INFLUENCE OF ERGOT ON SPRING WHEAT MILLING AND BAKING QUALITY[1]

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ABSTRACT

Ergot sclerotia were added to a spring wheat mix in amounts of 0.3, 1.5, and 3.0% on an as-is weight basis. The samples were milled on a Pilot mill and baked by three different procedures. The percent flour extraction decreased in proportion to the amount of ergot added. The physical dough and baking properties were not appreciably changed by the addition of the ergot, except for crumb color.

Ergot, *Claviceps purpurea* (Fr.) Tul., a fungus disease more commonly associated with rye, has on occasion reached epidemic proportions in wheat (1,2). The toxic effects of this fungus when consumed in large quantities is well known (3). Recently, Shuey et al. (4) described the effect of ergot on the milling properties of spring wheat mixes containing various quantities of ergot and the distribution of the ergot in the mill streams.

The study reported in this paper was conducted primarily to determine what effect ergot would have on the baking properties of flour milled from a spring wheat mix containing varying percentages of ergot. To ascertain if there was an effect on the baking properties, five and ten times the maximum allowable amount of ergot was added to the wheat mix so that the potency of the ergot might be measured.

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TABLE I
Milling and Baking Data on Ergot-Contaminated Hard Red Spring Wheat Lots

	Percent Ergot in Wheat			
	0	0.3	1.5	3.0
Flour extraction (Patent), %	66.9	63.8	62.5	61.3
Flour ash[a] (Patent), %	0.400	0.386	0.379	0.370
Percentage of ergot recovered (Patent)	0	11.7	12.6	13.3
Flour extraction (Total), %	75.1	73.8	72.6	71.1
Flour ash[a] (Total), %	0.451	0.436	0.427	0.420
Conventional lean (CSLF)				
Volume, cc.	911	920	907	932
Color	8.3	8.0	6.5 GD[b]	5.7 GD[b]
Conventional rich (CSRF)				
Volume, cc.	985	980	1,020	1,030
Color	100 Y[b]	99 SlY[b]	98	96 SlG[b]
Continuous unit (CBU)				
Color	100 Y[b]	98 SlY[b]	94	90 G[b]

[a]14% moisture basis.
[b]Sl = Slightly, G = Gray, Y = Yellow, D = Dull.

MATERIALS AND METHODS

Four lots of hard red spring wheat (HRSW) were milled on the Pilot mill described previously (5). The lots were comprised of the control (an ergot-free master blend of HRSW from the 1972 crop) and the same blend to which had been added 0.3, 1.5, and 3.0% (by weight) fungus sclerotia or ergot bodies.

The patent flour, both bleached and unbleached from each lot, was baked by three procedures: A conventional straight-dough lean formula (CSLF) (6), a conventional straight-dough rich formula (CSRF) (7), and a continuous-type bread process on a Wallace & Tiernan (Baker Process Co., Belleville, N.J.) laboratory model continuous-baking unit (CBU). The formulas and procedures are reported elsewhere (8). A developer speed of 150 r.p.m. was used for all samples produced on the continuous unit.

The flour was analyzed as described in AACC Approved Methods (9).

RESULTS AND DISCUSSION

Pertinent milling and baking data are given in Table I. Such data as absorption, which varied less than 0.5%, and mixing times, which were within 0.5 min., were excluded. Data included from the previous study (8) are designated on figures for comparison.

The milling data have consistently shown a decrease in flour extraction with increased ergot contamination. The change in flour extraction with addition of ergot is shown in Fig. 1. Correlation coefficients of 0.993 and 0.999 were found

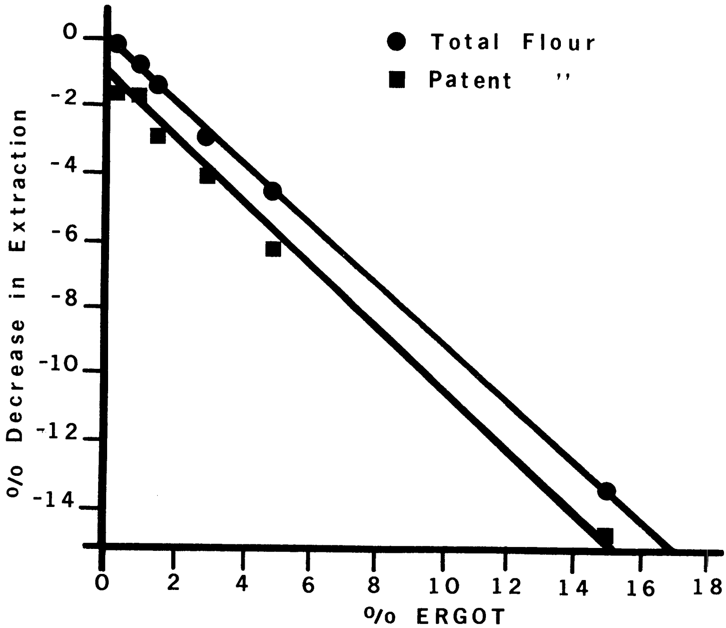

Fig. 1. Percent decrease in extraction vs. percent ergot contamination in mix.

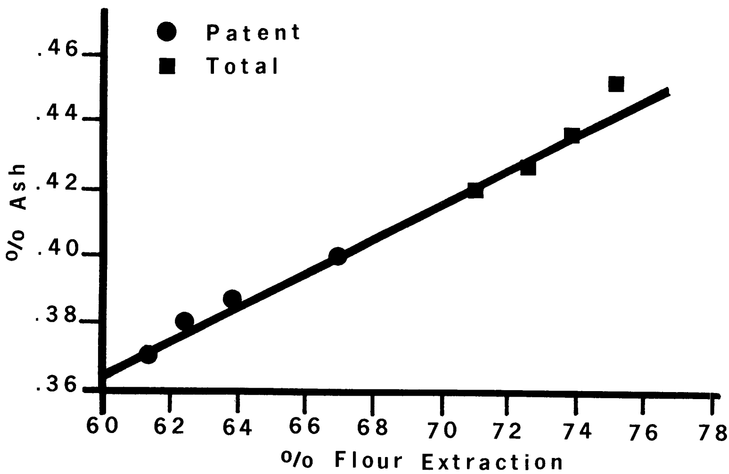

Fig. 2. Percent flour ash vs. percent flour extraction.

for the patent and total flour extraction, respectively. The data on patent flour extraction had a slightly different slope and were displaced by about 1% greater extraction than the data on total flour extraction. The regression equations were:

Δ Extraction = −0.922 (% Ergot) − 1.045 for Patent Flour
Δ Extraction = −0.888 (% Ergot) − 0.027 for Total Flour

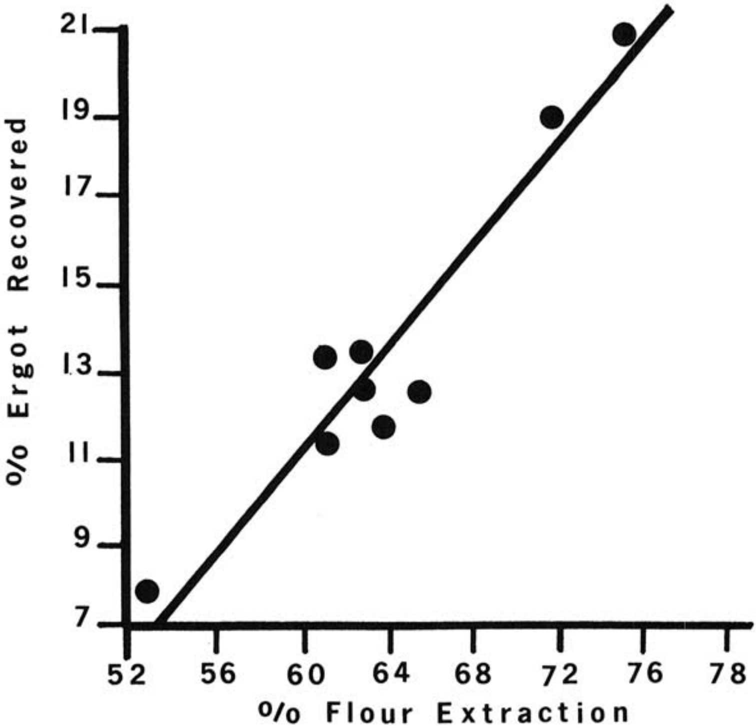

Fig. 3. Percent of total ergot recovered vs. percent flour extraction.

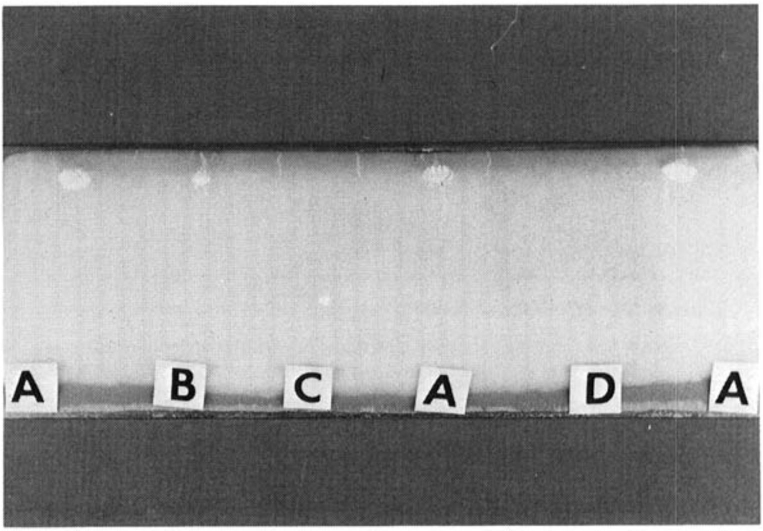

Fig. 4. Dried flour slick of unbleached flours milled from ergot-contaminated mixes. A, 0.0% ergot; B, 0.3% ergot; C, 1.5% ergot; D, 3.0% ergot.

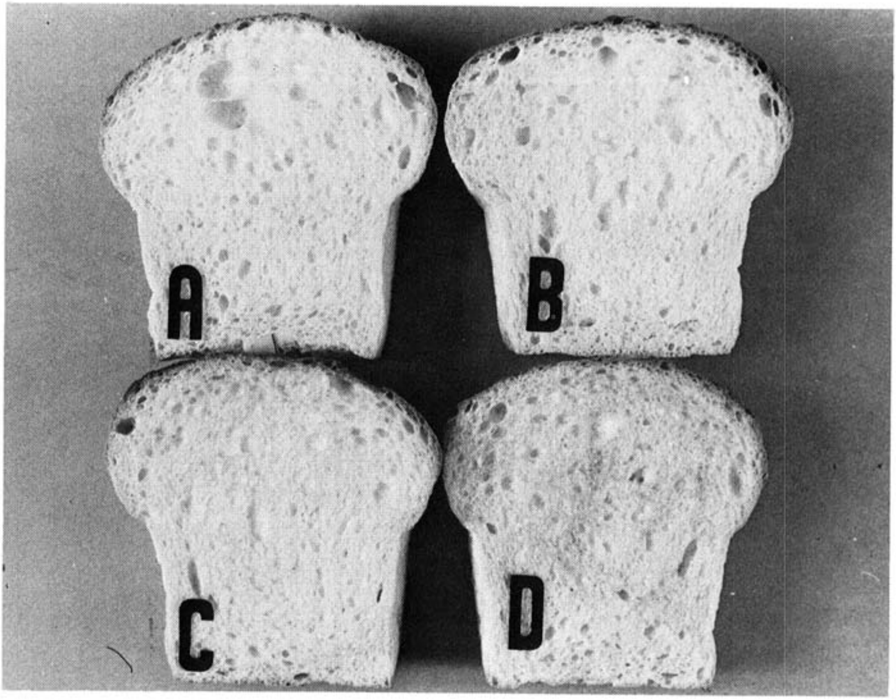

Fig. 5. Loaves baked by conventional straight-dough lean formula with flours milled from ergot-contaminated wheat mixes. A, 0.0% ergot; B, 0.3% ergot; C, 1.5% ergot; D, 3.0% ergot.

A correlation coefficient of 0.993 was found between percent flour ash and percent flour extraction. The differences in the flour ash were directly proportional to the flour extraction, as shown in Fig. 2. The regression equation was:

% Flour Ash = 0.0053 (% Flour Extraction) + 0.0444

A conclusion drawn from the initial study was, "The percent ergot recovered was proportional to the percent flour extraction" (4). The scatter diagram in Fig. 3 shows the percent ergot recovered versus the percent flour extraction. The correlation coefficient was 0.952 and the regression equation was:

% Ergot recovered = 0.571 (% Extraction) − 23.114

The decrease in flour extraction and proportional percent recovery of ergot demonstrates the deleterious effect of ergot on the milling properties of wheat. Ergot has extremely poor milling characteristics, yielding a maximum extraction of 20% when employing normal flour milling procedures. The influence of ergot on the milling properties was primarily exhibited in the reduction section of the mill, although the greatest percentage of ergot is recovered in the feed streams of the mill. The spongy nature of the ergot bodies tended to have a padding effect

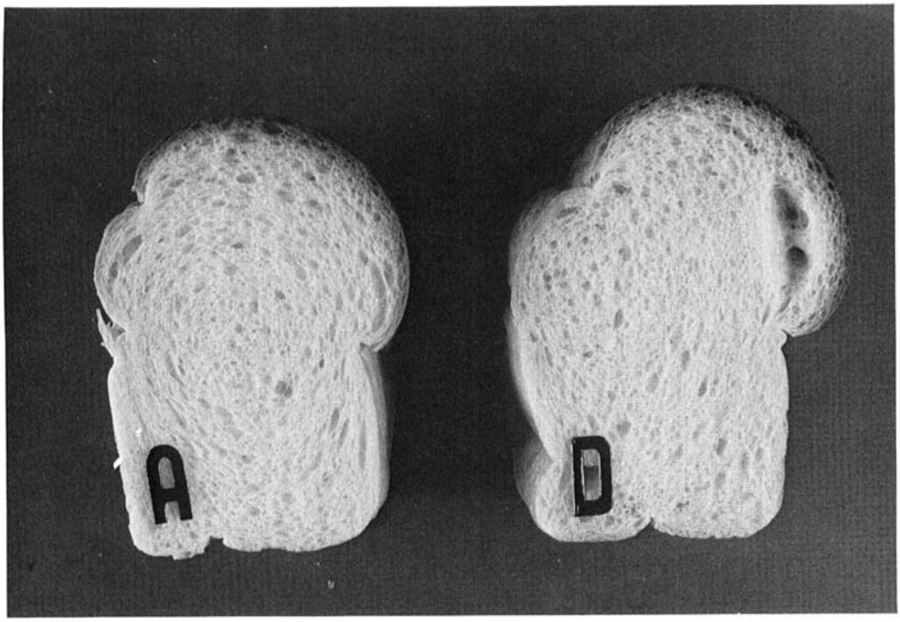

Fig. 6. Loaves baked by conventional straight-dough rich formula with flours milled from ergot-contaminated wheat mixes. A, 0.0% ergot; D, 3.0% ergot.

and minimized the grinding action on endosperm chunks between the rolls.

The dried (unbleached) flour slick (Pekar Test) in Fig. 4 shows the discoloration of the flour, especially at the higher levels of ergot. Because of the character of the ground ergot, the flours containing 1.5 and 3.0% ergot appeared to be mixed with quantities of "black pepper," while ergot in the 0.3% sample was barely perceptible. The discoloration of the doughs (muddy appearance) was carried through to the mixing stage, with the degree of "off color" relative to the amount of contamination.

The breads produced from the flours were similar in external appearance. This was true for both the bleached and unbleached samples. No appreciable differences in loaf volume were noted, although the CSRF baking procedure showed a tendency for the volume to increase with contamination.

The grain and texture of the loaves were similar for the bleached and unbleached samples, regardless of the baking method for each series.

The main effect noted with increased ergot contamination was on crumb color. The degree of change depended on the baking procedure and flour used. The CBU and CSRF procedures gave similar results, which were different from that of the CSLF for the unbleached flour. The effect on crumb color was not as noticeable with increased amounts of ergot on the bleached flour series as on the unbleached flour series.

There appeared to be a progressive increase in whiteness of the bread crumb from the control (unbleached flour) to the sample containing 3% ergot with both the CBU and CSRF baking procedures. This would suggest that the yellow pigments were oxidized by some component or components or enzyme systems contained in the ergot. However, the CSLF baking procedure gave different results, and the ergot contamination was apparent with a progressive increase in dull-grayish discoloration. This is very amply demonstrated by the loaves in Fig. 5 and data in Table I. The grayness was not observable in the CSRF baking procedure as shown in Fig. 6. Because the amount of ergot bodies added was extremely high, the factors causing the differences in crumb color were not pursued.

Although a bleaching or whitening effect was noted in the CBU and CSRF bread crumbs containing ergot, a grayish color or dullness probably attributable to the ground ergot was evident. The bleached flour produced bread showing a similar effect on crumb color, that is, an increased whitening with the presence of ergot.

The conclusions from this study were:

1. There would be no apparent influence on the baking properties of a flour milled from a wheat lot containing 0.3% ergot, which is the maximum allowed without penalty.

2. The effect of ergot on bread crumb color differed according to the baking procedure used. In those formulas that contained milk, increased amounts of ergot had a decided whitening effect on the crumb color. In general, one could conjecture that ergot had a bleaching effect by removing the yellow pigment, but that ground ergot was responsible for the grayness. In the lean formula (CSLF), bleaching either did not occur or was completely masked by the ergot present in the flour.

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