

THE EFFECT OF INFESTATION BY *TRIBOLIUM CASTANEUM* DUV. ON THE QUALITY OF WHEAT FLOUR¹

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ABSTRACT

The changes occurring in hard Indian wheat flour (75% extraction) subjected to infestation by *Tribolium castaneum* Duv., in 4-gal. tins provided with lever lids, at a temperature of $85^{\circ} \pm 5^{\circ}$ F. and a relative humidity of 70-75%, were studied during a period of 5 months. The uric acid content (derived from insect excreta) of the infested flour was proportional to the insect population and served as a good index of the unhygienic condition in the flour due to the presence of insect excreta. A marked increase in fat acidity and a decrease in the thiamine content were observed in the infested flour. The gluten obtained from flour infested for 4 to 5 months was brittle. The values for the wheat meal time test gradually decreased with the progress of infestation, indicating a deterioration in the quality of gluten. The loaf volume of the bread also gradually decreased as the infestation progressed. Organoleptic evaluation revealed that bread made from flour infested for more than 1 month had an off-flavor and bitter taste and was not acceptable. The uninfested control flour remained in good condition throughout, and the bread made from it was quite acceptable.

Several flour storage studies have been reported in the literature, but in most of the earlier studies no attempt has been made to follow the biochemical changes during storage. References to important studies on the subject have been given by Cuendet *et al.* (4) and Greer *et al.* (5). Cuendet *et al.* (4) reported a detailed study of the influence of moisture, temperature, and other factors on the keeping quality of flour. They found that when flours having moisture contents of 10 and 14% were stored at 37.8° C., a marked reduction in loaf volume occurred at the end of 38 and 10 weeks respectively. Under conditions prevailing in India and other tropical countries, wheat flour is frequently infested by insects. No information is available in the literature on the changes brought about by insect infestation on the quality of flour. The present paper deals with studies on the changes in the chemical composition and the baking quality of wheat flour infested by *Tribolium castaneum* Duv. during storage.

Materials and Methods

Materials. Wheat flour (75% extraction) prepared from Indian hard wheat was obtained from a mill in Bangalore within a week after milling. The material contained 10.6% moisture and was stored in tins

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TABLE II
 CHANGES IN CHEMICAL COMPOSITION DURING STORAGE OF WHEAT FLOUR (75% EXTRACTION)
 INFESTED BY *TRIBOLIUM CASTANEUM* DUV., AS COMPARED WITH UNINFESTED FLOUR^a

CONSTITUENT	CONTROL (INSECT-FREE) — MONTHS OF STORAGE				INFESTED FLOUR — MONTHS OF STORAGE		
	0	2	4	5	2	4	5
Moisture, %	10.6	10.6	10.8	10.9	10.8	11.5	13.1
Total nitrogen, %	1.524	1.522	1.526	1.520	1.526	1.610	1.625
Nonprotein nitrogen ^b	5.5	5.9	6.2	6.6	7.2	11.3	14.8
Nitrogen, soluble in water ^b	14.6	15.4	15.9	15.2	18.8	23.0	25.4
Nitrogen, soluble in dilute acetic acid ^b	77.3	76.6	75.0	74.3	67.2	63.6	58.3
Nitrogen, soluble in 60% alcohol ^b	42.2	42.7	41.0	40.8	40.7	38.0	36.2
Crude gluten, %	7.4	7.3	7.2	7.3	6.8	5.0 ^d	4.2 ^d
Wheat meal time test (minutes)	148	145	144	140	132	112	93
Fat, %	1.15	1.08	1.09	1.10	1.02	0.83	0.74
Thiamine, γ per 100 g.	160	160	152	146	153	92	76
Fat acidity ^c	66	81	102	120	149	199	225

^a All analytical values are expressed on 14% moisture basis.

^b Expressed as % of total nitrogen.

^c Expressed as mg. KOH per 100 g. flour.

^d The gluten was brittle and was partly lost during washing.

infested flour is fumigated and cleaned of insects and sold in the market, the uric acid content can very well serve as a good index of the degree of unhygienic conditions in the material. Flour infested for periods longer than 4 months turned slightly yellow and developed off-flavor as a result of accumulation of insect excreta.

Changes in Chemical Composition. The moisture content of the infested flour increased as the infestation progressed. A marked in-

TABLE III
LOAF VOLUME AND CONSUMER ACCEPTABILITY OF BREAD PREPARED FROM CONTROL AND INFESTED WHEAT FLOUR (75% EXTRACTION)

PERIOD OF STORAGE	LOAF VOLUME		ORGANOLEPTIC ACCEPTABILITY SCORE ^a	
	Control	Infested	Control	Infested
<i>months</i>	<i>cc</i>	<i>cc</i>		
0	2680	2680	0	0
1	2650	2500	0	1
2	2640	2420	0	2
3	2630	2340	0	3
4	2660	2250	0	4
5	2620	2130	0	4

^a Details of organoleptic score are given under "Methods."



Fig. 1. Cut surfaces of bread from wheat flour: uninfested control (no number) stored 5 months; and infested flour stored 5, 4, 3, 2, and 1 month.

crease in the nonprotein nitrogen was observed in the infested samples. This may be partly due to the nitrogenous constituents present in insect excreta and partly the result of proteolysis. An appreciable reduction was observed in the nitrogen soluble in dilute acetic acid in the infested flour, indicating a decrease in the gluten content due to its partial breakdown into nonprotein nitrogen. An appreciable loss of thiamine occurred in the infested flour. Fat acidity increased markedly with the progress of infestation. Gluten present in flour infested for 4 to 5 months was brittle and disintegrated easily. A part of it was lost during washing, thus lowering the gluten yield. Sullivan *et al.* (8) and Barton-Wright (3) reported that unsaturated fatty acids produced by the hydrolysis of fat present in wheat flour rendered the gluten short and brittle. Infestation caused a decrease in the time taken for dough balls to disintegrate in water, thereby indicating deterioration in gluten quality.

Baking Test. Table III shows that insect infestation affected the baking quality of the flour. The loaf volume of infested flour was reduced and the crumb was compact and inelastic. Organoleptic tests showed that bread prepared from the flour infested for more than 1 month had a bitter taste and off-flavor and was not acceptable to the average consumer. The loaf volume of the bread made from the uninfested control flour was, however, not affected and the bread was quite acceptable to the consumers.

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