Chlorine Treatment of Cake Flours. IV. Effects of Storing and Heating Nondefatted and Defatted Flours[1]

A. C. JOHNSON[2] and R. C. HOSENEY[3]

Cereal Chem. 57(2):92–93

ABSTRACT

Storing flour at room temperature for two months improved the volume and grain of cakes baked from the flour. More dramatic improvement resulted with flour at the top of a bag stored at 4°C for eight months; flour from the remainder of that bag showed no improvement. When untreated flour was defatted and stored at room temperature for two months, its cake-baking properties after reconstitution of lipids were comparable to those of Cl_2-treated flour. The changes occurring in stored flour can be accelerated by heat. Defatted flour was improved, with or without heating, after a much shorter storage period than was necessary for nondefatted flour. Flour appears to contain a component(s) that, at least to some extent, inhibits such changes, and the hexane extraction removes or inactivates that component. The data suggested that the better baking quality of defatted, heat-treated flour was in part, if not totally, because of changes in the starch.

Concern over the safety of chlorinated cake flour has led to alternate methods of treating flour to improve its baking properties. Russo and Doe (1970a) reported that a heated starch and gluten mixture produced better cakes than did the same mixture unheated. Procedures for heating flour to improve its cake baking properties were patented by Russo and Doe (1970b). Another patent described heating the whole grain or farina to improve baking properties of cake flour (Carwain et al 1976). Typical flour treatment conditions were: for flour, 6% moisture and 120–140°C for 30 min; for farina, 200°C for 6 min. Most of the work with heat treatments was on processes suitable for commercial operations. The mode by which flour is improved during heat-treatment procedures remains unknown.

Our interest came from changes noted in untreated flour during storage and the possibility that heating flour would accelerate those changes.

MATERIALS AND METHODS

The flour was commercially milled, soft wheat, cake flour. It had not been treated with chlorine and contained 8.6% protein and 0.32% ash.

Shortening was Durkee D-20 emulsified with 4.8% monoglycerides. Whole egg solids were from Seymour Foods, Inc. All other chemicals were reagent grade.

Cake Baking Methods

A modified Kissell's lean cake procedure (Kissell 1959) was used with the water optimized. Modifications consisted of using granular sugar instead of sugar solution and of blending all dry cake ingredients at low speed for 3 min before shortening and distilled water were added. The standard deviation of cake volume for cakes baked from Cl_2-treated flour was 15.6 cc. Starch yellow cakes were baked by the procedure of Carwain and Gough (1975). All cake data are the average at least of duplicate bakes and generally of several bakes.

Petroleum Ether-Defatted Flour

Untreated and Cl_2-treated flours were defatted in a Soxhlet apparatus for 72 hr with petroleum ether (35–60°C). The extracted flour was suspended in fresh petroleum ether, filtered, and then air-dried. The filtrate was combined with the main extract, filtered (Whatman No. 42), and concentrated on a rotatory evaporator below 40°C. The lipids were dissolved in fresh petroleum ether, transferred quantitatively to a tared, 50-ml, round bottomed flask, and again taken to near dryness on a rotatory evaporator. The lipids were dired in an oven (35°C) for 4 hr, allowed to cool, and then weighed. That procedure yielded from 0.78 to 0.81% lipid, based on the flour. The lipids from Cl_2-treated and untreated flours were stored separately in small vials at 4°C.

Lipid Reconstitution of Defatted Flours

The flour lipids were reconstituted with defatted flour in proportion to the quantity removed during defatting. The lipids were weighed into small, tared, watch glasses, transferred to a small mortar containing 5.0 g of flour, made into a mull, and blended with the remaining flour in a Stein mill for 30 sec. Lipids were reconstituted with all defatted flours before baking. The effect of free lipids on cake flour functionality is well documented (Kissell et al 1979).

Storage of Flours

Untreated flour (5 lb) was stored in a plastic bag at 4°C. After eight months, samples of flour were taken from both the top and the interior of the bag. Untreated and hexane-defatted untreated flours were stored in open air and in closed jars at room temperature for two months.

Heat-Treated Flours

Samples (200 g) of untreated defatted and nondefatted flours were heated in closed jars in an oven for 20–240 hr at 56°C. Each defatted flour was then reconstituted with its own lipid before cake baking.

TABLE I
Effects of Storage Conditions on Baking Properties of Untreated Flour

Flour	Storage Conditions: Time (months)	Storage Conditions: Temperature (°C)	Cake Qualities: Volume (cc)	Cake Qualities: Grain
Cl_2-treated control	···	···	575	Fine/close
Nondefatted	···	···	450	Thick/open
Nondefatted[a]	2	25	490	Fine/open
Nondefatted[b]	8	4	600	Fine/open
Nondefatted[c]	8	4	440	Thick/open
Defatted[a,d]	2	25	640	Fine/open
Defatted[a,d]	2	25	550	Fine/open

[a]Stored open to air.
[b]Surface flour in loosely sealed polyethylene bag.
[c]Inner flour in loosely sealed polyethylene bag.
[d]Lipids added back to flour before baking.
[e]Stored in a sealed jar, no attempt to exclude air.

[1]Contribution 79-2290-j, Department of Grain Science and Industry, Kansas Agricultural Experiment Station, Kansas State University, Manhattan 66506
[2]Present address: USDA-FGIS, 1221 Baltimore Avenue, Kansas City, MO 64105.
[3]Graduate research assistant and professor, respectively, Department of Grain Science and Industry, Kansas State University, Manhattan, 66506

0009-0352/80/02009202/$3.00/0

TABLE II
Effect of Heat Treatment (56° C) on Baking Properties of Untreated[a] Flour

Treatment Time (hr)	Qualities of Cakes Containing: Nondefatted Flour Volume (cc)	Nondefatted Flour Grain[b]	Defatted Flour Volume (cc)	Defatted Flour Grain[b]
0	450	T/O	440	T/O
24	···	···	515	F/C
48	450	T/O	540	F/C
72	···	···	520	F/S
96	460	F/O	530	F/S
120	···	···	600	F/S
144	400	F/C	···	···
192	470	F/C	···	···
240	400	F/C	···	···

[a]Untreated by Cl_2.
[b]T/O = thick/open, F/O = fine/open, F/C = fine/closed, F/D = fine/dense, F/S = fine/soft.

TABLE III
Baking Results from Heated Flours[a] in a Yellow Cake Formula

Heat Treatment Time (hr)	Nondefatted Flour Volume (cc)	Nondefatted Flour Grain[b]	Nondefatted Flour Collapse	Defatted Flour Volume (cc)	Defatted Flour Grain[b]	Defatted Flour Collapse
0	350	C	Yes	400	C	Yes
24	···	···	···	560	F/O	Yes
48	450	C	Yes	590	F/D	No
72	···	···	···	600	F/D	No
96	500	MF/C	Yes	570	F/D	No
120	···	···	···	600	F/D	No
144	525	MF/C	No	···	···	···
196	590	F/C	No	···	···	···
240	570	F/C	No	···	···	···

[a]Untreated by Cl_2.
[b]C = collapsed, MF/C = medium fine/closed, F/C = fine/closed, F/D = fine/dense, F/O = fine/open.

RESULTS AND DISCUSSION

Effects of Storage Conditions on Baking Properties of Untreated Flour

Baking results obtained with flours stored 2–8 months under different conditions are presented in Table I.

The data show that storing flour at room temperature in air for two months improved both the volume and grain of cakes baked from the flour. More dramatic improvement in volume resulted with flour at the top of a bag stored at 4°C for eight months, but flour from the remainder of the bag gave no improvement.

Defatting flour and storing it at room temperature for two months greatly improved its baking properties. After the lipids were reconstituted, it produced cakes of which both the volume and the grain were comparable to those of cakes made with Cl_2-treated flour. Storing the flour in a sealed jar rather than in air reduced the improvement in its cake baking properties.

Effects of Heating on the Baking Properties of Flour

Samples of nondefatted and hexane-defatted flour were heated at 56°C in sealed jars from 24 to 240 hr; baking results are summarized in Table II. Before being baked, defatted flours were reconstituted with lipids at their normal levels.

Heating nondefatted flour up to 240 hr did not significantly improve cake volume, but heating for 96 hr or more moderately improved cake grain. After 48 hr of treatment, defatted flours gave cakes of a quality nearly comparable to that of cakes made with Cl_2-treated flours. Heating defatted flour improved both the volume and grain of cakes in a shorter treatment period than was required by nondefatted flour.

The baking properties of the heat-treated flours in a lean cake formula modified to include whole eggs (4% based on flour, water optimized) were studied to determine whether heating untreated cake flour improved its baking response to egg lipids. Table III summarizes the results obtained with a modified yellow cake formula.

Heat-treated nondefatted and defatted flours gave bigger cakes with better grain than did the control unheat-treated flour. Heat treatment eliminated collapse of yellow cakes. The defatted flour required a much shorter treatment than did the nondefatted flour.

The baking properties of untreated flour could be improved by defatting and storing the flour in air. Changes that improve flour during storage can be accelerated by heating the flour. However, defatted flour was improved after a much shorter storage period than was necessary for nondefatted flour. We do not know why the defatted flours were improved more readily. Apparently, the native flour contains a component(s) that inhibits such changes, and hexane extraction removes or inactivates that material.

TABLE IV
Effects of Heat Treatment[a] on the Baking Quality of Starch Isolated from Defatted Flour

Source of Starch	Cake Qualities: Volume (cc)	Collapse	Grain[b]
Heat-treated flour	595	No	S
Untreated flour	450	Yes	U

[a]56°C for 48 hr.
[b]S = satisfactory, U = unsatisfactory.

Effects on the Baking Properties of Starch Isolated from Heated Flours

The starch fraction of defatted flour appears to be the component improved by chlorine treatment (Johnson and Hoseney 1979). The purpose of this part of the study was to determine if the starch fraction was also related to the better cake baking properties of defatted, heat-treated flour. The starch was isolated as described previously (Johnson and Hoseney 1979).

Starch isolated from defatted, heat-treated flour, was freeze-dried and then used to bake starch yellow cakes (Table IV). The cakes did not collapse when removed from the oven, and they had good volume and a fine grain. Starch isolated from defatted flour (not heat-treated) gave cakes that collapsed when removed from the oven and had lower volume and collapsed grain. The data suggest that the better baking quality of defatted, heat-treated flour was in part, if not totally, because of changes in the starch.

LITERATURE CITED

CARWAIN, S. P., and GOUGH, B. M. 1975. High-ratio yellow cake. The starch cake as a model system for response to chlorine. J. Sci. Food Agric. 26:1861.

CARWAIN, S. P., HODGE, D. G., MUIR, D. D., and DOBBS, N. J. H. 1976. Treatment of grain. U.S. patent No. 3,974,298.

JOHNSON, A. C., and HOSENEY, R. C. 1979. Chlorine treatment of cake flours. III. Fractionation and reconstitution techniques for Cl_2-treated and untreated flours. Cereal Chem. 56:443.

KISSELL, L. T. 1959. A lean-formula cake method for varietal evaluation and research. Cereal Chem. 36:168.

KISSELL, L. T., DONELSON, J. R., and CLEMENTS, R. L. 1979. Functionality in white layer cake of lipids from untreated and chlorinated patent flours. I. Effect of free lipids. Cereal Chem. 56:11.

RUSSO, J. V. B., and DOE, J. A. F. 1970a. Heat-treatment of flour as an alternative to chlorination. J. Food Technol. 5:363.

RUSSO, J. V. B., and DOE, J. A. F. 1970b. Flour treatment process. U.S. patent No. 3,490,917.

[Received March 8, 1979. Accepted November 5, 1979]