Microwave Heating of Cottonseed: A Pilot Plant Study

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Two cottonseed samples (50 kg) were exposed to microwaves at 45 KW and 2450 MHz for 4 min in an air temperature of 94°C. The final temperature of the seed was 76°C, and the treatment caused a 20% reduction in seed moisture. Examination of the seed immediately after microwave heating (MWH) indicated no differences in the total or soluble protein content of the meal or the content, quality or color of the oil as compared with unheated seed. There was some reduction in the quality of the oil from unheated seed during storage, but only minimal reduction in the quality of the oil from the MWH samples. Protein quality deteriorated in all samples; however, the deterioration was reduced in the microwave-heated seed.

KEY WORDS: Cottonseed storage, free fatty acids, microwave heating, moisture, oil color, pilot plant, protein.

Recent laboratory studies (1) demonstrated that microwave heat reduced the moisture content of cottonseed and preserved the quality of the protein and the oil during storage. Because of the interest generated throughout the cottonseed crushing industry by this study, an experiment was designed in which commercial microwave equipment was used to treat 50-kg samples of cottonseed. Analyses of the microwave-treated seed before and after storage were compared with analyses of unheated seed. The results are presented in this communication.

MATERIALS AND METHODS

Two samples of cottonseed from the 1991 crop in the Mississippi Delta were supplied by Yazoo Valley Oil Mill (Greenwood, MS). Sample A contained <2% free fatty acid (FFA); Sample B contained >2% FFA. At Microdry, Inc. (Crestwood, KY), a 50-kg portion of each sample was placed on a conveyor and passed through a microwave/convection heating unit. The samples were exposed to microwaves of 45 KW and 2450 MHz for 4 min in an air temperature of 94°C. The final temperature of the seed was 76°C. Immediately after treatment, each sample was mixed, and 1-kg portions were placed and tightly sealed in plastic containers. At the same time, 1-kg portions of unheated seed from each sample were packed in similar containers. The containers were shipped to the Southern Regional Research Center (New Orleans, LA). After removal of samples for initial analyses, the remaining containers were stored for 40 wk at an average temperature of 45°C.

Moisture, FFA and oil contents and color were determined according to the *Official Methods and Recommended Practices of the American Oil Chemists' Society* (2). Nitrogen was determined by LECO nitrogen analysis. Soluble protein was determined on 10% NaCl extracts of defatted meals as described by Conkerton *et al.* (1). Cottonseed samples were graded by a certified commercial laboratory according to the Trading Rules of the National Cottonseed Products Association (3).

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RESULTS AND DISCUSSION

The moisture content of Sample A was 10.7% before and 8.1% after microwave heating (MWH), and that of Sample B was 10.8 and 8.4%, respectively. This amounted to a moisture reduction of 24% for Sample A and 22% for Sample B. Moisture contents and oil contents remained constant throughout the storage period. The oil content of Sample A was 32% and that of Sample B was 29%. There was no change in oil content as a result of MWH, nor was there any change in the oil color. The bleached color values of the oil from unheated and MWH seed from Samples A and B were 27Y, 2.7R; 21Y, 2.1R; 19Y, 1.9R; and 14Y, 1.4R; respectively. The FFA contents of the oils before and after storage are listed in Table 1. Although there was a 74% increase in the FFA content of oil from the unheated Sample A, the increase in the FFA content of the MWH example was only 12%. Similarly, in Sample B, the increase of FFAs in the oil from the unheated seed was 58% whereas that in the MWH was 15%. MWH did preserve the protein quality of the meal, as indicated by the soluble nitrogen content of the meals (Table 1), but the treatment was not as effective on this parameter as it was on the oil quality. During storage, protein quality of the unheated seed from both samples was reduced 78% and that of MWH samples A and B was reduced 73 and 66%, respectively. It may be possible, however, to maintain protein quality more effectively by changing the conditions of the microwave treatment. In the laboratory study (1), the amount of salt-soluble protein present in seeds stored for 9 wk was reduced 50% by a 1.5-min exposure, but after a 2.0-min exposure there was only a 12% reduction. From the data on FFAs and soluble protein reported in these studies, it appears that MWH is more effective in retarding lipolytic enzyme activity than proteolytic enzyme activity.

The trading rules of the National Cottonseed Products Association (3) provide a formula for calculating the grade

TABLE 1

Free Fatty Acid Content of Oils, Salt-Soluble Protein Content of Meals and Grade of Seed from Unheated (UNH) and Microwave-heated (MWH) Cottonseed Before and After Storage for 40 wk at 45°C

	A		B	
	UNH	MWH	UNH	MWH
FFA (%)[a]				
Initial	1.20	1.20	2.15	2.15
Stored	2.09	1.34	3.39	2.48
Sol. Protein (%)[b]				
Initial	34.6	39.7	39.3	42.5
Stored	7.7	10.4	8.3	14.3
Grade[c]				
Initial	181.5	180.5	152.0	179.0
Stored	103.0	106.5	95.5	101.0

[a]FFA, free fatty acid; as oleic, S.D., 0.1%.
[b]S.D., 1.5%.
[c]Determined by Woodson-Tenent Laboratories (No. Little Rock, AK).

of a cottonseed sample from the Quantity Index (oil and protein content) and Quality Index (foreign matter, moisture and FFA content). The basis grade is 100, with grades above 100 listed as "High" and below 100 listed as "Low." Grades of these samples (Table 1) indicated that all samples were "High" initially, and there was some reduction in grade during storage. However, all samples except unheated B remained in the "High" category. It may be possible that MWH would be more effective in preserving seed quality if the initial sample was of "Low" rather than "High" grade.

This pilot plant study substantiated the results obtained in the laboratory and demonstrated that microwave heat had no effect on oil color. Based on the previous study (1) and on the results reported here, it is apparent that MWH prior to storage can be an effective means for reducing the moisture content of cottonseed and for preserving quality of the seed during storage. The potential use of this procedure in an oilseed processing mill would be dependent on the availability of microwave/convection units capable of handling the seed flow into the mill and on the economics of installing and operating this equipment. These aspects are presently under investigation.

ACKNOWLEDGMENT

Technical assistance was provided by T.B. Brown.

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[Received September 26, 1993; accepted December 22, 1993]