A Note on the Formation of Free Radicals in Dough during Mixing

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It has been speculated by cereal chemists for some time that free radicals might be formed during mixing of wheat flour doughs, and hence would be directly involved in dough development and breakdown. However, no one has so far been able to devise an experiment to test this hypothesis. We have recently obtained what appears to be positive evidence of the formation of free radicals in dough by mixing.

In our experiments we added to dough methylmethacrylate, a monomer which readily polymerizes by a free radical mechanism if initiated by free radicals. We used ^{14}C-labeled methacrylate so that copolymerization of small amounts of monomer onto flour components could be readily detected by radioactive tracer techniques. Doughs were mixed at 150 r.p.m. in a farinograph in nitrogen and air. Control doughs were mixed for 2 min. and then allowed to rest in the mixer for the remainder of the mixing time. The doughs were frozen in liquid nitrogen and freeze-dried for analyses. Free methylmethacrylate was removed by extraction with ethyl acetate in a Soxhlet apparatus.

That copolymerization does indeed occur is suggested by the increase in farinograph consistency and also by the presence of residual activity in the dough after removal of the monomer. The data for one concentration of monomer are given below:

Mixing Time			*Controls*	
min.	*Nitrogen*	*Air*	*Nitrogen*	*Air*
5	9,240	4,250	3,865	4,120
15	13,775	7,025	5,715	6,685

The above results are in disintegrations/min./g. dry solids. The activity added to the dough was 66,110 d.p.m./g. flour.

These results show that methylmethacrylate is incorporated into doughs. The incorporation is greater for doughs mixed in nitrogen; presumably oxygen inhibits copolymerization because it is an efficient free-radical scavenger. There is indication that the amount of incorporation increases with mixing time. These facts are, in general, consistent with the free-radical hypothesis, although further work will be necessary to confirm these preliminary observations. Studies are in progress to assess the fundamental and practical implications of these observations.

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