2018 Mole Pepper Drying Trial

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A mole pepper variety trial was planted at the Saginaw Valley Research and Extension Center (43.399097, -83.694497, Frankenmuth, Michigan). Sakata (SK), PanAmerican (PAN), Siegers (SG), and Harris (HR) seed companies and private Wisconsin breeder, James Nienhuis (JN), donated seeds to the trial. A client wanted to make mole (pronounced "molay") sauces from Michigan-grown and Michigan-dried poblano (dried ancho), chilaca (dried pasilla), and guajillo peppers. Poblanos that ripen to a brown color are called mulattos when dried. Thirteen pepper varieties were trialed for their horticultural characteristics, in a separate report. The objective of this report is to discuss the economics of the drying processes that we tried.

Starting 26 September, mature red peppers were harvested from all plants in each 20-foot row (between 11 and 16 plants). A second and final harvest occurred on 11 October and included fruits that had started to color (breakers). Total red fruit weights were recorded for each plot. Cull fruit with spots and rots were counted but not weighed.

Two attempts were made to dry the fruits. The standard treatment for drying peppers uses high heat to quickly reduce fruit moisture content to discourage fungal and bacterial rots. Dried fruit weight is 1/8th of their fresh weight. The industry refers to this as an 8-to-1 drying ratio, or an 8-fold reduction. We did not have access to a high heat source until November. Therefore, we tried low heat and cool drying on unreplicated subsamples. No statistics were performed.

Fruit harvested on 26 September were placed into perforated blueberry lugs (Monte Packaging item PL-000, 3752 Riverside Road, Riverside, MI 49084) according to their variety. They were piled, and not laid in a single layer. Lugs were stacked on a pallet with a modified screened floor, and pallet collars (Uline model no. S-18394, 12575 Uline Drive, Pleasant Prairie, WI 53158) were stacked around them. Then they were covered with padded shipping blankets and centrifugal fans forced air into the modified screen floors and up through the blueberry lugs. The air temperature was an ambient ~85 degrees F, and this process lasted three weeks.

Red and breaker fruit harvested on 11 October were stored in a similar fashion, but the fan forced air at an ambient ~ 45 degrees F for five weeks until most fruit had ripened and then a subsample of sound fruit was dried in a commercial food warmer on 13 November (Cres Cor model no. 0671 054, 12825 Taft Cleveland, OH 44108) with an air temperature ~165 degrees F, for 24 hours. The subsamples of peppers were placed on metal wire trays that slide into the machine such that air can move around and through them. We placed as many peppers per variety as would fit onto one tray in one layer.

Results

Low heat drying at 85 degrees F for three weeks resulted in a 5.57 – 8.74-fold reduction in water content and a loss of 23.73% - 100.00% of fruit from rots, depending on variety (Table 1). However, an average of 67.25% of the peppers across all varieties were unrecoverable from rots during this process. Some would look dry on the outside but were fleeced with white mold on the inside. Others were spotted with orange coloration, with mold opposite the spots inside the fruit. Darker colored fruit made it harder to identify rots.

Cool drying at 45 degrees F for five weeks resulted in a reduced water content by 1.49 – 2.03-fold and a loss of 20.82% – 85.21% of the fruit from rots, depending on variety (Table 2). A subsample of these peppers were then placed into a high heat treatment of 165 degrees F for 24 hours, which resulted in an additional 2.87 – 5.62-fold reduction in water content and no further fruit loss (Table 3). These two processes combined resulted in a reduction of 4.89 – 7.28-fold, depending on variety.

Economics and Discussion

Selling dried peppers can offer a unique shelf-stable item for winter or spring farm markets when few fruiting vegetables are available for purchase among easy-keeping hard squashes, root crops and cold-tolerant leafy greens. Their production may be supported by local food movements thriving in certain regions. Drying and selling peppers may require following licensing, inspections, packaging and labeling regulations under state and federal Food Codes.

The arid production regions of the world have a strong agronomic advantage to drying peppers because pepper plants will yield more in that warmer and longer season climate and they can reduce their moisture content up to 4-fold on the plant in open air, thus reducing drying cost (personal communication with Aaron Boese, of Cass River Farms/Boese Harvester Company, Saginaw, MI). However, in our trial, we measured the costs to drying our sample peppers and found that electricity-based drying resulted in a break-even price competitive with some online retailers packaging in 1-pound bags (Table 4). However, it is not competitive against local ethnic stores that buy in bulk quantities and repackage into 1-pound bags (Table 5).

Keys to improve the success of this endeavor will include maximizing fully ripened and unblemished fruit, drying them as soon as possible without piling them on top of one another, and drying them with a cheap heat source. Improving unblemished yields will rely on choosing varieties that produce ripe fruit early without blossom end rot or stip disorder. Though diseases were not prevalent in the field trial, choosing bacterial spot resistant varieties would be important. Growing peppers on black plastic and/or in a hoophouse or greenhouse will push heat units to increase early yields.

Using a cheaper heat source and identifying minimum loads of peppers for efficiently heating discrete units of space will also bring down the costs. Heated and unheated greenhouses and hoophouses could be converted into solar heaters late in the summer, as long as vents and fans can be used to release condensation and increase air flow. An automated natural gas or wood/corn cob heat source and venting system could be beneficial on cool and cloudy days to maintain high temperatures temporarily. Further, rather than add extra heat to an entire house for small loads of peppers, smaller sections can be heated by installing additional temporary structures within the warm ambient space that can multiply the solar radiation (more plastic layers) or be heated with some other fuel source. An additional heater would not need to run as hot with the ambient heat provided by the hoophouse structure, but extra care must be taken to avoid high humidity or fire hazards. More information on dehydrating in a hoophouse can be found in a 2014 report from a Michigan Sustainable Agriculture Research & Education Project FNC13-933 (https://projects.sare.org/sare_project/fnc13-933/).

New and used equipment considerations for this purpose could also include commercial dehydration units, or certain pieces of grain-drying equipment. One idea a local grower considered is to modify a refrigeration room, shipping container or some other structure to use

indirect natural gas heat, much like bulk curing barns used for tobacco. If considering investments in infrastructure for drying peppers, one should also consider spreading the investment across multiple products.

Table 1. Peppers harvested on 26 September were dried using forced air at ~85 degrees F until 20 October. The number and weights of marketable fresh and dried fruit are recorded in the table. The cull percentage describes the loss that occurred during dry down after harvest.

Variety	26-Sep		20-Oct		Weight fold reduction	% Cull
	Number of red fruit	Pounds per red fruit	Number of red fruit	Pounds per red fruit		
Baron	59	0.24	45	0.03	6.96	23.73
Capitan	63	0.26	10	0.03	8.52	84.13
Don Matias	31	0.23	0	NA	NA	100.00
Alteno	96	0.26	9	0.03	9.28	90.63
Hidalgo	57	0.24	24	0.03	8.74	57.89
Trident	24	0.28	3	0.03	8.31	87.50
Vencedor	52	0.25	5	0.03	8.33	90.38
Masivo	19	0.28	6	0.03	8.29	68.42
SHP9018	102	0.11	66	0.02	7.03	35.29
Holy Mole	117	0.12	67	0.02	7.36	42.74
Durango	146	0.09	44	0.02	5.70	69.86
WI Wroaster	150	0.12	14	0.02	6.48	90.67
Aji Rico	1201	0.04	805	0.01	5.57	32.97
Mean	-	-	-	-	7.55	67.25

Table 2. Peppers harvested on 11 October were stored using forced air at ~45 degrees F until 13 November. The number and weights of marketable fresh and partially dried fruit are recorded in the table. The cull percentage describes the loss that occurred during dry down after harvest.

Variety	11-Oct		13-Nov		Weight fold reduction	% Cull
	Number of red fruit	Pounds per red fruit	Number of red fruit	Pounds per red fruit		
Baron	135	0.30	29	0.15	1.96	78.52
Capitan	66	0.25	14	0.16	1.55	78.79
Don Matias	125	0.26	37	0.14	1.79	70.40
Alteno	107	0.29	30	0.18	1.61	71.96
Hidalgo	79	0.29	29	0.16	1.86	63.29
Trident	142	0.34	21	0.20	1.66	85.21
Vencedor	96	0.24	19	0.15	1.55	80.21
Masivo	31	0.28	10	0.18	1.59	67.74
SHP9018	65	0.12	39	0.06	2.03	40.00
Holy Mole	80	0.13	63	0.07	1.85	21.25
Durango	199	0.09	137	0.05	2.02	31.16
WI Wroaster	158	0.14	89	0.09	1.49	43.67
Aji Rico	831	0.05	658	0.03	1.80	20.82
Mean	-	-	-	-	1.75	57.92

Table 3. Peppers harvested on 11 October were stored using forced air at ~45 degrees F until 13 November, then they were fully dried using an electric food warmer at ~165 degrees F for 24 hours. The number and weights of marketable partially dried (13 Nov) and dried fruit (14 Nov) are recorded in the table. No culls were found after 24 hours of high heat drying.

Variety	13-Nov		14-Nov		Weight fold reduction	Total fold reduction
	Number of red fruit	Pounds per red fruit	Number of red fruit	Pounds per red fruit		
Baron	23	0.15	23	0.03	4.51	6.47
Capitan	14	0.16	14	0.03	5.05	6.60
Don Matias	25	0.14	25	0.03	4.73	6.51
Alteno	22	0.18	22	0.03	5.33	6.94
Hidalgo	20	0.16	20	0.04	4.27	6.13
Trident	18	0.20	18	0.04	5.62	7.28
Vencedor	18	0.15	18	0.03	5.25	6.80
Masivo	11	0.18	11	0.04	4.65	6.23
SHP9018	39	0.06	39	0.02	3.49	5.52
Holy Mole	52	0.07	52	0.02	3.91	5.76
Durango	54	0.05	54	0.02	2.87	4.89
WI Wroaster	57	0.09	57	0.02	4.91	6.40
Aji Rico	126	0.03	126	0.01	3.76	5.56
Mean	-	-	-	-	4.49	6.24

Table 4. The costs of drying peppers with three electric methods at different temperatures and hold times. This does not include amortized equipment costs. This cost per pound of peppers does not take into consideration the entire cost of production, but is an estimate of wholesale fresh market prices for green unripe poblanos. These measurements and calculations represent the bulk weight summed across all varieties. *The third drying attempt reduced the weight of peppers from the second attempt by an additional 4.42-fold. Drying a similar load of fresh peppers for six more hours would cost little more.

Item or Process	85° F, three-weeks	45° F, five-weeks	165° F, 24-hours
Pounds of all fresh peppers	199.70	321.05	42.13
Pounds of all dried peppers	26.65	268.08	9.54
Pounds of water weight removed	173.05	52.97	32.59
Fold reduction	7.49	1.20	4.42 (+ 1.20 = 5.62)*
Pounds of marketable dried peppers	11.50	69.85 (not dried)	9.54
% Loss from rotting	56.85%	73.94%	0.00%
Centrifugal Air Blower			
Watts	500.00	500.00	
Hours run	504.00	840.00	
Kilowatt-hours (kwh)	252.00	420.00	
Commercial Food Warmer			
Watts			2000.00
Hours run			24.00
Kilowatt-hours (kwh)			48.00
Electricity cost at $0.15 per kwh	37.80	63.00	7.20
Cost of peppers at $1 per lb	199.7	321.05	42.13
Labor at $10 per hour	80.00	80.00	80.00
Cost	**317.50**	**464.05**	**129.33**
Breakeven price per dried lb	**27.61**	**not dried**	**13.56**

Table 5. Prices per pound for the types of dried peppers in this trial from two local ethnic-food retailers and three online retailers. Online bulk prices for 5- or 10-pound bags are closer to the prices seen at local ethnic retailers, who purchase in bulk and repackage peppers at the store.

Retailer	Ancho/Mulatto	Guajillo	Pasilla	Aji
Store 1, bulk repackaged	6.00	7.00	7.00	-
Store 2, bulk repackaged	7.99	7.99	7.99	-
Online 1	17.92 - 18.89	18.40	22.10 - 39.49	20.72 - 25.45
Online 2	14.65 - 32.43	15.42	36.77 - 58.96	25.96 - 36.77
Online 3	17.07 - 19.53	17.52	19.73 - 21.05	24.24