Effects of Drying on Sunflower Seed Oil Quality and Germination

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ABSTRACT

Sunflower seed (SunGro 380) were harvested 101 to 121 days after planting, and their moisture levels were between 43 and 15%. The seed were dried at 35, 53, 72, and 88 C to a final moisture level of 10% or below. Drying air flow was 2000 $m^3/hr./m^3$ seed. Temperature had no effect on peroxide values, total oil, or fatty acid composition. Free fatty acids increased as initial moisture decreased. For a given drying temperature, germination increased with decreasing initial moisture, and for a given initial moisture, germination increased with decreasing drying temperature. This study indicates that a drying temperature greater than 53 C should not be used if seed viability is to be maintained.

INTRODUCTION

Drying is an important step in the processing of sunflower seed and can affect the quality of both seed and oil. Losses can be minimized if the seed are harvested at 16% moisture or higher, then dried to 9.5% or below for extended storage or to 10.5% for limited storage in cool weather (1).

Schuler and Zimmerman (1) reported that drying at 38-93 C for 30 to 60 min did not adversely affect fatty acid composition or total oil content. However, drying has been shown to affect the viability of sunflower seed. The values reported in the literature for the maximum temperature at which seed may be dried without affecting germination vary considerably (1-3), and the reports mention no drying times. Chanet (4) reported that drying temperatures above 60 C reduced germination. Hall (2) reported that most seed are killed at 52 C or above. Jensen et al. (3) suggests drying at 49 C.

Our initial study (5) confirmed the results of Schuler and Zimmerman (1) concerning total oil content and fatty acid composition. We also showed that germination increased as initial moisture decreased but that it decreased with increasing drying temperature for a given harvest moisture.

In this second study, we undertook to determine whether we could verify the trends in germination and free fatty acid buildup noted in the original work.

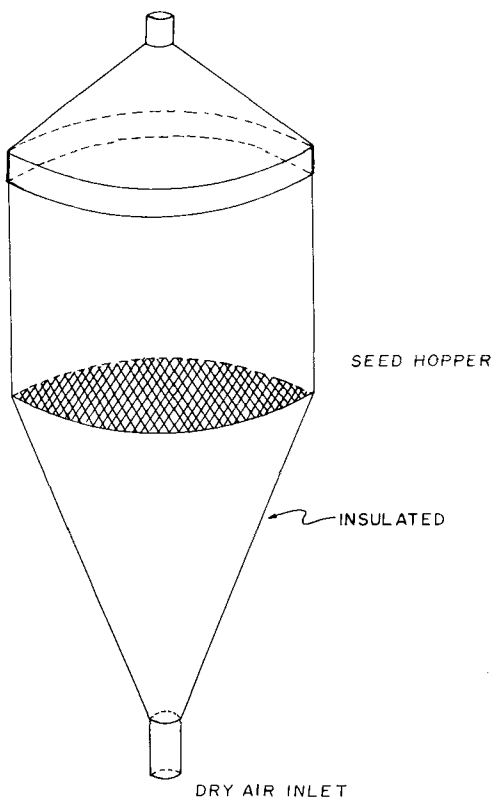

FIG. 1. Laboratory seed dryer.

MATERIAL AND METHODS

SunGro 380 hybrid sunflower seed were planted in Watkinsville, Georgia. After reaching physiological maturity, which is defined by Anderson (6) as occurring when seed moisture is about 40%, about 250 heads were covered with paper bags so that bird damage would be prevented. Bird damage was quite severe in the latter part of the study for uncovered plants. Seed were harvested at moisture levels of 43, 31, 22, and 15% (which corresponded to 101, 107, 111, and 121 days after planting, respectively). Seed were thrashed either by hand or by machine and stored in plastic bags at 1 C until the seed were ready for drying. The seed were dried at 35, 53, 72, and 88 C in an apparatus that simulated a commercial batch dryer (Fig. 1). Drying air was supplied by passing compressed air through a copper coil immersed in a constant temperature bath maintained a few degrees higher than the desired drying temperature to compensate for the temperature drop between the bath and dryer. Rate of air flow was 2000 $m^3/hr/m^3$ seed, and the drying temperatures, measured when the dryer was empty were 35, 53, 72, and 88 C.

Samples of seed (spread to a depth of 7.2 cm over an area of 137.5 cm^2) were dried in triplicate at each drying temperature to a final moisture level of 3 to 10%. The time necessary for drying the seed to the desired level was determined by drying a sample of seed and analyzing for moisture at regular intervals. Also, a sample of each seed lot was spread on the bench top and dried at room temperature to 10% or lower moisture. After drying, the seed were transferred to Mason jars, sealed, and frozen until tested and compared for chemical contents and germinability.

Moisture, free fatty acids, and peroxide value were determined by official AOCS methods (7-9). Total oil was determined by the procedure of Robertson (10). Fatty acid compositions were determined by the method of Metcalfe et al. (11), and use of a Tracor MT 220 gas liquid chromatograph equipped with an Infotronics Model CRS 101 digital integrator. A 6 ft x 1/8 in. glass column packed with 10% EGSS-X on 100/120 mesh Gas Chrom P was used for the analyses, and the oven was operated at 190 C. Germinability was determined by the AOSA method (12).

TABLE I

Effects of Heating on Germination and Free Fatty Acids

Initial moisture (%)	Day harvested after planting	Days from flowering to harvest	Germination (%)					Free fatty acids (% as oleic)			
				Drying temperature (°C)				Drying temperature (°C)			
			Air-dried[a]	35	53	72	88	35	53	72	88
43	101	35	51	21	24	55	0	0.31	0.39	0.31	0.42
31	107	41	32	32	36	4	0	0.28	0.28	0.31	0.46
22	111	45	41	26	26	11	1	0.35	0.44	0.44	0.54
15	124	58	54	56	60	61	8	0.74	0.78	1.03	0.91

[a]Air-dried at room temperature on bench top until moisture was 10% or below.

TABLE II

Comparison of Drying Times (hr) Needed to Reduce Moisture to 10% of Below

Drying temperatures (C)	Drying times (hr)			
	Harvest moistures (%)			
	43(37)	31(32)	22(19)	15(13)
35(35)[a]	6.0(4.0)	6.0(4.0)	4.5(2.0)	2.8(1.0)
53(51)	3.5(2.0)	3.5(2.0)	2.5(1.0)	2.0(0.3)
72(69)	2.0(1.0)	2.0(1.3)	1.2(0.8)	0.8(0.3)
88(91)	1.5(1.0)	0.9(0.8)	0.7(0.4)	0.4(0.2)

[a]Figures in parentheses represent the results of the initial study.

Analysis of variance was run on all determinations to evaluate the significance of any change with respect to drying temperature and initial moisture. All analyses were run in duplicate to give six values for each initial moisture and drying temperature. Duncan Multiple Range Tests were carried out to determine which means within a given temperature or moisture were significant.

RESULTS AND DISCUSSION

The results from this study support the findings of our earlier work (5) and those of Schuler and Zimmerman (1). Several points suggested in our initial study were also clarified.

The oils extracted from the dried seed contained an average of 5.3% palmitic, 3.5% stearic, 41.6% oleic, and 48.5% linoleic acid. Slight variations of fatty acid composition have been observed (J.A. Robertson and G. Chapman, unpublished work), but they were believed to result from fluctuations in the daily mean temperature between flowering and physiological maturity. For each harvest moisture, drying temperature had no significant effect on fatty acid composition; hence, the percentages of the acids were combined and averaged. Our second study shows minor changes in the fatty acid composition only for the 31% moisture.

With the exception of the low moisture sample in our first study (5) that had undergone extreme field damage as indicated by elevated free fatty acids, all three studies show no effect of drying temperature on total oil or fatty acid composition.

Table I shows the effect of drying on the free fatty acid content and germination at each initial moisture level. Although free fatty acids appeared to increase with increase in drying temperature within each harvest moisture, analysis of variance showed that the increases were not significant. The increases in free fatty acids with decreasing moisture were significant at the 1% level for the 15% moisture samples when compared to all samples of higher moisture. As in our initial study, the peroxide values and total oil content were independent of initial moisture or drying temperature. Since all seed were harvested after they had reached physiological maturity, when oil filling is complete, a change in oil content would not be expected.

The effect of drying on germinability is shown in Table I. The percentage of seed germination is lower than would be expected probably because the length of storage before seed viability was measured was insufficient to break dormancy (D.C. Zimmerman, personal communication). Generally within each harvest moisture, germination decreased as the drying temperature increased. This would be expected since increased heating would denature proteins involved in germination. In addition, prolonged exposure to even mild temperatures generally appeared to reduce viability. However, for a given drying temperature, germination increased as harvest moisture decreased; and the Duncan Multiple Range Test showed that the samples with 15% initial moisture had significantly higher germination than the other samples. With decreasing moisture, the time required at a given temperature to reduce the moisture below 10% should decrease. Since the seed at the lower moistures are not in contact with the warm air as long as those at the higher moistures, protein denaturation would be minimized. Furthermore, proteins in a dry medium are less prone to denaturation than those in a moist medium.

Our initial study suggested that germination was moderately reduced when seed were dried at 69 C. In this study, a Duncan Multiple Range Test showed that only those samples dried at 88 C had significantly lower germination than samples dried at the other temperatures. Because of the low germination for the 31 and 22% moisture samples dried at 72 C, 53 C probably represents the maximum temperature at which seed for planting should be dried. This figure is in good agreement with temperatures suggested by Hall et al. (2) and Jensen (3).

The high free fatty acid content of the oil from the seed of lowest moisture in our first study (5) was attributed to possible field damage. In the present study the lowest moisture seed had a free fatty acid content about double that of the next lowest moisture. While the magnitude of the free fatty acids in the first study may be attributed to field damage, both studies suggest that the application of dessicants should be applied at a seed moisture between 19 and 32% in order to keep free fatty acids to a minimum and retain maximum viability for foundation seed.

The reports of the temperature at which seed should be dried and above which seed lose viability show no real agreement. Whereas one author reported that temperatures above 60 C only reduce viability (4), others stated that most seed are killed above 52 C (2), and still another suggested 49 C as an acceptable temperature (3). In many of these reports airflow and the type of dryer used were not detailed. Without such information, meaningful comparisons are difficult.

Table II shows the harvest moistures used in each of our studies, temperatures used for drying, and the number of hours required to reduce the moisture below 10%. The table shows that under identical drying conditions, the time required to dry seed differing by only one percentage point in harvest moisture could almost double. The reason for the differences were not investigated, but might be explained by differences in seed sizes and seed hull porosity, which would affect the rate of diffusion of moisture from the seed. Another possibility could be a difference in surface and internal moisture between the samples of the two studies. Any of these factors could affect drying times and, therefore, account for the lacks of agreement in and effect on germination in relation to drying temperature.

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