OSAD, or MD+OSAD, there was an increase in springiness. The cake containing the mixture of MD and AD exhibited the same springiness as the control. The amylodextrins, regardless of the modification, caused the cake crumb to be more rigid. The amylodextrin tends to retrograde or associate quickly after gelatinization (Komiya and Nara 1986; Stanley and Harris 1995). Thus, the cake containing AD or OSAD may have set quickly, resulting in textural rigidity. This agrees with the proposed suggestion made previously with regard to the fast-setting cake volume by AD.

For moistness, which is related to the eating quality, the MD cake gave the highest value among the samples. The AD or OSAD and MD+OSAD cakes, however, revealed substantially lower values for moistness than the control. It has been reported that maltodextrin has a good water-retention property in baked goods, which in turn maintains the soft texture during storage (Alexander 1991). The water-retention ability of MD, however, made the cake more adhesive than all other cakes (Table IV). Overall flavor, associated with the ingredients used, revealed that the MD+AD and MD+ OSAD cakes were not significantly different from the control whereas the MD cake exhibited the highest flavor score.

By using a mixture of both dextrins (MD+AD or MD+OSAD), the shortening in the yellow layer cake could be favorably replaced without changing the overall sensory texture or flavor of the cake. The MD+AD cake, especially, exhibited no statistical differences in firmness, springiness, moistness, and overall flavor compared to the control. This favorable result was obtained from the combined actions of the two dextrins. In the mixture, MD likely contributed to the air incorporation at batter mixing as shown by high cake batter viscosity, whereas AD contributed to stabilization of the air-incorporated texture or the air cells to give a good final volume to the cake. The softness and rigidity, which were provided by MD and AD, respectively, were also favorably compensated in the cake product. The high adhesiveness of the MD+AD cake remains to be resolved because it may be an undesirable quality characteristic. By reducing the amount of MD, the adhesiveness could be reduced. Further experiments in optimizing the formula should be undertaken.

Textural Properties During Storage

To study the textural changes during storage up to eight days at 4°C, texture profile analysis (TPA) was conducted with a rheometer. Firmness of the fresh MD, MD+AD, and MD+OSAD cakes (74-89 × 10^3 dyne/cm^2) were less than that of the control (165 × 10^3 dyne/cm^2) (Table V). The fresh AD and OSAD cakes, however, were significantly firmer than the control with values of 220 and 237 × 10^3 dyne/cm^2. This result was similar to that observed in sensory evaluation. All cakes showed gradual increases in firmness as the storage time increased. Among the cakes, the MD cake displayed a rather dramatic increase within two days of storage. This sharp increase from the lowest firmness value at day 0 was followed by a final value on the eighth day similar to that of the control cake. The firmness of AD and OSAD remained higher than the control or the MD-containing cakes throughout the eight-day storage period. The MD+AD and MD+OSAD cakes had lower firmness (107 and 126 × 10^3 dyne/cm^2, respectively) than the control on the eighth day, indicating that these cakes remained softer during storage.

The springiness of all the cakes decreased as the storage time was increased. Fresh AD and OSAD cakes were the most springy with values of 88.8 and 90.5%, respectively, indicating the setting effect of the amylodextrins. The MD cake had the lowest springiness (75.76%) of all the samples. These trends were also observed in the sensory evaluation. The springiness of the control cake was significantly reduced from 83.02 to 78.49% after one day of storage after which only minor decreases in springiness were observed. The MD+AD cake showed similar springiness values to the control cake up to the sixth day of storage, and then showed a significantly lower value on the eighth day. No significant differences were observed between the MD+OSAD and the control cake. The loss of springiness in the control cake might be due to the retrogradation of the cake in the early stages of storage. But this texture loss was minimized by the use of mixed dextrins in the cake.

Adhesiveness of all cakes gradually increased with storage time. The fresh MD cake displayed the greatest adhesiveness among the fresh cakes, which is in agreement with the sensory data. Adhesiveness of the MD cake increased during storage to ≈3× higher than the initial value (–11.56 vs. –4.00). The control cake also increased in adhesiveness with storage to ≈3× the original value (–6.67 vs. –2.22). The AD and OSAD cakes were less adhesive than the control or the MD-containing cakes, and this trend was consistent throughout storage. The adhesiveness of the MD+AD and MD+OSAD cakes increased to ≈2× the original value, indicating that increased adhesiveness during storage could be retarded by the mixed dextrins.

Overall the cakes became firmer, less springy, and more adhesive as the storage time increased. These changes were presumably caused by the retrogradation or structural rearrangement of starch chains in the flour or in the dextrins added as a fat replacement. The results suggest that the replacement of shortening with maltodextrin and amylodextrin did not cause any significant textural changes in the cake, and likely stabilized the cake against the textural changes induced by retrogradation which occurs with cold storage. Therefore, equal mixtures of maltodextrin and amylodextrin can be used as a favorable replacement of the shortening in yellow layer cakes.

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