california almonds

STOCKPILE MANAGEMENT BEST PRACTICES

ALMOND PROCESSORS

STOCKPILE MANAGEMENT TO PREVENT CONTAMINATION

When it becomes necessary to stockpile almonds before processing, steps must be taken to protect the harvest from various sources of contamination, such as vertebrate pests, insects and bacteria. Moisture can be a source of contamination, both through water drainage or runoff that transports harmful bacteria or other contaminants into the stockpile, and can also increase the potential for mold growth and aflatoxin development.

Excess moisture in the stockpile can also lead to concealed damage,[1] a condition in which nuts develop off-color and off-flavors after roasting.

Aflatoxins are naturally occurring chemicals produced by certain molds. They are a health concern because of their potential to cause cancer. Because of this health risk, maximum allowable levels of aflatoxin contamination in foods have been set by certain countries around the world — including countries that are some of the largest markets for California Almonds.

When almonds that have been shipped to these countries are tested in the lab for aflatoxins and are found to have levels above the allowable limits, the consignment will have to be reconditioned or rejected, at significant cost to both the grower and the handler.

AFLATOXIN SAMPLING PLAN

Since controlling aflatoxins is important to the almond industry, the Almond Board of California created the Voluntary Aflatoxin Sampling Plan (VASP). The VASP program proactively monitors aflatoxin levels in California Almonds before they are exported to ensure they meet standards set by the European Union.

Almond Board of California–funded research has found that certain conditions in stockpiled almonds increase the risk, growth and spread of *Aspergillus* spp., the fungal molds that produce aflatoxins.[2]

The California Almond industry prides itself on providing safe, high-quality almonds to a worldwide market.

Under certain conditions, in-hull almonds that are stockpiled can develop fungal molds that produce aflatoxins.

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[1] Niederholzer, Franz. Concealed damage field studies. 2012–2013 Research Update, Almond Board of California.
[2] Lampinen, Bruce. Almond stockpile monitoring for aflatoxin potential. 2008–2009 Final Research Report, Almond Board of California.

As is the case with most molds, the most significant factor in the growth of *Aspergillus* is moisture content. When in-hull almonds are stockpiled, moisture in the almonds combined with hot weather can create a breeding ground for the *Aspergillus* molds to grow and produce aflatoxins. By monitoring and adjusting the amount of moisture in stockpiled almonds, it is possible to limit the amount of moisture that builds up in stockpiles, thus preventing the growth of *Aspergillus* molds.

ALMOND STOCKPILING BEST PRACTICES

Additional research funded by the Almond Board of California has resulted in the following best practices for stockpile management to prevent aflatoxins.

MOISTURE LEVELS

The first step to effectively manage *Aspergillus* growth and concealed damage is to ensure moisture content of the almonds does not exceed allowable levels. To accurately determine moisture levels of almonds, it is important to take a good sample of nuts as they arrive in the yard before stockpiling.

Before stockpiling, moisture content for almonds should be:
- Below 6% for the in-shell kernel;
- Less than 9% for the total fruit (in-hull almond); and
- Less than 12% moisture content for hulls.

As a practical guideline, do not stockpile if either the hull moisture content exceeds 12% or the kernel moisture content exceeds 6%.

CREATING STOCKPILES

When choosing where to stockpile almonds before they are processed, look for an area where you can have a raised or sloped bottom. This encourages any moisture to drain away from the stockpile, further limiting mold growth.

The stockpile area should be free of trash and stored equipment or other potential harborage of insects and vertebrate pests.

The shape and positioning of stockpiles can also be used to control moisture and mold growth. Stockpiles should have an even, flat top. This helps minimize areas where condensation can build up on the underside of the tarp, with the resulting moisture affecting the nuts.

Build stockpiles with the long axis facing north to south to reduce the risk of mold growth.

Stockpiles should be built with an even, flat top to prevent valleys where moisture can collect.

An uneven surface on a stockpile is conducive to mold growth.

Also, position the long side of the stockpile on the north-south axis. Condensation and mold growth are usually worse on the north end of the pile when the long side is oriented on the east-west axis.

MANAGING STOCKPILES

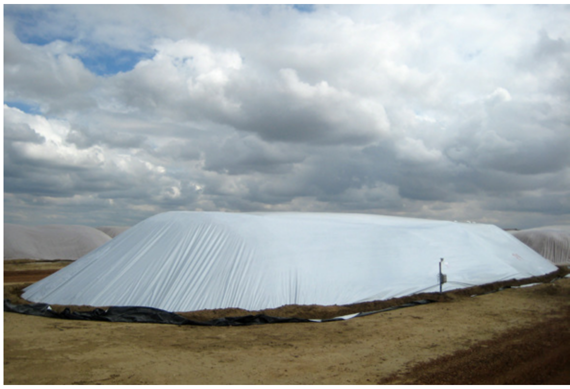
To protect stockpiled almonds:

- Cover stockpiles with tarps.
- Monitor closely for evidence of pests — insects, rodents and even birds — and if found, treat or fumigate as necessary. Pests carry diseases and can spread bacteria such as *Salmonella* and *E. coli* and other contaminants in a stockpile.
- Create drainage channels to prevent water from rain or equipment-washing areas from reaching stockpiles.
- Maintain storage areas to prevent contamination from trash, sanitary facilities, dust and other potential sources of contamination.
- Dispose of waste regularly, as this reduces the number of insects attracted to the waste and also reduces the risk of contaminating stockpiles.
- Keep detailed records of the use of any fumigants, including the date used, location and dosage levels.

Keep detailed records of fumigation treatments, including date, time, product, location and dosage levels.

Covering a stockpile with a tarp is necessary, but it can increase the humidity within the stockpile, causing an increase in moisture and an increase in the risk of mold growth and concealed damage. When choosing a tarp, keep in mind:

- A white-on-black tarp is the best choice to minimize temperature fluctuations, which lead to condensation and eventual mold growth.
- Clear tarps allow the greatest temperature fluctuations, but can be used on dry, in-hull almonds that are well below the moisture threshold.
- White tarps fall between white-on-black and clear tarps in terms of temperature fluctuations.



A white-on-black tarp, with the white side facing upward, is most effective at minimizing temperature fluctuations.

MANAGING MOISTURE

Controlling the relative humidity (rH) in a stockpile is critical to food safety. If you find that moisture levels are too high in a stockpile, open up the tarps in the daytime to allow moisture to escape, and close them at night, when relative humidity tends to increase. Also, pay close attention to the outside of the piles, where large changes in temperature and condensation can increase moisture levels. This is not a uniform problem throughout high-moisture-content piles because the equilibrium rH within the piles comes to a steady state below maximum limits recommended for storage.

To best calculate the moisture content of a stockpile based on the relative humidity, use the accompanying chart. An rH of greater than 65% within the pile is the maximum for almond storage. In the chart, green-shaded areas indicate moisture contents that are suitable for stockpiling. Yellow areas are borderline, and red areas indicate moisture contents that are too wet for stockpiling.

The California Almond industry prides itself on providing safe, high-quality almonds to a worldwide market. Making sure that stockpiles are managed to exclude contaminants such as aflatoxins, harmful bacteria and pests, and to prevent mold-inducing moisture, will help maintain almond quality and safety. Your commitment to food safety plays a critical role in keeping California Almonds as the Nut of Choice by consumers worldwide.

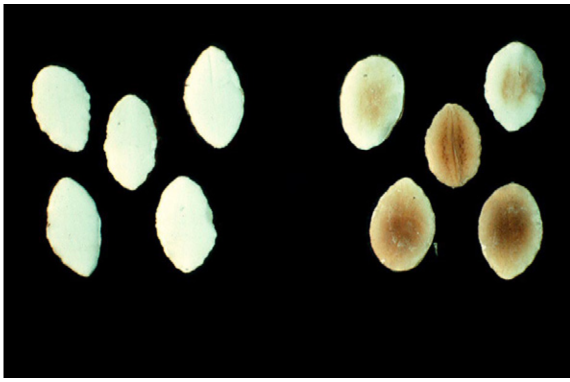
		WATER CONTENT			
Relative Humidity	Water Activity	Kernels + Hulls	Hulls	Kernels	
30	.30	3.80	4.43	2.73	🟩
31	.31	3.89	4.59	2.79	🟩
32	.32	4.00	4.76	2.85	🟩
33	.33	4.11	4.94	2.92	🟩
34	.34	4.22	5.12	2.99	🟩
35	.35	4.34	5.31	3.06	🟩
36	.36	4.47	5.50	3.14	🟩
37	.37	4.61	5.71	3.22	🟩
38	.38	4.75	5.92	3.31	🟩
39	.39	4.89	6.13	3.40	🟩
40	.40	5.05	6.36	3.50	🟩
41	.41	5.20	6.59	3.60	🟩
42	.42	5.37	6.83	3.71	🟩
43	.43	5.54	7.07	3.82	🟩
44	.44	5.72	7.32	3.98	🟩
45	.45	5.90	7.58	4.06	🟩
46	.46	6.09	7.85	4.18	🟩
47	.47	6.29	8.12	4.31	🟩
48	.48	6.49	8.40	4.45	🟩
49	.49	6.70	8.69	4.59	🟩
50	.50	6.92	8.98	4.73	🟩
51	.51	7.14	9.28	4.88	🟩
52	.52	7.37	9.59	5.03	🟩
53	.53	7.60	9.90	5.19	🟩
54	.54	7.84	10.22	5.35	🟩
55	.55	8.09	10.55	5.51	🟩
56	.56	8.34	10.89	5.69	🟩
57	.57	8.60	11.23	5.86	🟩
58	.58	8.87	11.58	6.04	🟩
59	.59	9.14	11.94	6.23	🟨
60	.60	9.42	12.30	6.42	🟨
61	.61	9.70	12.67	6.61	🟨
62	.62	9.99	13.05	6.81	🟨
63	.63	10.29	13.43	7.01	🟨
64	.64	10.59	13.82	7.22	🟨
65	.65	10.90	14.22	7.43	🟨
66	.66	11.22	14.62	7.65	🟨
67	.67	11.54	15.04	7.87	🟨
68	.68	11.87	15.45	8.10	🟨
69	.69	12.20	15.88	8.33	🟨
70	.70	12.55	16.31	8.56	🟨
71	.71	12.89	16.75	8.80	🟥
72	.72	13.25	17.20	9.05	🟥
73	.73	13.61	17.65	9.30	🟥
74	.74	13.97	18.11	9.55	🟥
75	.75	14.34	18.58	9.81	🟥
76	.76	14.72	19.06	10.07	🟥
77	.77	15.11	19.54	10.34	🟥
78	.78	15.50	20.03	10.61	🟥
79	.79	15.89	20.52	10.89	🟥
80	.80	16.30	21.02	11.17	🟥
81	.81	16.71	21.53	11.45	🟥
82	.82	17.12	22.05	11.75	🟥
83	.83	17.55	22.57	12.04	🟥
84	.84	17.97	23.10	12.34	🟥
85	.85	18.41	23.64	12.64	🟥
86	.86	18.85	24.18	12.95	🟥
87	.87	19.30	24.74	13.27	🟥
88	.88	19.75	25.29	13.59	🟥
89	.89	20.21	25.86	13.91	🟥
90	.90	20.68	26.43	14.24	🟥
91	.91	21.15	27.01	14.57	🟥
92	.92	21.63	27.60	14.90	🟥
93	.93	22.11	28.19	15.25	🟥
94	.94	22.60	28.79	15.59	🟥
95	.95	23.10	29.39	15.94	🟥
96	.96	23.60	30.01	16.30	🟥
97	.97	24.11	30.63	16.66	🟥
98	.98	24.63	31.26	17.02	🟥
99	.99	25.15	31.89	17.39	🟥
100	1.00	25.68	32.53	17.76	🟥

CONCEALED DAMAGE

Another consequence of moisture in harvested almonds is concealed damage, which can significantly impact quality and reduce returns in years with late harvests and/or early rains. Concealed damage is apparent only after roasting, when the kernel interiors turn darker than undamaged nuts, and flavor can be bitter. In extreme cases, kernel internal color and flavor are altered before roasting. Prolonged moisture at elevated temperatures (above storage yard temperatures) and even at ambient temperatures can create this condition.

Current Almond Board–funded research seeks a better understanding of the field conditions that contribute to concealed damage as well as mold, and management practices in the field that can reduce these risks.

Among other factors, the research is establishing a threshold for the specific kernel moisture content, temperature, and the various time and storage management scenarios that will lead to the appearance of concealed damage, and refine guidelines for when action should be taken under different field and handling temperature and moisture scenarios.



Concealed damage is apparent only after roasting (right), when the kernel turns darker than undamaged nuts (left).

FOR MORE INFORMATION ON STOCKPILE MANAGEMENT CONTACT STAFF@ALMONDBOARD.COM OR VISIT ALMONDS.COM/HANDLE

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