Early Harvest and Oven Drying Temperatures Influence Pecan Kernel Flavor

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Abstract. 'Western Schley' pecans [*Carya illinoensis* (Wangenh.) K. Koch] were evaluated for flavor by a 17-person sensory panel after oven-drying nuts that had been harvested 1 to 7 weeks before normal harvest in 1985. The nuts were 1) not dried, 2) oven-dried 24 hours at 29C, 3) oven-dried 24 hours at 35C, 4) oven-dried 30 hours at 29C, 5) oven-dried 30 hours at 35C, 6) dried at room temperature for 72 hours, and 7) collected at normal harvest time (control). At the start of the experiment, kernel moisture was 14%. Some of the treatments reduced kernel moisture to <5 % the first week of the experiment, but drying nuts at room temperature for 72 hours reduced kernel moisture as effectively as other treatments. Judging by kernel flavor, pecans can be harvested $\approx$ 4 weeks before normal harvest (performed after the first freeze in Las Cruces, N.M.) and artificially dried without affecting flavor.

Nut quality is important in pecan marketing. Kernel quality is usually determined by color, flavor, texture (Woodroof and Heaton, 1961, 1967), and absence of insect and disease damage. Desirable characteristics of commercially marketed pecan kernels are good color, $\approx$ 5% moisture, crisp texture, and the absence of staleness and rancidity (Forbus et al., 1980; Kays, 1987; Woodroof and Heaton, 1967). Quality can be affected by seasonal growing conditions and cultivar differences (Kays, 1979). However, peak flavor, color, and texture are usually reached during maturity, which is an after-ripening period that occurs before harvest (Kays, 1987; Woodroof and Heaton, 1961).

Good flavor, consisting of taste and aroma, is one of the main attributes of high-quality pecans (Kays, 1987). Harvest time (Heaton et al., 1975; Kays, 1987; Smith and Loustalot, 1944), moisture content (Heaton and Beuchat, 1980; Heaton and Woodroof 1965), and oil content (Kays, 1987; Love and Young, 1970; Wagner, 1977) are the most influential factors affecting pecan kernel flavor. Flavor improves gradually during maturation, but it is the first characteristic that can be negatively affected after pecans have been harvested (Forbus et al., 1980; Kays, 1987).

Optimum flavor occurs when pecans stay on the tree until they are fully mature (Heaton et al., 1975; Wagner, 1977), a process that takes 3-4 weeks (Woodroof and Heaton, 1961). A sharp drop in fruit moisture is part of this process. An immature flavor often is associ-

ated with pecans harvested early (Heaton and Beuchat, 1980), whereas pecans harvested too late in the season can be rancid and bitter (Kays, 1987; Love and Young, 1970; Smith and Loustalot, 1944).

Harvesting pecans early in the season and reducing moisture artificially can improve market prices for western-region pecan growers. They are usually the last growers in the United States to harvest because they wait until after fall temperatures reach about -6C, causing leaf fall and decreased nut moisture. With the exception of 1990-92, pecan prices usually decrease after the Christmas season (information determined by analyzing trends in the U.S. Dept. of Agriculture's *Pecan Market Weekly Harvest Report* from 1985 to 1992; reports available from Phoenix Marketing News, Phoenix).

Kernels containing $\approx$ 5% moisture have optimum flavor (Heaton and Woodroof, 1965, 1970). Kernels with <4% moisture are brittle (Heaton and Woodroof, 1965, 1970), but kernels with a moisture content of >8% are undesirably soft. Improved quality, especially flavor, can be achieved by curing pecans in dry storage for a few weeks after harvest (Woodroof and Heaton, 1967). Kernel moisture drops to $\approx$ 5% during this process (Heaton and Woodroof, 1965, 1970); pecan kernels dried at 0 or 2C lacked flavor and were rubbery, and those dried at 35C had normal flavor and color but were somewhat brittle. Smith and Loustalot (1944) found that kernels dried at 50C were also brittle, but the flavor resembled that of roasted pecans. Pecans cured at room temperature appeared to have normal color and flavor and were of acceptable texture.

When a sensory panel evaluated kernels for flavor, appearance, and color, only flavor was affected by harvest date (Heaton et al., 1975). Pecans harvested early received significantly lower flavor ratings and had a high moisture content and a flabby texture. In con-

trast, pecans harvested later and cured had higher flavor ratings, less moisture, and better texture (Heaton and Beuchat, 1980; Heaton et al., 1975).

I conducted this research to determine acceptability of kernel flavor for southern New Mexico pecans harvested earlier than normal and artificially dried.

Materials and Methods

Pecans from a commercial pecan orchard south of Las Cruces, N. M., during the 1985 growing season were used in this study. Pecans were harvested from uniform, healthy, 46-year-old 'Western Schley' pecan trees.

To prevent disparity in maturity among nut samples, pecans were randomly tagged in one orchard section 1 week before beginning the experiment. At the time of tagging, the involucre (shuck) of the selected nuts was still green, but one or two sutures were slightly open and their surrounding tissues were turning black and drying out.

Random samples from tagged nuts were taken weekly beginning 15 Oct. and ending 18 Nov. This period ran from 6 weeks to 1 week before normal harvest (WBNH). Normal harvest started after 18 Nov. because temperatures below 0C occurred 15, 16, and 17 Nov. At each harvest, a 50-nut sample was taken for each of six treatments: 1) not dried, 2) oven-dried 24 h at 29C, 3) oven-dried 24 h at 35C, 4) oven-dried 30 h at 29C, 5) oven-dried 30 h at 35C, and 6) air-dried 72 h at room temperature, with $\approx$ 30% relative humidity. I also used a control group (not dried sample) that consisted of pecans collected during normal harvest time. Kernel and moisture percentages were recorded for each sampling date.

The goal for the oven drying was to decrease kernel moisture to $\approx$ 5%, which is the usual moisture content for cold-stored pecans, (oven manufactured by W.H. Curtin, Houston). Oven-dried pecans were cracked and shelled. After the kernel percentage was recorded, kernel moisture was determined with a Steinlite moisture tester (model 400G; Seedburo Equipment, Chicago). An average of five readings per sample was used to determine the respective moisture percentage from a reference chart. The same procedure was used for all treatments, except for the nondried sample and the control, for which kernel moisture percentages were determined immediately after harvest.

After their moisture content had been determined, kernels were placed in labeled plastic bags and kept at 0C for 3 months; then their flavor was judged by a 17-person, untrained sensory panel. Kernels removed from storage were brought to ambient temperature before evaluation. The panel members were not familiar with pecan flavor, and when taste panels were assembled, they were not informed which kernels belonged to the normal harvest sample. All seven treatments were compared on a week-by-week basis. No comparisons were made of weeks within treatments.

Flavor panelists ranked samples on a scale from 7 (best) to 1 (worst). No information

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regarding sampling dates or terminology to describe their perception during pecan tasting was provided. Data from the sensory tests were analyzed using the Kruskal-Wallis H test for a completely randomized designed. This is a nonparametric test for comparing populations that require no assumptions concerning the population probability distributions. I used this test because the response variable was the value assigned to samples by the panel members. Moisture was analyzed using a completely randomized design with repeated measures over time. The least square means procedure was used to determine significant differences among means.

Results and Discussion

Samples collected at normal harvest time were consistently rated better than pecans from the other harvests (Table 1). Most samples taken 6 WBNH had an immature off-flavor associated with early harvested pecans (Heaton and Beuchat, 1980; Heaton et al., 1975), causing panel members to rank the control higher. The high moisture content (Table 2) along with short maturation time of the nondried kernels likely caused them to be ranked lowest (Table 1). Their flavor remained undesirable for 5 weeks, i.e., until 1 WBNH when the sample had significantly improved in flavor and was statistically similar to the control. At this time, moisture content had dropped <5%. Kernels from treatments dried for 30 h at either 29 or 35°C harvested 6 WBNH showed lower moisture content than the control (Table 2), but the flavor was not ranked as high (Table 1). Possibly pecans from the control had a better

flavor due to the curing that occurred naturally in the field (Heaton and Woodroof, 1970; Smith and Loustalot, 1944).

Beginning with samples taken 5 WBNH, flavor for all pecans, except for those harvested 3 WBNH, dried at room temperature was ranked statistically similar to those of the control (Table 1). Moisture content was significantly lower than for the control during the same period (Table 2). Also, for samples collected 5 WBNH, moisture content of pecans dried for 30 h either at 29 or 35°C was similar to that of the control, but flavor was ranked lower (Table 1). Bringing kernel moisture to $\approx 5\%$ was not sufficient to obtain good kernel flavor during the first 2 weeks of the experiment. It seems that pecans need an after-ripening period to complete maturity (Heaton et al., 1975; Kays, 1987; Love and Young, 1970), which improves flavor. Nondried samples continued to rank the highest in moisture and lowest in flavor, with the exception of the 18 Nov. sampling date when nuts were mature. Other studies also have shown that a sharp drop in kernel moisture during maturation improves flavor (Heaton et al., 1975; Wagner, 1977).

With the exception of the nondried samples, kernel flavor was ranked statistically the same for most treatments 4, 3, 2, and 1 WBNH (Table 1). At the same time, kernel moisture content for all those treatments had fallen to <5% (Table 2). Possibly, maturation had started in some pecans at the time they were tagged for the experiment. Nuts sampled during the 4 WBNH period had at least 3 weeks of maturation when collected. Maturing time, along with a moisture drop to commercially accept-

able levels, improve kernel flavor (Smith and Loustalot, 1944; Wagner, 1977; Woodroof and Heaton, 1961).

At all sampling dates, pecans dried at room temperature for 72 h ranked similarly in flavor to pecans harvested at the normal time. Bringing moisture down slowly to the required level seems to replace the period needed for natural maturation. However, this procedure would be a problem when harvesting large lots early in the harvest season because it would be difficult to dry pecans at room temperature unless artificially cooled air is used. It may not only be impractical, but mold could become a problem. The alternative may be harvesting pecans ≈ 3 weeks before normal harvest begins, when pecan moisture content has dropped to $\approx 10\%$. Pecan moisture would decrease naturally to required levels during the 3-week harvest interval. This procedure would maintain good kernel flavor and assist growers to enter the pecan market earlier and obtain higher prices. Other areas of the country may benefit from harvesting pecans early to prevent pregermination problems (Finch and VanHorn, 1936; Ou et al., 1989). Future experiments should emphasize the use of sensory panels with pecans harvested ≈ 3 WBNH. Nut weight loss related to kernel moisture decrease during the harvest season also needs to be studied.

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Table 1. Effect of drying time and temperature on kernel flavor of 'Western Schley' pecans harvested at six weekly intervals before normal harvest (NH), Mesilla Valley, N.M., 1985.

Harvest date	WBNH ^y	Flavor rating ^z						NH (control)
		Non-dried	Drying time (h)/temp (°C)					
			24/29	24/35	30/29	30/35	72/21 ^x	
15 Oct.	6	1.0 d ^w	4.1 bc	4.2 bc	3.3 c	4.9 b	4.3 b	6.3 a
22 Oct.	5	1.3 e	4.2 cd	4.5 bc	3.7 cd	3.5 d	5.1 a	5.7 a
29 Oct.	4	1.2 c	4.3 ab	3.9 b	4.6 ab	4.2 ab	4.4 ab	5.1 a
4 Nov.	3	1.6 d	4.7 ab	4.5 abc	4.2 bc	3.6 c	4.0 bc	5.4 a
11 Nov.	2	1.9 c	3.6 b	4.9 a	3.8 b	4.1 ab	4.6 ab	4.8 a
18 Nov.	1	3.8 ab	4.6 a	4.6 b	3.4 ab	3.8 ab	3.5 b	3.5 b

^xRanked on a scale from 7 (best) to 1 (worst).

^yWeeks before normal harvest.

^zRoom temperature.

^wLSD_{0.05} = 1.03 for rows.

Table 2. Effect of drying time and temperature on moisture content of 'Western Schley' pecans harvested at six weekly intervals before normal harvest (NH), Mesilla Valley, N.M., 1985.

Harvest date	WBNH ^z	Moisture (%)							NH (control)
		Non-dried	Drying time (h)/temp (°C)						
			24/29	24/35	30/29	30/35	72/21 ^y		
15 Oct.	6	12.2 aB ^x	5.7 cA	5.3 dA	3.4 fD	3.2 fC	6.5 bA	4.2 e	
22 Oct.	5	13.0 aA	5.5 bA	5.3 bA	4.4 cA	4.2 cA	3.9 dB	4.2 c	
29 Oct.	4	11.1 aC	4.9 bB	4.6 bB	3.8 dB	3.8 dB	3.7 dBC	4.2 c	
4 Nov.	3	11.0 aC	4.5 bC	4.2 bC	3.8 cBC	3.7 cB	3.5 cC	4.2 b	
11 Nov.	2	6.4 aD	3.8cD	3.3 dD	3.3 dD	3.2 dC	3.3 dC	4.2 b	
18 Nov.	1	4.6 aE	3.2 bE	3.2 bD	3.5 bCD	3.3 bC	3.4 bC	4.2 a	
25 Nov.	0	4.2 F	4.2 C	4.2 C	4.2 A	4.2 A	4.2 B	4.2	

^xWeeks before normal harvest.

^yRoom temperature.

^zLSD_{0.05} = 0.342 for rows, small letters; LSD_{0.05} = 0.333 for columns, capital letters.