NOTE

Flour Fraction Interchange Studies of Effects of Chlorination on Cookie Flours

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ABSTRACT

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Flour fractionation-reconstitution procedures were used to study the spread-depressing effects of chlorination on cookie flours. In a series of interchanges between individual flour fractions from untreated and chlorinated flours, the reduction in cookie spread was found to be the result of changes in the chlorinated starch fraction. Hydration data (alkaline water retention capacity) indicated the loss in cookie spread was related to increased hydration of the chlorinated starch fraction.

Chlorination of flours has a deleterious effect on cookie baking performance; cookies are smaller and appearance is impaired when treated flours are used in a sugar-snap cookie formulation. However, chlorinated cookie flours are useful commercially when it is necessary to control spread to achieve uniformity. Sollars (1958) employed fractionation-reconstitution techniques to study the spread-depressing effects of chlorination on cookie flours. In a series of interchanges between fractions from untreated and chlorinated flours, bake results showed that starch and gluten fractions were affected most by chlorination; minor and sometimes contradictory responses were noted for the tailings and water-solubles fractions. The doughing treatment needed to produce reconstituted flours suitable for baking from blends of fractions may have contributed to these diverse results by introducing abnormal interactions among fractions.

During aqueous fractionation of flour, much of the free lipid is bound to the gluten fraction (Olcott and Mecham 1947) and is incapable of performing its vital role in cookie baking (Yamazaki and Donelson 1976). Yamazaki and Donelson (1976) showed that normal bake responses could be obtained from a blend of flour fractions if the free lipids were extracted from the flour with hexane prior to aqueous fractionation and restored to the blend of fractions prior to baking. Thus, the extra doughing, freeze-drying, and grinding treatments needed for blends of fractions from nonextracted flours can be avoided.

As an alternative to extracting flour with hexane prior to aqueous fractionation, a procedure was developed for extracting and recovering the free lipids bound to the dried ground gluten fraction so that blends of fractions from nonextracted flours could be used directly in baking tests. Details of the procedure are presented here, together with the results of fraction interchange studies of effects of flour chlorination on individual flour fractions.

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TABLE I
Bake Results for Parent Flours and Fraction Blends

Flour	Cookie Diameter[a] (cm)	Cake Volume[b] (cm^3)
Parent flour	17.9	1,113
Fraction blend		
Extracted gluten without lipids	14.7	821
Extracted gluten with lipids restored	17.8	1,109

[a]Results are diameters of two cookies baked with cookie flour.
[b]Baked with cake flour.

TABLE II
Cookie Diameters and Alkaline Water Retention Capacity (AWRC) for Parent Flours and for Reconstituted Flours with Interchanges of Fractions Between Chorinated and Untreated Flours

Fraction Interchanged	Flour A				Flour B			
	Cookie Diameter[a] (cm)		AWRC[c] (%)		Cookie Diameter (cm)		AWRC (%)	
	U[b]	Cl[b]	U	Cl	U	Cl	U	Cl
None (control)	17.5	16.6	72	73	17.8	16.7	71	74
Starch	16.6	17.6	78	67	16.8	18.2	77	68
Starch tailings	17.4	16.6	71	74	17.8	16.7	68	79
Gluten	17.4	16.6	69	78	17.7	16.8	70	74
Water solubles	17.4	16.5	70	76	17.7	16.8	69	74
Lipid	17.4	16.6	72	73	17.7	16.8	73	72
Parent flour	17.8	16.8	53	59	17.9	16.5	55	62
Starch fraction	...	...	61	69	...	...	63	69

[a]Least significant difference for cookie diameter = 0.2 cm.
[b]U = untreated; Cl = chlorinated.
[c]Data on 14% mb; least significant difference for AWRC = 2%.

MATERIALS AND METHODS

Flour

The flours used in fractionation-reconstitution studies for demonstrating the gluten extraction technique were typical straight-grade cookie flours and chlorinated cake patent flours. Two commercially milled soft wheat cookie flours were used in the fraction-interchange experiments. Aliquots of each flour were chlorinated in the pH 3.90–3.66 range (Kissell and Marshall 1972).

Fractionation and Reconstitution

The flours were fractionated by an aqueous procedure described by Yamazaki et al (1977) for hexane-extracted flours that is also suitable for nonextracted flour. The procedure was modified for use with the chlorinated flours by the addition of sodium carbonate (1–2 g per kilogram of flour) to the flours prior to fractionation (Gaines and Donelson 1982). The fractions were dried, ground, and blended together in proportion to their recovery yields. Lipids were restored to the fraction blends by contact wetting with the required volume of lipid solution, after which the solvent was removed by rapid evaporation in a fume hood. All treatments were duplicated. Alkaline water retention capacity (AWRC) was determined in duplicate by method 56-10 (AACC 1983).

Baking Procedure

Cookies were baked by the procedure in method 10-52 (AACC 1983). Cookie diameters are sums of diameters of two cookies. Method 10-90 (AACC 1983) was used for cake baking.

Extraction of Gluten Lipids

Dry gluten and 95% ethanol (1.5 ml/g) were mixed, and the mixture was covered and allowed to stand for 15 min. The mixture was then washed on a Buchner funnel fitted with a fast filter paper with three fresh portions of hexane (2 ml/g). The filtrate was saved as the lipid fraction. Residual solvent was removed from the gluten by rapid evaporation in a fume hood.

RESULTS AND DISCUSSION

The procedure for extracting the free lipids bound to the gluten fraction is based on the fact that lipid-gluten bonds are broken with alcohol treatment (Sullivan 1940, Olcott and Mecham 1947). The procedure was tested on gluten fractions from four cookie flours and four chlorinated cake flours. Lipid recovery as the percentage of total free lipids of the parent flours was about 50% for cookie flours and 40% for cake flours. Representative bake results with this reconstitution procedure (Table I) show clearly the efficacy of the recovered lipid in restoring baking performance.

These fractionation-reconstitution procedures were employed in a study to assess the effect of chlorinating cookie flours on individual flour fractions. Cookie diameters and AWRC data for these studies are presented in Table II. The reduced cookie spread and increased hydration (AWRC) of the parent flours typify the effects of chlorination on cookie flours. Cookie spread data for the control blends and their corresponding parent flours were nearly identical, indicating that flour fractionation and reconstitution was not detrimental to baking performance. Bake results from complete fraction interchanges for each flour showed that the loss in cookie spread due to flour chlorination was related to changes in the starch fraction. Interchanges of starch fractions produced changes in cookie spread of 0.9–1.5 cm, whereas other fraction interchanges exerted essentially no effect on baking performance.

The starch fractions figure predominantly also in flour hydration. AWRC data for the parent flours and their starch fractions showed that increased flour hydration due to chlorination may be attributed mainly to the increased hydration of their starch fractions. The negative relationship between AWRC and cookie diameters for the control blends and the starch interchange treatments is in accord with similar relationships established for cookie flours and fraction blends (Yamazaki 1953, Yamazaki et al 1977). Overall, the hydration data indicated that reduction in cookie spread due to flour chlorination was related to the increased hydration of the starch fraction.

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