
THE ALMOND CONFERENCE
50
YEARS

CEU INSTRUCTIONS: HOW TO RECEIVE CREDIT

VIA QR CODES

1. **Separate QR codes will be provided** at the start and end of each session. Participants will scan QR code with their smart phones where their check-in/out times are recorded and will provide their information.
2. **The QR codes can be found on the stands at the** entrance of each session.
3. **The check-in QR codes will be pinned 10 minutes** before the session starts and available until 10 minutes after the presentation has started. The check-in QR code will be removed after 10 minutes into the session to prevent late attendees from checking in.
4. **The checkout QR codes will be provided 5 minutes** before the session is scheduled to end, and available for 15 minutes afterwards before being removed.

VIA ATTENDANCE BOOTH

1. **A staff member will be present** at the attendance booth to help assist participants who are unable to use the QR code.
2. **Attendees will check in before the session starts** and check out after the session is over by filling out a copy of the check-in/out form.
3. **Attendees will provide** name, email address, license type and number, and credit type that they wish to receive.
4. **The same policy will apply** as above for check-in and checkout times.

MONITORING

One to two Almond Board staff members will be present at each session for monitoring attendance. Staff will monitor any attendees who leave at any point during session. They will remind these attendees of their credit being denied and won't allow them to checkout at the end of the session.

CERTIFICATES

- **Attendance information will be tracked** and compiled after the sessions.
- **Course Completion Certificates will only be provided** to attendees that were present for the entire duration of each session.
- **Course Completion Certificates will be emailed** to attendees within 14 days after the conclusion of the conference.
- **No partial credits** will be offered.
- **No print certificates** will be provided. Certificates will be emailed shortly after The Almond Conference.

50 YEARS of The Almond Conference

THANK YOU
TO THE ALMOND CONFERENCE 2022
METAL SPONSORS!

PLATINUM — AMVT LLC IMPROVING THE PROCESS — The Almond Conference

GOLD — BORRELL — The Almond Conference

SILVER — TOMRA — The Almond Conference

EMERALD — QCIFY — The Almond Conference

TITANIUM — BAYER — The Almond Conference

BRONZE — HORN AC HORN MANUFACTURING — The Almond Conference

COPPER — SATAKE — The Almond Conference

NICKEL — ANYSORT U.S.A — The Almond Conference

STEEL — MILLER A HUBER COMPANY — The Almond Conference

COBALT — THE AG CENTER — The Almond Conference

We Want to Hear from You!

The Almond Board is conducting research to understand your experiences, perceptions and needs/wants of The Almond Conference. This information will improve future conferences. During the conference, we'll conduct several focus group sessions and short individual interviews.

Focus Group Sessions

These will be in Room 15 (Level 2–across from Ballroom B-5) during the following times:

Wednesday, December 7, 2022

- 9:30–10:30 a.m.
- 11:45 a.m.–12:45 p.m.
- 4:00–5:00 p.m.

Thursday, December 8, 2022

- 10:30–11:30 a.m.

If you are interested in being a part of the focus group, please use this QR code to select a time!

Short Individual Interviews

Throughout the conference, Vivayic, the research organization, will also ask select attendees about their conference experiences.

Vivayic will have a neon yellow ribbon on their name badges that says, **"Tell me more."**

Please take a few moments to provide your insights if asked.

VISIT THE INCENTIVE AND GROWER SUPPORT ZONE!

This year the Almond Board of California is offering a new and improved ***Incentive and Grower Support Zone***. This is **THE** place to learn about government incentives and other forms of support. Many of these incentive programs began as research projects with funding from the ABC, with proven agronomic benefits.

Grower incentives through federal, state and local programs provide funding for adoption of many practices of interest to almond growers.

Examples of available funding include:

- More efficient irrigation and nutrient management systems
- Cleaner on-farm equipment
- Low-dust harvesters
- Groundwater recharge
- Habitat projects including pollinator hedges
- Navel orangeworm mating disruption and integrated pest management
- Planning grants and many other practices

Located on Level 2 in the Ballroom B Foyer

The tables with agency staff and program materials will be outside the breakout sessions, in the Ballroom B Foyer.

Just keep an eye out and you can't miss it, or ask at the ABC booth for more information.

Food Truck Village

Tuesday. December 6
11:00 a.m. – 2:00 p.m.

Wednesday, December 7
11:00 a.m. – 2:00 p.m.

Thursday, December 8
10:30 a.m. – 1:30 p.m.

Located Outside in the
West Lobby Plaza

OPENING RECEPTION

Sponsored by Alzchem LLC

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Sponsored by Wilbur-Ellis

WILBUR-ELLIS
AGRIBUSINESS

3:30 – 5:00 p.m.
Almond Conference Expo

Almond Quality & Safety Research Hot Topics

December 6, 2022

Moderator: Brian Dunning (ShoEi Foods)
Speakers: Alyson Mitchell (UC Davis)
Zhongli Pan (UC Davis)
Vivian Wu (USDA Albany)

california almonds®
Almond Board of California

Characterization of cyanogenic glycosides and key chemical and physical measurements of almond quality in regional varietal trails to support new almond varietal selection

12.06, 2022 / Alyson Mitchell, PhD

california almonds®
Almond Board of California

Project Goals

Objective 1:

- Measure a range of chemical markers of almond (*Prunus dulcis*) quality in 10-15 varieties of new almond varieties for the 2021 regional varietal trail (RVT), and in commercial varieties, in support of identifying new varieties with highest quality impact
  - Moisture, color, texture, lipids as fatty acid methyl esters (FAMEs), tocopherols, cyanogenic glycosides (amygdalin, prunasin), and free amino acids

Objective 2:

- Develop extraction techniques and high-throughput methods for the analysis of amygdalin and its degradation products benzaldehyde, mandelonitrile and possibly HCN
  - These will be measured in the 2022 and 2023 harvests in 13 major almond varieties and in the top performing varieties

Sample Information

- Almonds (2021 field-run) were received from Phippen, Vann and South Valley Farms
  - 7 varieties from 3 locations
  - 5 varieties from 2 locations
  - 2 varieties from 1 location
  - Total of 33 almond varietal samples
- Storage
  - Whole almonds are stored in the cold storage (4°C) upon receiving
    - Moisture and texture are measured immediately
  - Almonds are hulled and shelled and kernels are vacuum-packed and placed in refrigeration
    - Oil is extracted and kept in refrigerated storage

	Variety	Farm	Region
1	Aldrich	Phippen	Manteca central region
	Aldrich	Vann	northern region
	Aldrich	South Valley Farms	Wasco, CA
2	Carmel	Vann	northern region
	Carmel	Phippen	
	Carmel	South Valley Farms	Wasco, CA
3	Non-Pareil	Phippen	Salida central region
	Non-Pareil	Vann	northern region
	Non-Pareil	South Valley Farms	Wasco, CA
4	Sonora	Vann	northern region
	Sonora	Phippen	
	Sonora	Phippen	
5	Supareil	Vann	northern region
	Supareil	South Valley Farms	Wasco, CA
	Supereil	Phippen	
6	Winters	Vann	northern region
	Winters	Phippen	
	Winters	South Valley Farms	Wasco, CA
7	Wood Colony	Vann	northern region
	Wood Colony	Phippen	
	Wood Colony	South Valley Farms	Wasco, CA
1	Butte	Vann	northern region
	Butte	South Valley Farms	Wasco, CA
2	Butte-Padre	Phippen	central region
	Butte-Padre	Phippen	
3	Fritz	Vann	northern region
	Fritz	South Valley Farms	Wasco, CA
4	Independence	Phippen	Stockton central region
	Independence	Vann	northern region
5	Monterey	South Valley Farms	Wasco, CA
	Montery	Vann	northern region
1	Padre	South Valley Farms	Wasco, CA
2	Price	South Valley Farms	Wasco, CA

Objective 1: Quality Monitoring

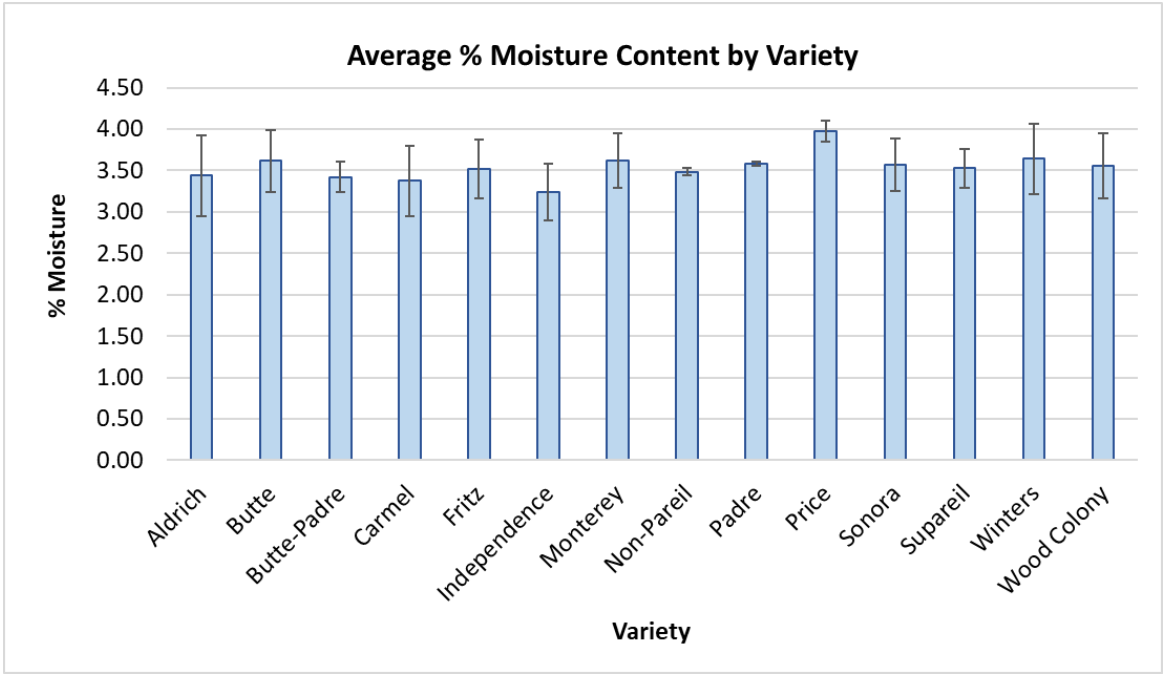
- Quality measurements completed in 33 almond samples
    - Moisture (2021)
    - Texture (2021)
    - Color (2021)
    - Fatty Acid Methyl Esters; FAMEs (2021)
    - Tocopherols (2021)
    - Cyanogenic Glycosides (2021)
        - Amygdalin and Prunasin (2021)
- Measurements in process:
    - Amino Acid Profiles (2021)
    - Cyanogenic Glycosides profiling (2021)
        - Amygdalin, Prunasin, Benzaldehyde and Mandelonitrile (HCN)

2022 Harvest

Average Moisture Content (%)

2021

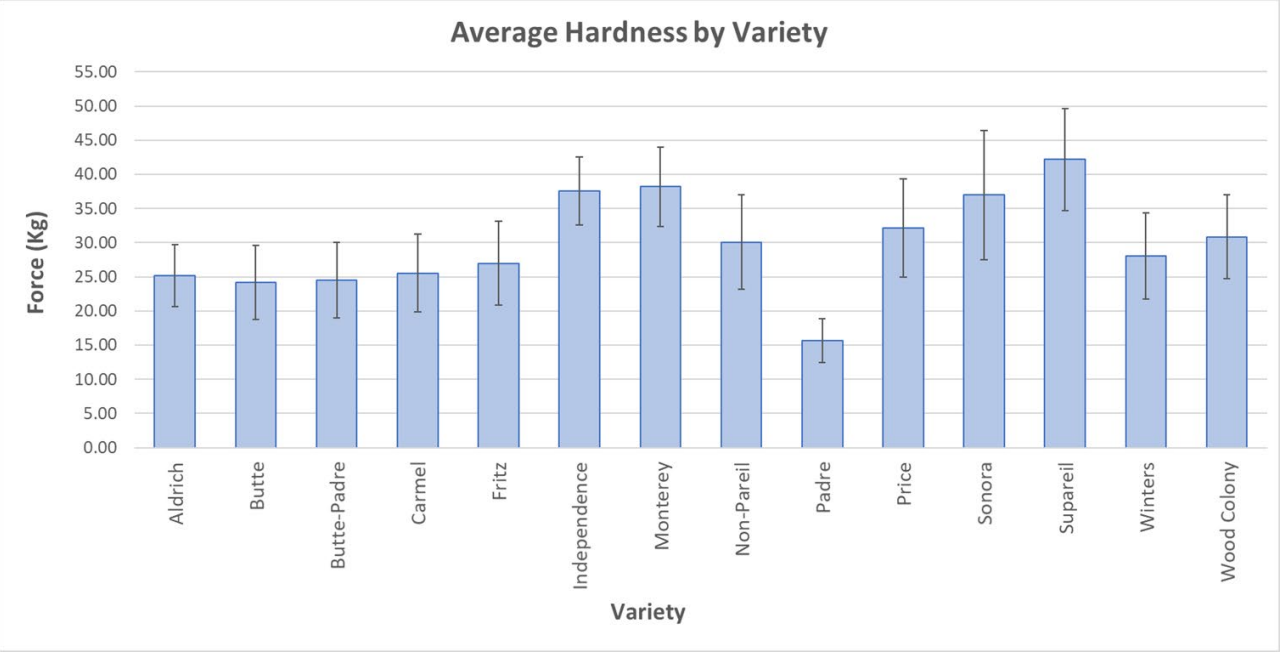
- Moisture content is relatively constant between varieties
- Average: 3.52% ± 0.33
- Range: 2.84 - 4.15%



Average Hardness by Variety

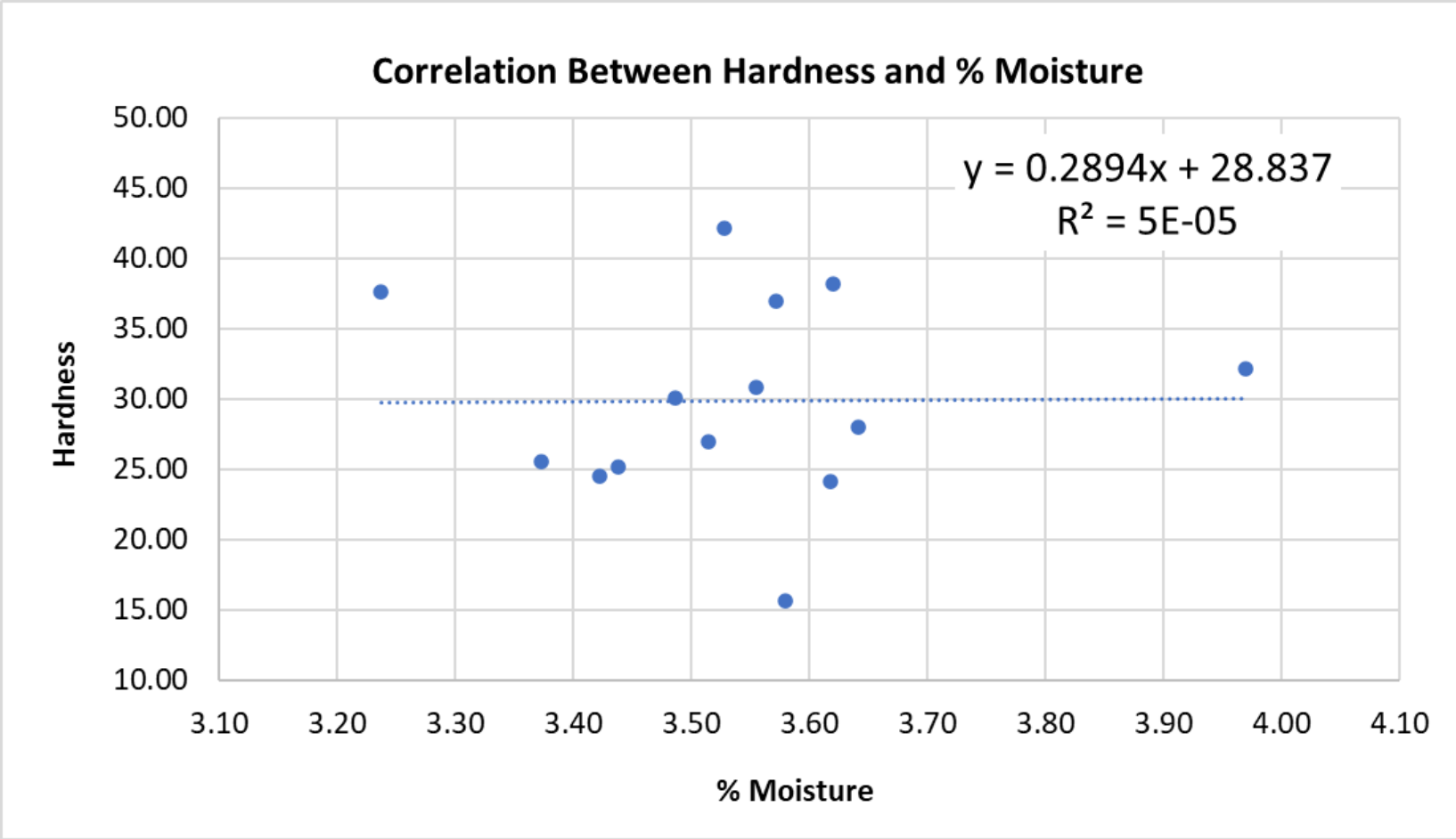
2021

- Texture analysis evaluates almond hardness and crunchiness
- The value obtained correlates with the force required to shear the almond between the molars
  - Supareil was the crunchiest
  - Padre was the softest



Hardness is not related to Moisture Content

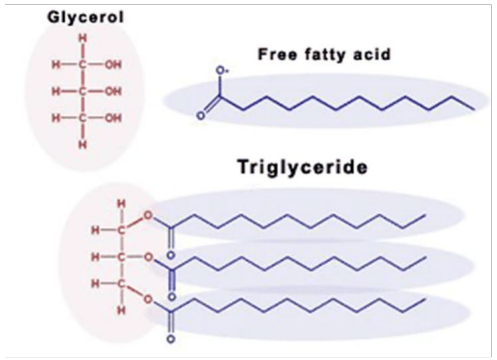
2021

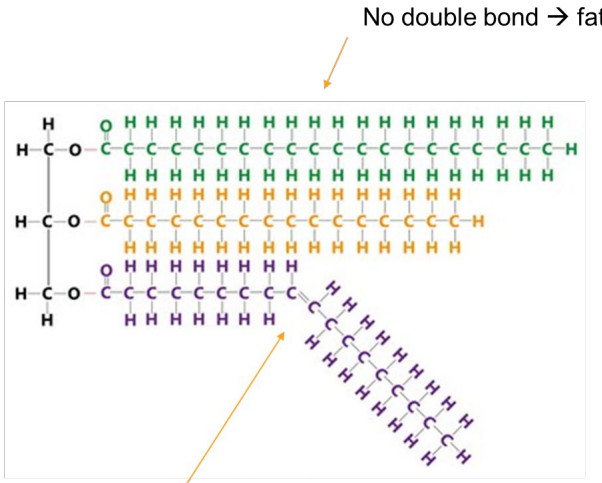


Lipids in Almonds

2021

- Almonds are composed of 40-77% fat
- Fat in almonds is composed of triglycerides
- A triglyceride is molecule composed of 3 fatty acids chains attached to a molecule of glycerol

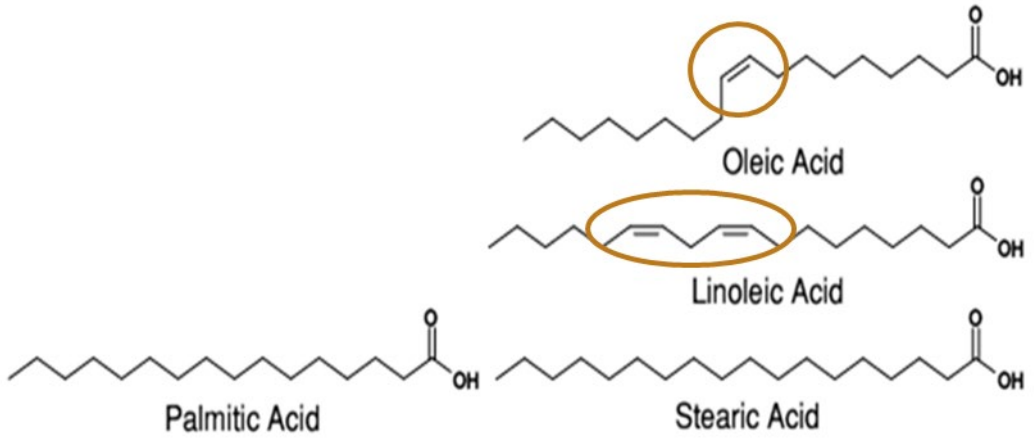




Triglycerides in Almonds

- The primary fatty acids in almonds are *"Good Fats"*
  - Monounsaturated and polyunsaturated fats → lower disease risk
- Oleic (18:1, 62–80%) and linoleic acid (18:2, 10–18%)
- One serving of almonds (28 g) has 13 g of unsaturated fat and only 1g of saturated fat

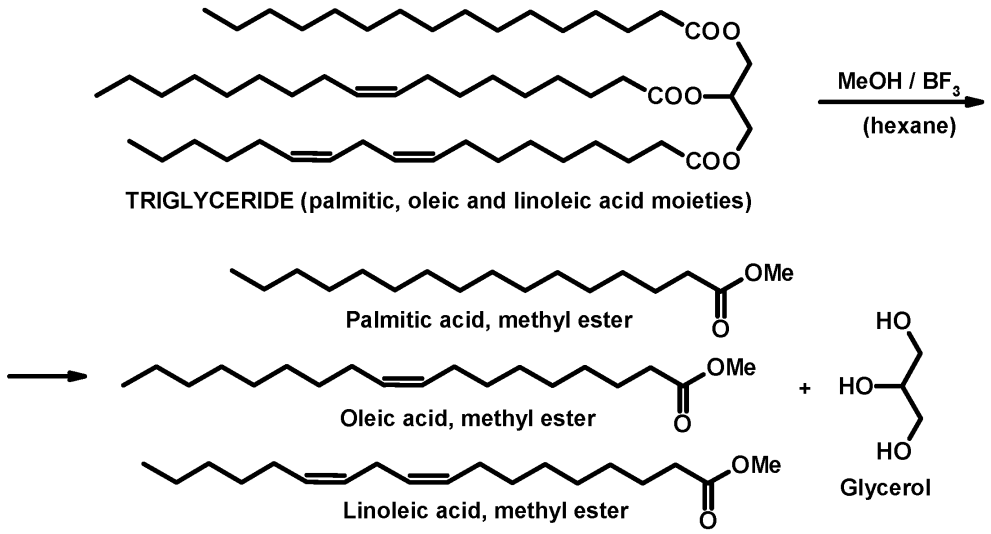
Name	Number of Carbons:Double bonds	Percent in Almond Oil
Oleic	18:1	60-80%
Linoleic	18:2	10-18%
Palmitic	16:0	0.5-8%
Stearic	18:0	1-3%

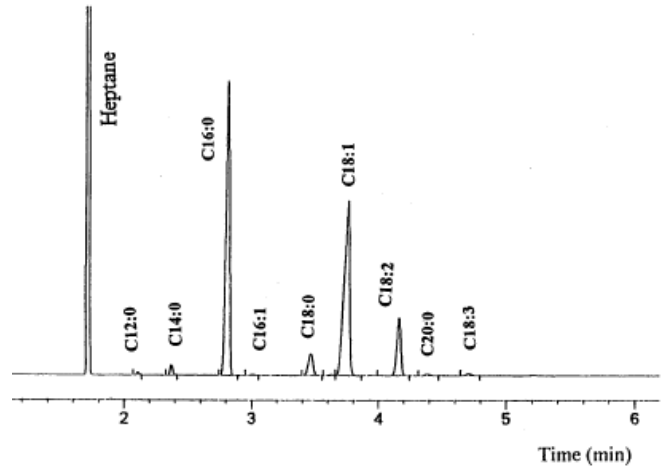


Measuring Fatty Acid Methyl Esters (FAMEs) in Almonds

2021

- Triglycerides are hydrolyzed in the presence of methanol to form fatty acid methyl esters (FAMEs)
- FAMEs are measured by GS-MS/MS





Fatty Acid Composition in Commercial Varieties

2021

	Mean ± SD Percent of Total Fatty Acids					
Variety	Palmitic Acid (C16:0)	Stearic Acid (C18:0)	Oleic Acid (C18:1)	Linoleic Acid (C18:2)	Oleic : Linoleic	Oleic + Linoleic
Aldrich	6.538 ± 0.122	1.325 ± 0.008	66.417 ± 0.866	25.720 ± 0.843	2.587 ± 0.152	92.138 ± 0.110
Butte	6.359 ± 0.132	1.728 ± 0.040	60.030 ± 0.470	31.882 ± 0.373	1.888 ± 0.170	91.912 ± 0.089
Butte-Padre	6.234 ± 0.077	1.799 ± 0.037	62.384 ± 2.477	29.584 ± 2.517	2.110 ± 0.090	91.967 ± 0.134
Carmel	6.617 ± 0.071	1.496 ± 0.091	60.676 ± 0.932	31.211 ± 0.942	1.959 ± 0.260	91.887 ± 0.368
Fritz	6.022 ± 0.051	1.249 ± 0.059	66.831 ± 0.230	25.898 ± 0.206	2.585 ± 0.174	92.729 ± 0.035
Independence	6.862 ± 0.058	1.534 ± 0.041	64.090 ± 0.996	27.514 ± 1.095	2.337 ± 0.233	91.604 ± 0.069
Monterey	6.563 ± 0.216	1.522 ± 0.145	65.261 ± 0.255	26.654 ± 0.300	2.465 ± 0.345	91.915 ± 0.137
Nonpareil	6.503 ± 0.122	1.376 ± 0.134	67.730 ± 0.807	24.391 ± 0.608	2.784 ± 0.209	92.121 ± 0.063
Padre	6.012 ± 0.011	1.501 ± 0.075	66.201 ± 0.074	26.286 ± 0.011	2.518 ± 0.002	92.487 ± 0.086
Price	6.429 ± 0.302	1.085 ± 0.000	66.742 ± 0.286	25.745 ± 0.016	2.592 ± 0.010	92.486 ± 0.302
Sonora	6.729 ± 0.092	1.273 ± 0.029	63.297 ± 0.614	28.701 ± 0.616	2.217 ± 0.138	92.051 ± 0.108
Supareil	6.652 ± 0.139	1.153 ± 0.039	66.864 ± 0.752	25.330 ± 0.656	2.667 ± 0.401	92.195 ± 0.224
Winters	6.866 ± 0.112	1.224 ± 0.048	63.806 ± 0.495	28.104 ± 0.398	2.282 ± 0.244	91.910 ± 0.171
Wood Colony	6.378 ± 0.107	1.272 ± 0.013	68.413 ± 0.636	23.938 ± 0.646	2.859 ± 0.079	92.351 ± 0.113
Average	**6.483 ± 0.268**	**1.396 ± 0.210**	**64.910 ± 2.598**	**27.143 ± 2.503**	**2.418 ± 0.296**	**92.125 ± 0.301**

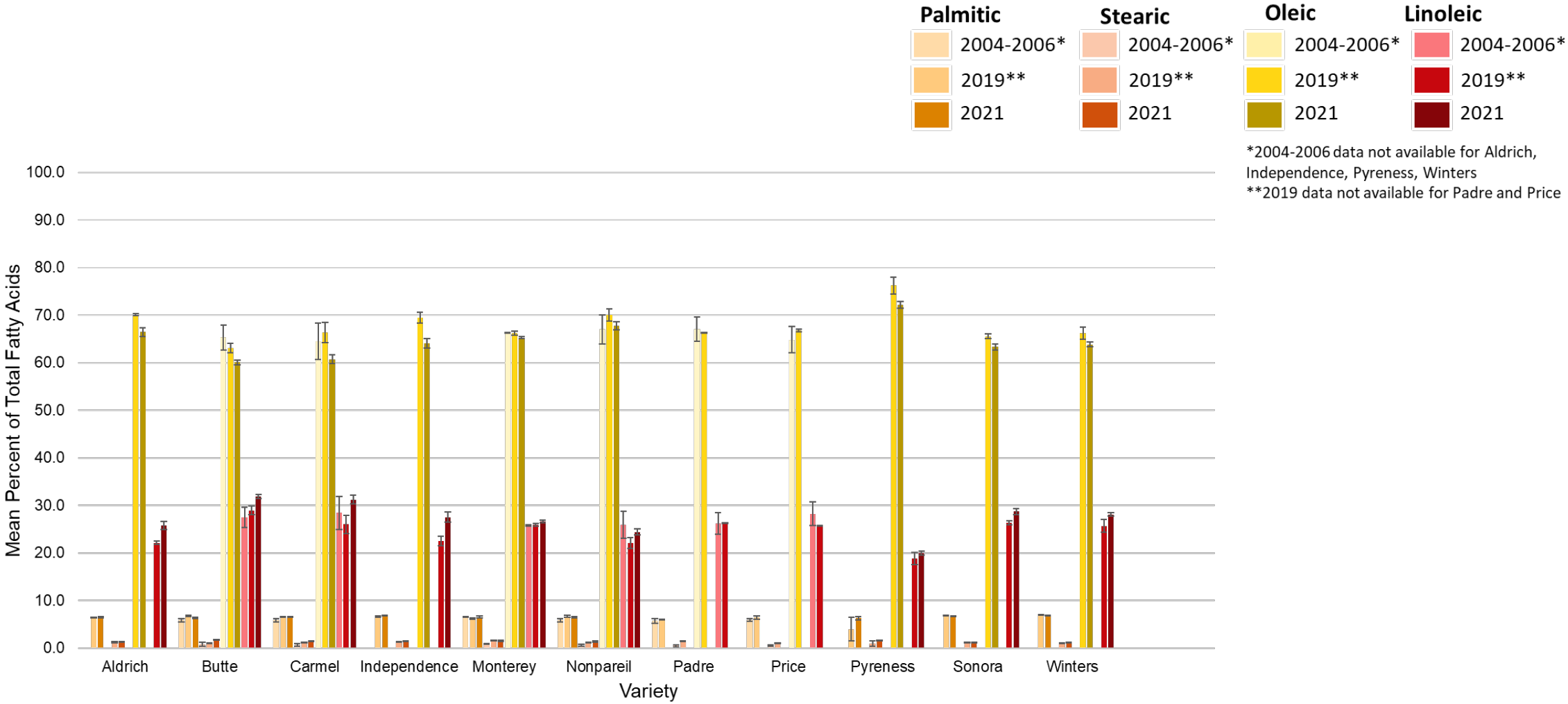
Fatty Acid Composition in Experimental Varieties

2021

	Mean ± SD Percent of Total Fatty Acids					
Variety	Palmitic (C16:0)	Stearic (C18:0)	Oleic (C18:1)	Linoleic (C18:2)	Oleic : Linoleic	Oleic + Linoleic
Y117-106-03	6.801 ± 0.171	1.379 ± 0.085	72.238 ± 0.381	19.582 ± 0.295	3.690 ± 0.075	91.820 ± 0.086
Y119-12-11	6.912 ± 0.134	1.959 ± 0.221	65.392 ± 0.685	25.738 ± 0.331	2.541 ± 0.059	91.129 ± 0.355
Buralmondfour Lassen	6.702 ± 0.035	1.797 ± 0.201	**75.033 ± 0.357**	**16.467 ± 0.191**	**4.557 ± 0.074**	91.500 ± 0.166
Conway	7.174 ± 0.071	1.241 ± 0.026	67.206 ± 0.291	24.378 ± 0.388	2.757 ± 0.056	91.584 ± 0.097
Pyrenees	6.303 ± 0.309	1.619 ± 0.019	72.165 ± 0.722	19.913 ± 0.432	3.625 ± 0.115	92.077 ± 0.290
UCD-B3	7.037 ± 0.077	**1.181 ± 0.009**	62.133 ± 0.638	29.649 ± 0.705	2.096 ± 0.071	91.782 ± 0.067
UCD-B4	**6.220 ± 0.054**	**2.360 ± 0.042**	64.747 ± 0.415	26.673 ± 0.402	2.428 ± 0.052	91.420 ± 0.012
UCD-B5	7.075 ± 0.048	1.272 ± 0.010	64.123 ± 0.558	27.531 ± 0.501	2.330 ± 0.063	91.654 ± 0.058
UCD-B6	6.852 ± 0.149	1.770 ± 0.049	66.758 ± 0.070	24.621 ± 0.170	2.712 ± 0.022	91.378 ± 0.100
UCD-B8	6.456 ± 0.052	1.280 ± 0.009	67.311 ± 0.312	24.952 ± 0.252	2.698 ± 0.040	**92.263 ± 0.060**
UCD-B9	6.957 ± 0.175	1.297 ± 0.025	68.012 ± 0.475	23.735 ± 0.275	2.866 ± 0.053	91.747 ± 0.200
UCD-B11	6.819 ± 0.330	1.984 ± 0.266	66.005 ± 0.347	25.191 ± 0.411	2.621 ± 0.056	91.196 ± 0.064
UCD-B12	**8.651 ± 0.512**	1.282 ± 0.038	**55.330 ± 0.519**	**34.737 ± 0.045**	**1.593 ± 0.017**	**90.067 ± 0.474**
UCD-B14	6.692 ± 0.137	1.455 ± 0.059	66.524 ± 0.033	25.329 ± 0.229	2.627 ± 0.025	91.853 ± 0.195
UCD-B15	7.327 ± 0.023	1.457 ± 0.064	61.522 ± 0.999	29.694 ± 0.958	2.074 ± 0.101	91.215 ± 0.041
Average	**6.932 ± 0.566**	**1.556 ± 0.347**	**66.300 ± 4.778**	**25.213 ± 4.455**	**2.748 ± 0.732**	**91.512 ± 0.514**

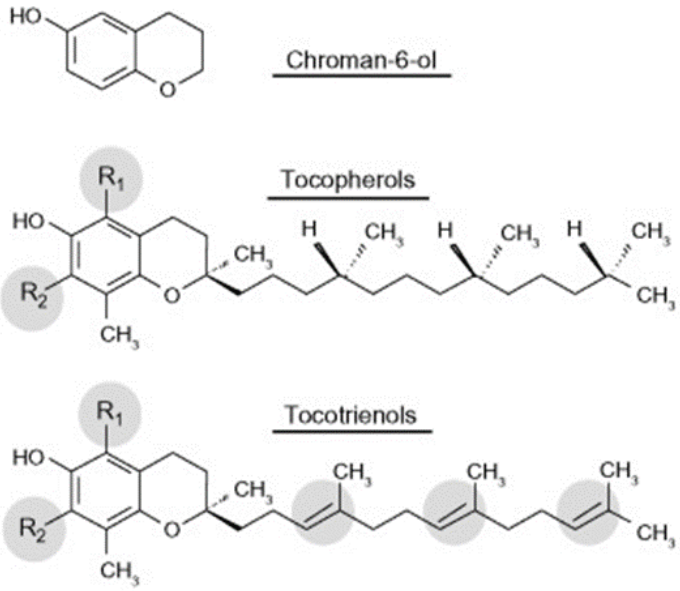
Comparative Fatty Acid Profiles

2004-2006, 2019, 2021



The Tocopherols (Vitamin E)

- Vitamin E is a group of plant-derived vitamins
  - Fat soluble
- Comprised of a chroman-6-ol ring with a side chain located at the C2 position
- Present in foods in 8 different forms
  - Tocopherols = saturated side chain
  - Tocotrienols = side chain with double bonds at C3′, C7′ and C11′
- Chroman-6-ol ring can have different groups attached at R1 or R2 positions
- Prefixes alpha- (α-), beta- (β-), gamma- (γ-), and delta- (δ-)



Compound	R_1	R_2	Activity versus α-Tocopherol: α-TPP binding	Vitamin E	Antioxidant (*in vitro*)
α-Tocopherol	CH_3	CH_3	100	100	100
α-Tocotrienol	CH_3	CH_3	12.5	16	100
β-Tocopherol	CH_3	H	38	56	71
β-Tocotrienol	CH_3	H	nd	5	71
γ-Tocopherol	H	CH_3	9	16	68
γ-Tocotrienol	H	CH_3	nd	nm	68
δ-Tocopherol	H	H	1.5	<1	28
δ-Tocotrienol	H	H	nd	nm	28

Tocopherols in Almonds

- α-tocopherol is the most biologically active form and most prevalent form in almonds
  - The daily recommended intake is 15 mg a day for adults (22.4 IU, International Units)
    - Almonds also contain tocopherols (β, δ, γ)
- Vitamin E is an antioxidant against free radical-mediated lipid peroxidation
- Levels can decrease during storage and vary between cultivars

Tocopherols	mg / 100 g oil
α-tocopherol	15 (CA) - 450 (Italy)
β-tocopherol	0.93 (Itlay)
δ-tocopherol	0.10 - 2.2 (Spain)
γ-tocopherol	0.61 (Spain)- 7.5 (Italy)

S. Yada et al. / Journal of Food Composition and Analysis 24 (2011) 469–480476

Tocopherols Profiles in Commercial Varieties 2021

	Mean ± SD (mg/kg almond oil)				
Variety	Alpha (α)	Beta (β)	Delta (δ)	Gamma (γ)	Total
Aldrich	371.915 ± 15.810	3.915 ± 0.156	0.700 ± 0.037	15.623 ± 0.494	392.153 ± 16.497
Butte	390.564 ± 8.403	2.712 ± 0.240	0.956 ± 0.105	18.788 ± 1.761	413.019 ± 10.510
Butte-Padre	432.736 ± 10.116	3.014 ± 0.199	0.946 ± 0.081	**25.176 ± 1.538**	461.872 ± 11.934
Carmel	399.808 ± 15.742	**2.625 ± 0.097**	0.758 ± 0.035	16.229 ± 0.800	419.420 ± 16.675
Fritz	344.000 ± 10.178	3.945 ± 0.205	**0.477 ± 0.025**	**5.585 ± 0.679**	354.007 ± 11.087
Independence	**292.914 ± 14.169**	4.019 ± 0.118	0.524 ± 0.025	9.199 ± 0.139	**306.656 ± 14.450**
Monterey	313.287 ± 24.695	2.986 ± 0.045	0.508 ± 0.050	8.298 ± 0.752	325.079 ± 25.541
Nonpareil	353.473 ± 11.098	3.198 ± 0.144	0.808 ± 0.067	17.242 ± 2.059	374.721 ± 13.368
Padre	**441.785 ± 20.330**	3.619 ± 0.314	1.009 ± 0.022	22.676 ± 0.724	**469.089 ± 21.389**
Price	392.472 ± 1.372	**5.417 ± 0.111**	0.855 ± 0.006	18.722 ± 0.740	417.466 ± 2.229
Sonora	412.068 ± 11.671	4.324 ± 0.191	**1.121 ± 0.064**	19.843 ± 1.232	437.357 ± 13.158
Supareil	353.744 ± 20.785	3.948 ± 0.589	0.912 ± 0.082	13.535 ± 0.746	372.139 ± 22.202
Winters	347.975 ± 23.710	4.643 ± 0.207	0.742 ± 0.071	12.781 ± 0.962	366.141 ± 24.950
Wood Colony	352.860 ± 15.123	2.918 ± 0.157	0.688 ± 0.075	15.348 ± 1.702	371.813 ± 17.058
Average	**371.400 ± 42.789**	**3.663 ± 0.807**	**0.786 ± 0.196**	**15.646 ± 5.474**	**391.495 ± 47.794**

- The higher the vitamin E content, the longer the shelf-life
- The higher the total vitamin E the greater the nutritional value

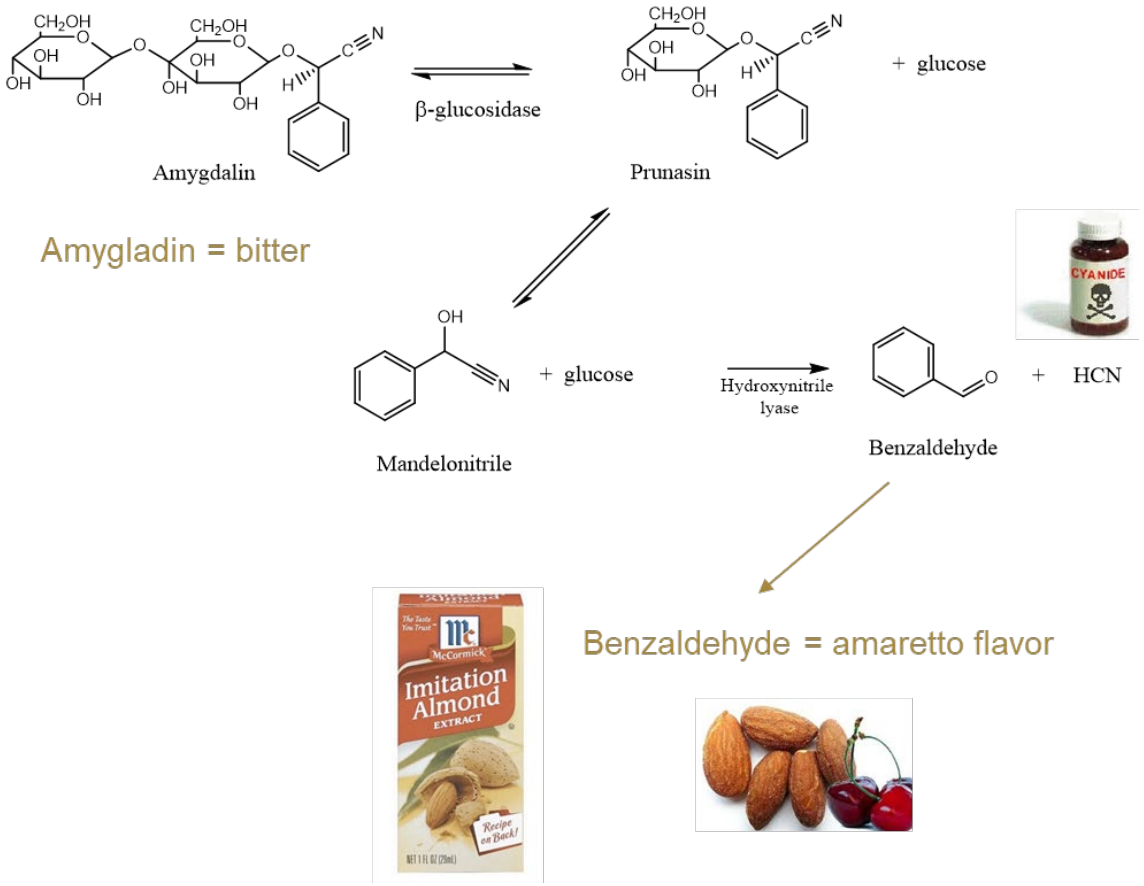
Tocopherols Profiles in Experimental Varieties 2021

	Mean ± SD (mg/kg almond oil)				
Variety	Alpha (α)	Beta (β)	Delta (δ)	Gamma (γ)	Total
Y117-106-03	501.414 ± 24.917	3.298 ± 0.191	1.304 ± 0.146	28.268 ± 0.570	534.283 ± 25.824
Y119-12-11	550.619 ± 3.290	3.378 ± 0.092	1.638 ± 0.055	**39.561 ± 1.314**	595.195 ± 4.751
Buralmondfour Lassen	348.608 ± 7.093	3.668 ± 0.153	**0.504 ± 0.025**	14.296 ± 0.023	367.076 ± 7.295
Conway	**582.869 ± 51.467**	3.579 ± 0.485	0.970 ± 0.141	26.589 ± 2.820	**614.007 ± 54.913**
Pyrenees	471.386 ± 7.296	4.268 ± 0.605	1.158 ± 0.059	38.047 ± 0.814	514.858 ± 8.775
UCD-B3	377.417 ± 2.303	2.353 ± 0.165	0.777 ± 0.044	16.971 ± 1.370	397.518 ± 3.882
UCD-B4	**268.214 ± 16.321**	**1.843 ± 0.054**	0.584 ± 0.069	**11.305 ± 1.262**	**281.945 ± 17.706**
UCD-B5	348.233 ± 30.628	4.368 ± 0.056	0.613 ± 0.068	12.098 ± 1.408	365.312 ± 32.160
UCD-B6	356.413 ± 31.530	3.338 ± 0.115	1.067 ± 0.149	33.208 ± 5.274	394.026 ± 37.068
UCD-B8	477.110 ± 11.850	5.584 ± 0.151	1.098 ± 0.041	21.597 ± 2.277	505.389 ± 14.318
UCD-B9	337.930 ± 19.687	**7.318 ± 0.870**	0.606 ± 0.049	12.732 ± 0.664	358.586 ± 21.270
UCD-B11	328.111 ± 6.894	2.366 ± 0.193	0.690 ± 0.004	15.699 ± 0.654	346.866 ± 7.745
UCD-B12	367.323 ± 16.108	3.083 ± 0.075	**1.815 ± 0.006**	28.907 ± 1.283	401.127 ± 17.472
UCD-B14	346.842 ± 31.258	3.310 ± 0.234	0.852 ± 0.032	12.262 ± 1.507	363.266 ± 33.030
UCD-B15	574.849 ± 48.612	3.665 ± 0.218	1.640 ± 0.122	26.485 ± 0.567	606.639 ± 49.519
Average	**415.822 ± 100.812**	**3.695 ± 1.347**	**1.021 ± 0.422**	**22.535 ± 9.758**	**443.073 ± 107.987**

- The higher the vitamin E content, the longer the shelf-life
- The higher the total vitamin E the greater the nutritional value
- On average the experimental varieties have higher levels of α-tocopherol and total vitamin E

Cyanogenic Glycosides in Almonds

- Amygdalin is a cyanogenic di-glycoside
- Provides plants with immediate chemical defense via generation of hydrogen cyanide (cyanogenesis)
- Responsible for almond **bitterness** and almond **aroma**
  - The disruption of almond tissue (e.g. chewing) enables amygdalin to come into contact with enzymes (*b*-glycosidase) to form benzaldehyde (almond aroma) and trace levels of HCN (toxic)

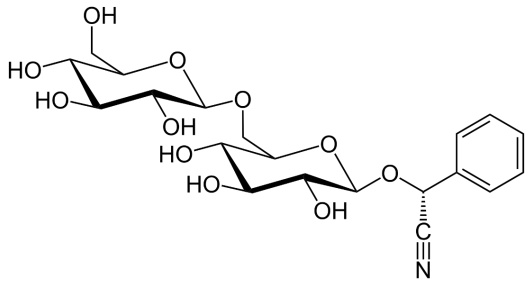


Amygdalin in Almonds

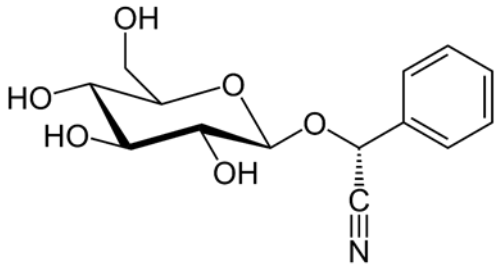
- Levels of amygdalin can vary within a tree, across cultivars and regions and in response to water stress (drought)
  - *Little is know regarding the variability in amygdalin levels in almonds in response to environment*
- Human acute toxicity to HCN occurs at doses between 0.5 and 3.5 mg/kg body weight
  - The European Food Safety Authority is currently considering setting a limit of 35 mg kg-1 for HCN in almonds (35 PPM)
- Monitoring amygdalin in almond kernels and characterizing levels in almond hulls is critical for maintain a safe high quality product and identifying safety of co-products
- Issues:
  - Amygdalin methods don't usually include prunasin or mandelonitrile
  - HCN methods are titration methods specific for only HCN
  - Measured HCN levels are significantly lower than calculated values based upon amygdalin content

Measuring Amygdalin in Almonds

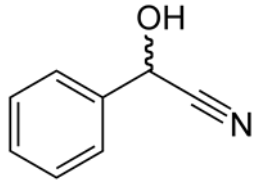
- Amygdalin degrades into a range of products that can all contribute to the HCN in almonds



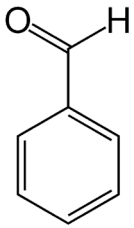
amygdalin



prunasin



mandelonitrile



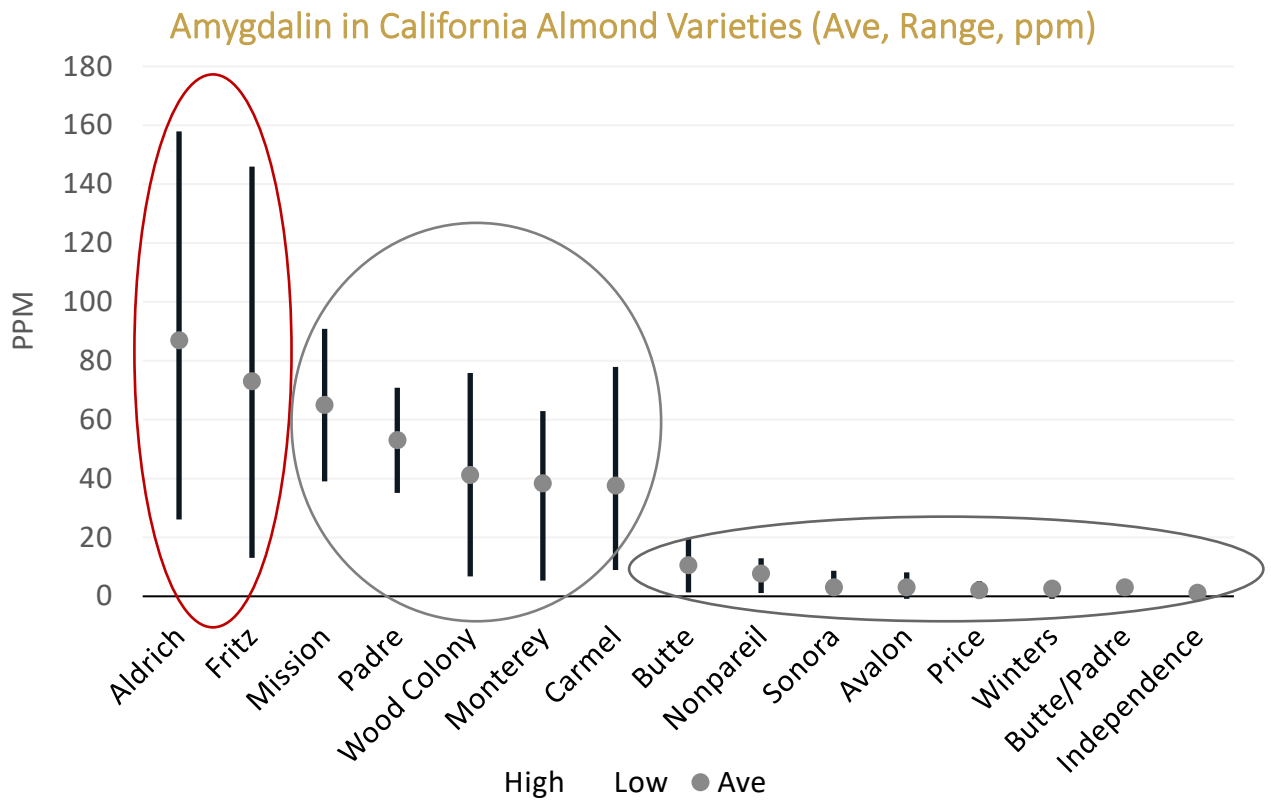
benzaldehyde

H-CN

cyanide

- In 2013 we developed a method for measuring amygdalin and in 2021 we developed a method for measuring amygdalin and prunasin
  - Kernels and hulls
- Developing a UHPLC- (QQQ)MS/MS method for the simultaneous analysis of amygdalin, prunasin, mandelonitrile, benzaldehyde and HCN (2023)

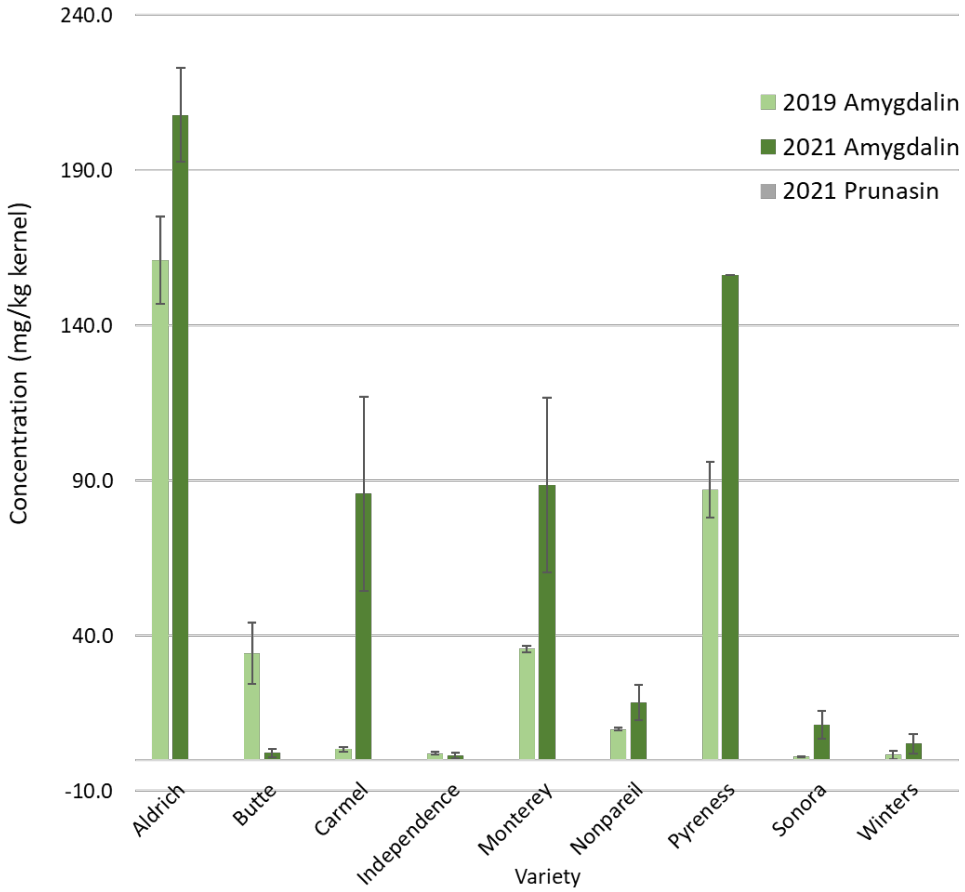
Amygdalin Levels in California Almond Varieties



- The reported levels in CA almonds: 0.1 to 215 ppm from 4 crop seasons, with large cultivar variations observed:
  - Crop 2010: 0.8 – 215 ppm
  - Crop 2014: 1.6 – 76 ppm
  - Crop 2015: 0.7 – 100 ppm (unpublished)
  - Crop 2016: 0.1 – 27 ppm
- Varietal variation in 3 ranges
- >70 PPM ; 40-65 PPM; < 20 PPM
- Regional variations also noticed
- Averages ranging from 0.1–87 mg kg^{-1}

Comparison of Amygdalin and Prunasin Content

2019 vs 2021

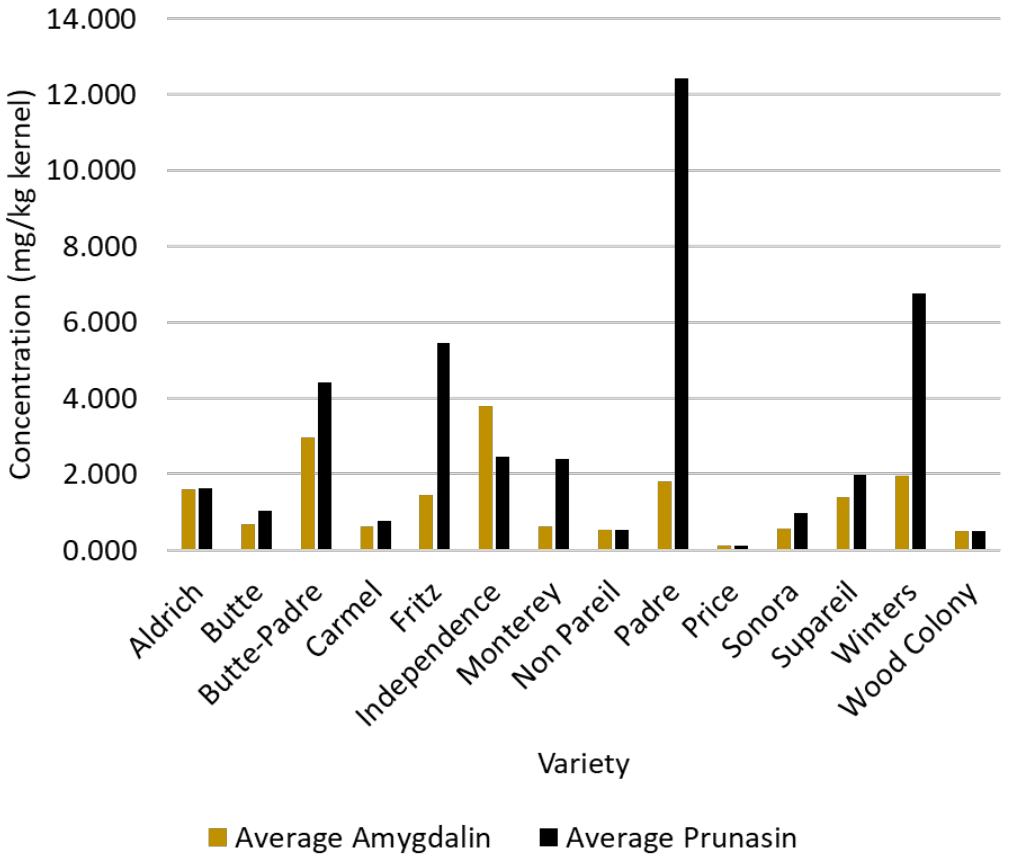


Year	2019		2021		2021	
Variety	**Amygdalin**		**Amygdalin**		**Prunasin**	
	Concentration (mg/kg)		Concentration (mg/kg)		Concentration (mg/kg)	
	Mean	SD	Mean	SD	Mean	SD
Aldrich	160.969	14.145	207.756	15.128	0.316	0.060
Butte	34.325	9.880	2.290	1.291	0.279	0.187
Carmel	3.504	0.704	85.867	31.254	0.179	0.057
Independence	2.223	0.340	1.534	0.908	0.143	0.137
Monterey	35.804	1.094	88.555	28.154	0.135	0.053
Nonpareil	9.929	0.427	18.585	5.769	0.237	0.057
Pyreness	87.141	9.098	156.208	0.000	0.221	0.000
Sonora	1.077	0.056	11.373	4.482	0.172	0.018
Winters	1.682	1.302	5.289	3.208	0.184	0.048

Amygdalin and Prunasin Content in Hulls

2021

Variety	Average Amygdalin (mg/kg hull)	Average Prunasin (mg/kg hull)
Aldrich	1.595 ± 1.589	1.627 ± 1.520
Butte	0.674 ± 0.724	1.028 ± 1.214
Butte-Padre	2.955 ± 2.129	4.426 ± 3.313
Carmel	0.630 ± 0.615	0.759 ± 0.762
Fritz	1.442 ± 0.831	5.447 ± 1.785
Independence	3.793 ± 2.534	2.464 ± 0.765
Monterey	0.633 ± 0.795	2.399 ± 3.121
Non Pareil	0.531 ± 0.604	0.531 ± 0.456
Padre	1.805 ± 0.000	12.422 ± 0.000
Price	0.107 ± 0.000	0.103 ± 0.000
Sonora	0.570 ± 0.267	0.974 ± 0.237
Supareil	1.401 ± 0.218	1.993 ± 0.939
Winters	1.969 ± 0.981	6.757 ± 4.239
Wood Colony	0.505 ± 0.252	0.498 ± 0.213



Amygdalin and Hydrogen Cyanide (HCN)

- Complete hydrolysis of 1 gm of amygdalin (MW 457.43 g/mole) will theoretically result in 60 mg of HCN (MW 27.03 g/mole)
- The highest level of amygdalin reported in the California kernels (207 mg kg^{-1}) would result in a theoretical value of only 12.4 mg kg^{-1} HCN
  - This value is well below the value of the proposed EU limit of 35 ppm (mg kg^{-1})
- The highest level of amygdalin reported in the California hulls (12.42 mg kg^{-1}) would result in a theoretical value of 0.74 mg kg^{-1} HCN
  - This value is well below the value of the proposed EU limit of 35 ppm (mg kg^{-1})
  - Co-product is extracted which can concentrate amygdalin


THANK YOU
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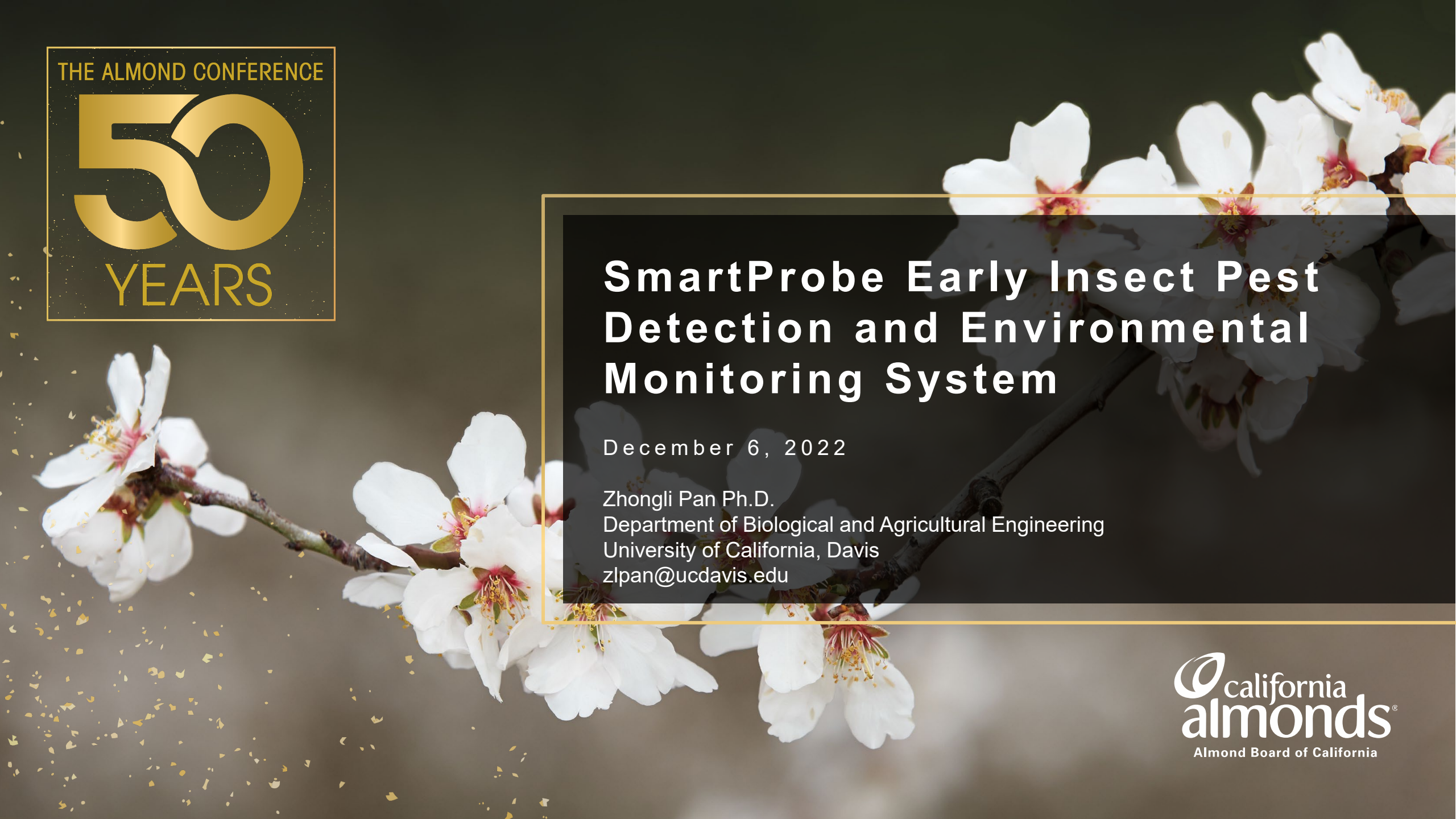
FOOD SCIENCE AND TECHNOLOGY

Acknowledgments

Mary-Ann Chen, RA
Larry Lerno, PhD

50 YEARS of The Almond Conference



SmartProbe Early Insect Pest Detection and Environmental Monitoring System

December 6, 2022

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Insect Pest Infestation and Quality Management Problems

Inaccuracy

Human visual inspection can not find pest until it's **too late**

Expensive

Current chemical fumigation and product loss cost over **$350M** each year for **tree nuts alone** in U.S.

Health & Food Safety

Toxic chemicals used for fumigation impact worker health and food safety.

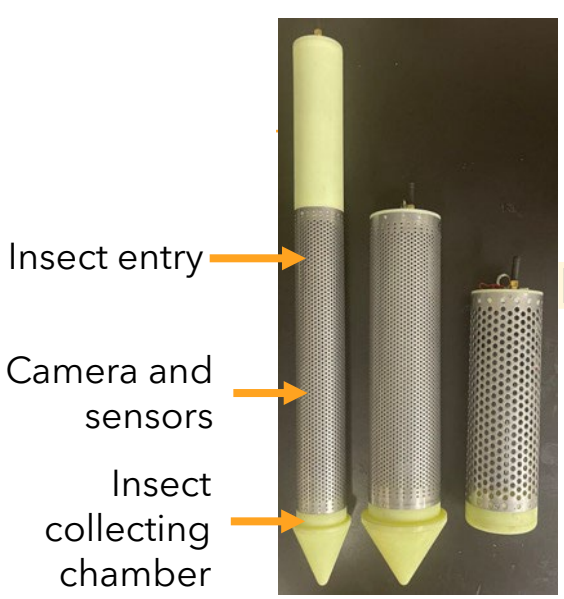
Questions to Be Answered

- Significance and rate of insect damage?
  - Kernels
  - In-shell almonds
  - In-hull almonds
- Fumigation?
  - Timing
  - Uniformity
  - Effectiveness
  - Chemical use
- Smart technology?
  - Detect insect pest early
  - Solve the problems associated insect infestations
  - Monitor environmental conditions

SmartProbe System for Insect Pest Detection and Environmental Monitoring

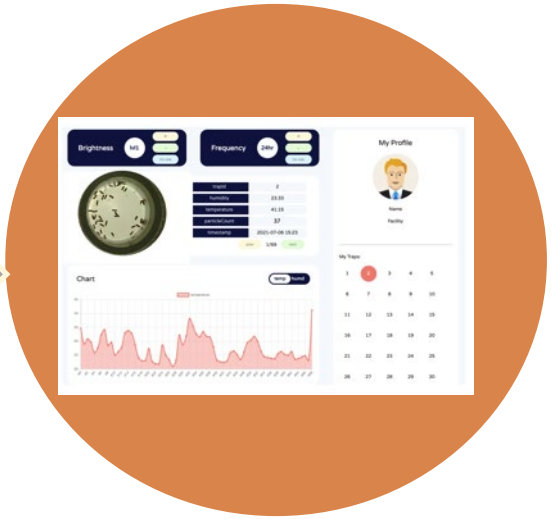
Early detection and control

- Novel design of SmartProbe: detect insects at an emerging stage
- Integrated detector with sensors: capture and photograph insects
  measure and record temperature & humidity
- Cloud computing: analyze images and count insect number, and predict insect occurrences
- Notification: send out information about insects and environmental conditions for taking necessary actions to control the pests



SmartProbe

Big Cloud Data and Computing



User Interface and PestDetect App

Research Goal and Objectives

Goal: Demonstrate the value and feasibility of the new technology for commercial implementation.

Objectives:

- Assess the insect damage levels in almonds under different infestation rates and conditions.
- Detect insect activity in almonds in different packaged, stored, and stockpiled almonds during processing, handling, and stockpiling.
- Investigate insect infestation and its location characteristics, as well as fumigation effectiveness in stockpiled almonds.

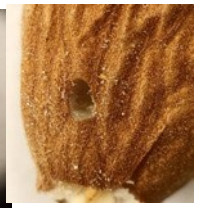
Evolution of Product Damage Rate from Insects

- Almonds
  - Kernels
  - In-shell almonds
  - In-hull almonds
- Infestation rate of red flour beetles
  - 1:100, 5:100, 10:100 (insects : almonds)
- Storage conditions:
  - Temperatures: 10, 20, 30ºC
  - Relative Humidity: 64%
  - Storage time: up to 56 days



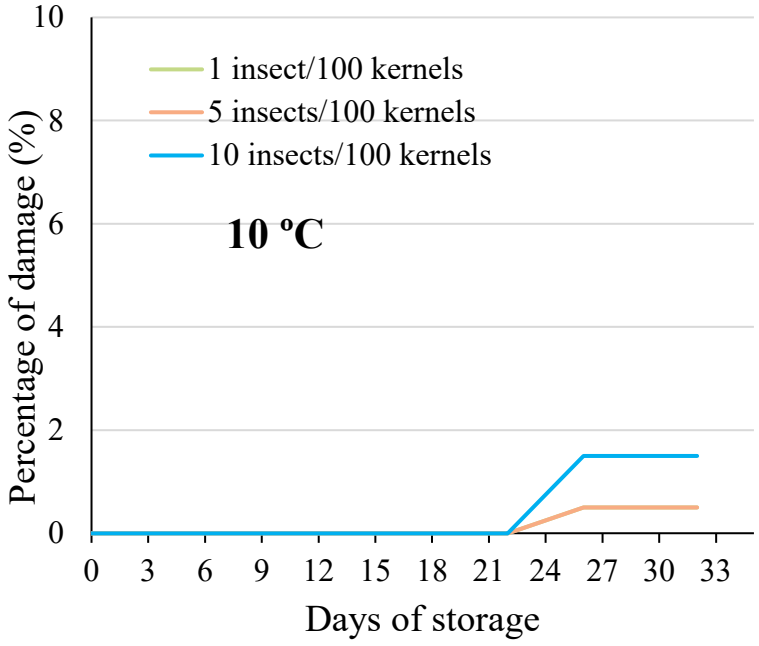


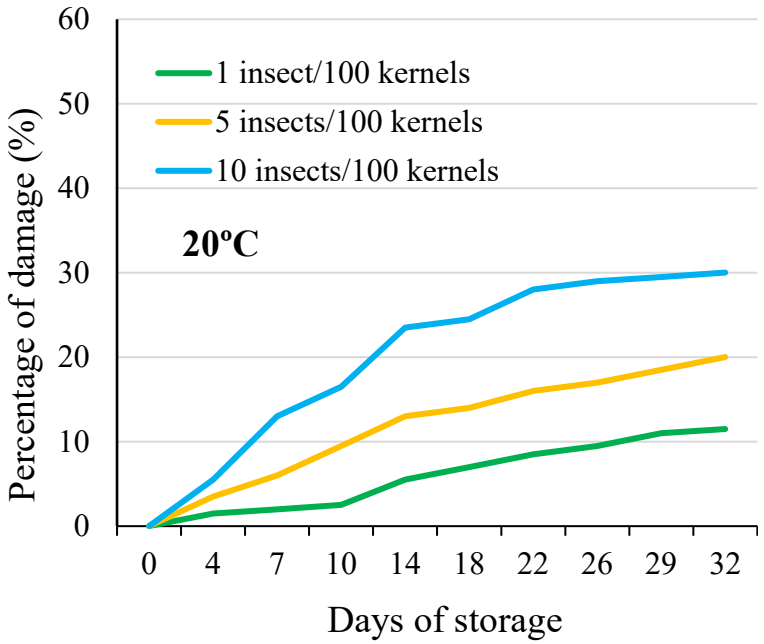


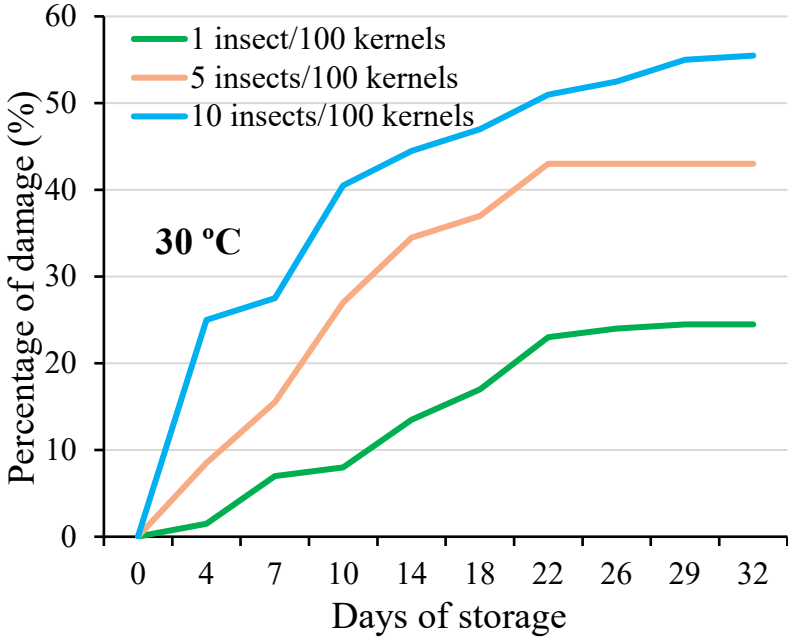



Insect damaged almonds

Insect Damage Rate: Infested Kernels

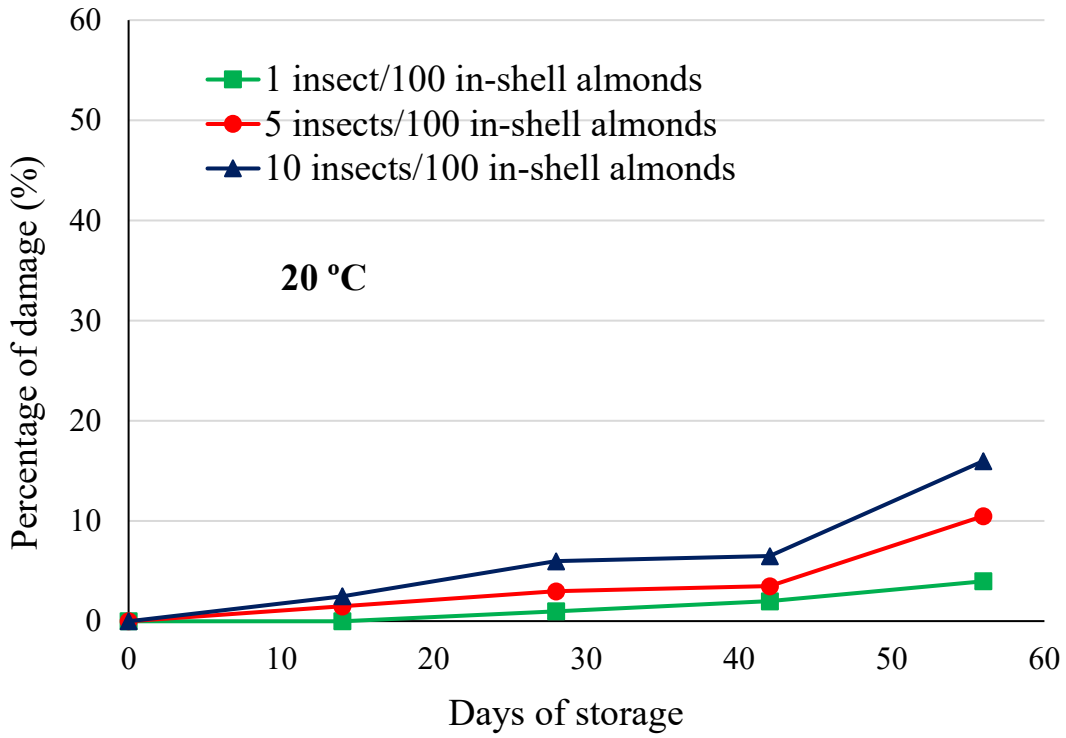


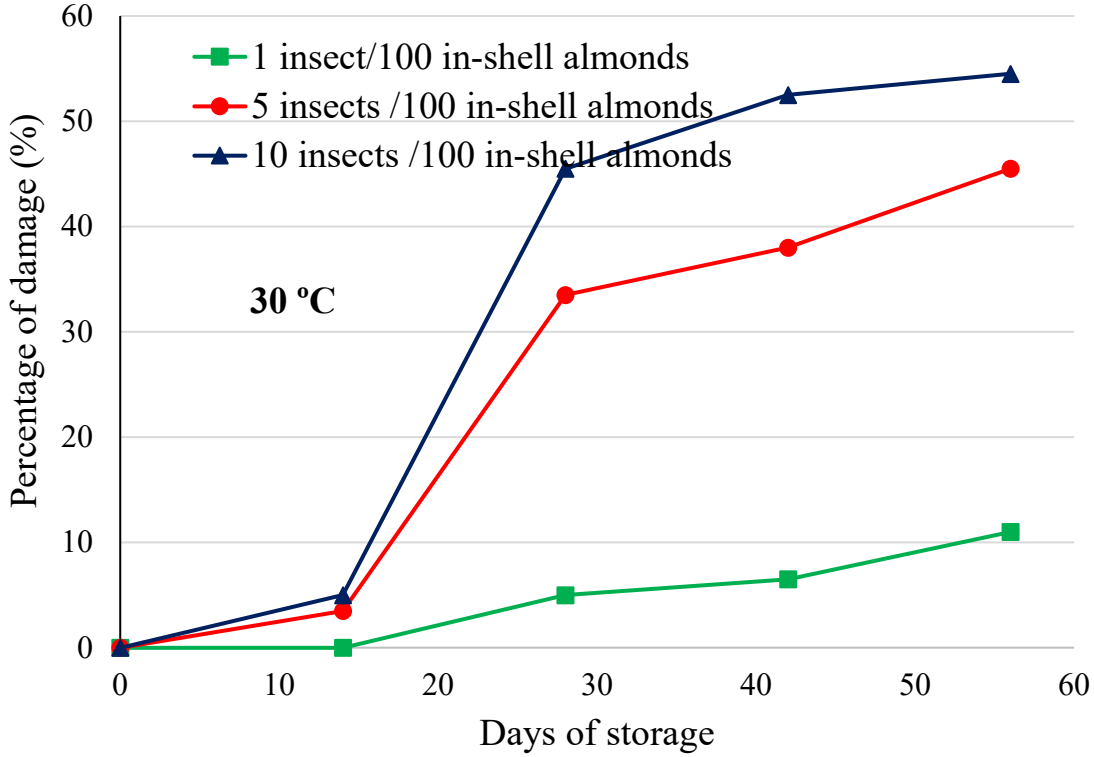




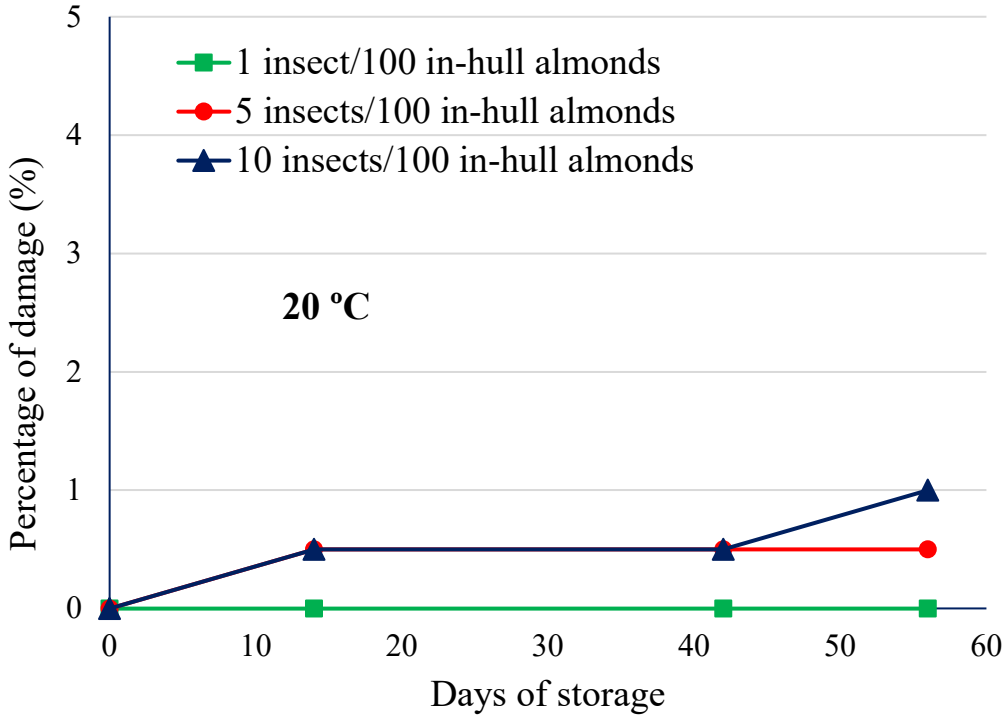
Early detection is important

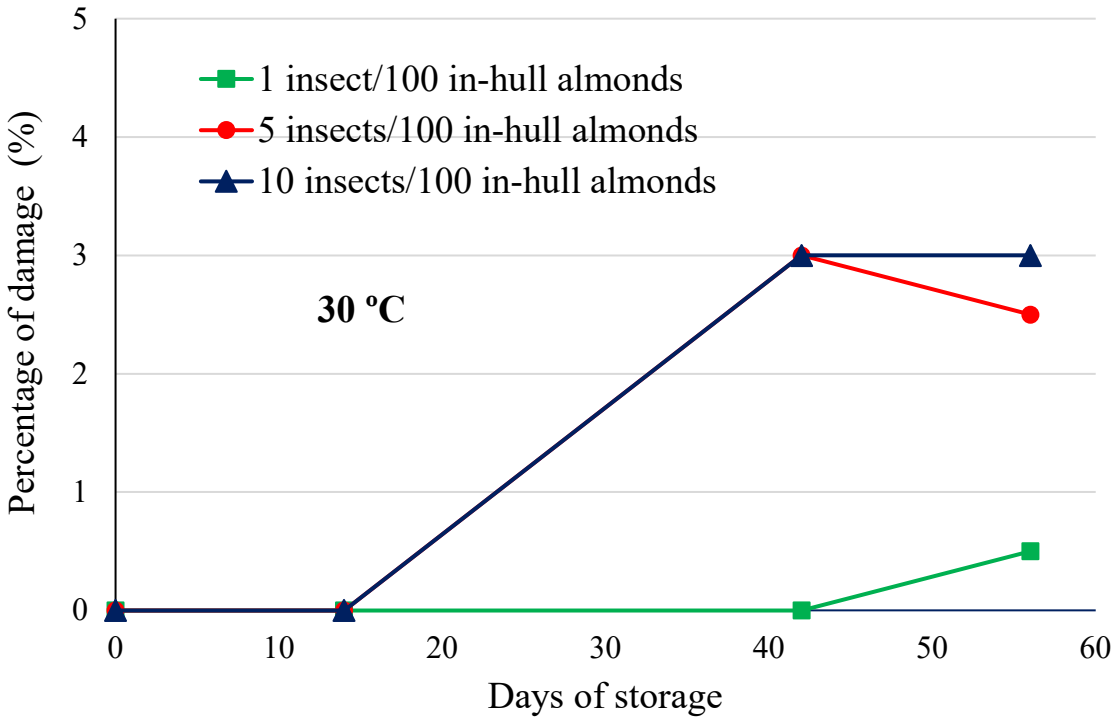
Insect Damage Rate: Infested In-shell Almonds





Insect Damage Rate: Infested In-hull Almonds

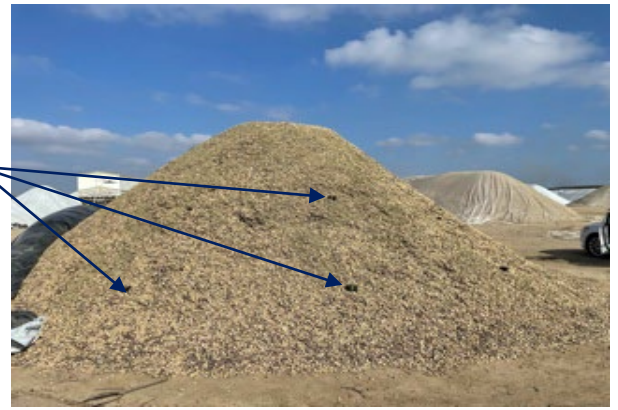




Experiments Conducted: 2021

- Almond Huller and Sheller
  - Rejected kernels in four bins
  - Stockpiled almonds – four stockpiles
- Almond Processor
  - Almonds in carton boxes with and without a plastic liner
  - Almonds in bins (2) with plastic liner, ready for final packaging
  - Rejected kernels in bins (2)

Installed smart insect catching traps in stockpile



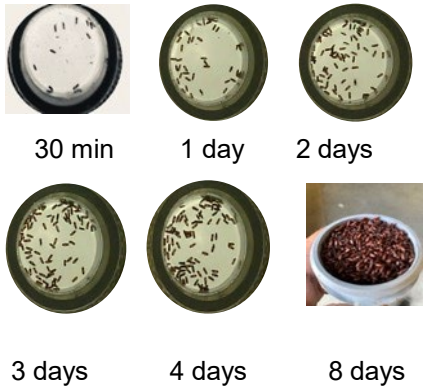
Results 2021 – Almond Huller and Sheller - Processing Facility

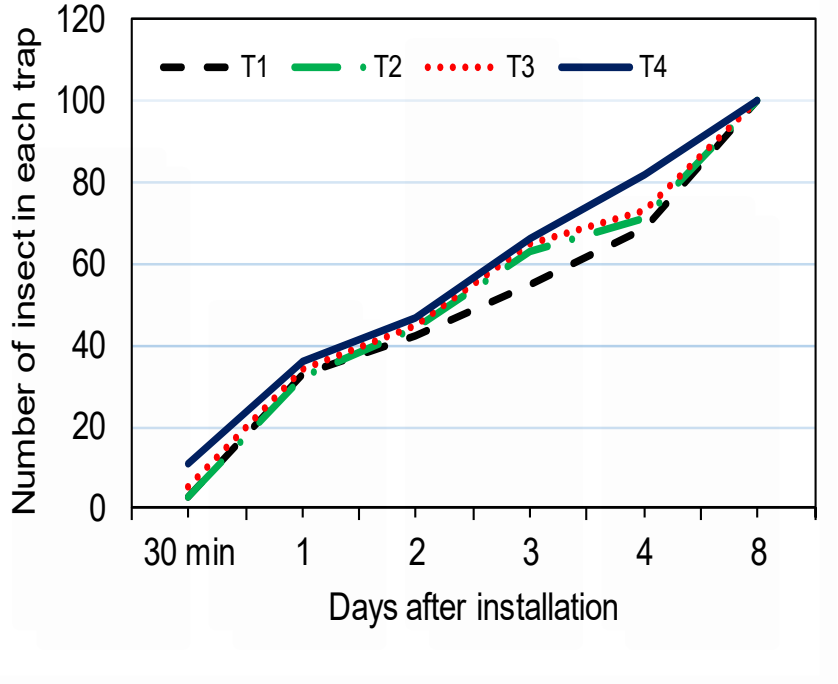
- Insects detected in different bins of rejected almond kernels.
- Average temperature: 27.1 - 29.6ºC.
- Relative humidity: 54.6 - 49.6%.

Container type	Product	Installation date	Uninstallation date	Traps no	Time detected the first insect	Final number of insects	Insect type
Wood bins	Rejected almond kernels	6/9/2021	6/17/2021	T1-Bin 1	30 minutes	Full (Too many to count)	Red flour beetles
				T2-Bin 2			
				T3-Bin 3			
				T4-Bin 4			

Smart insect catching device/trap

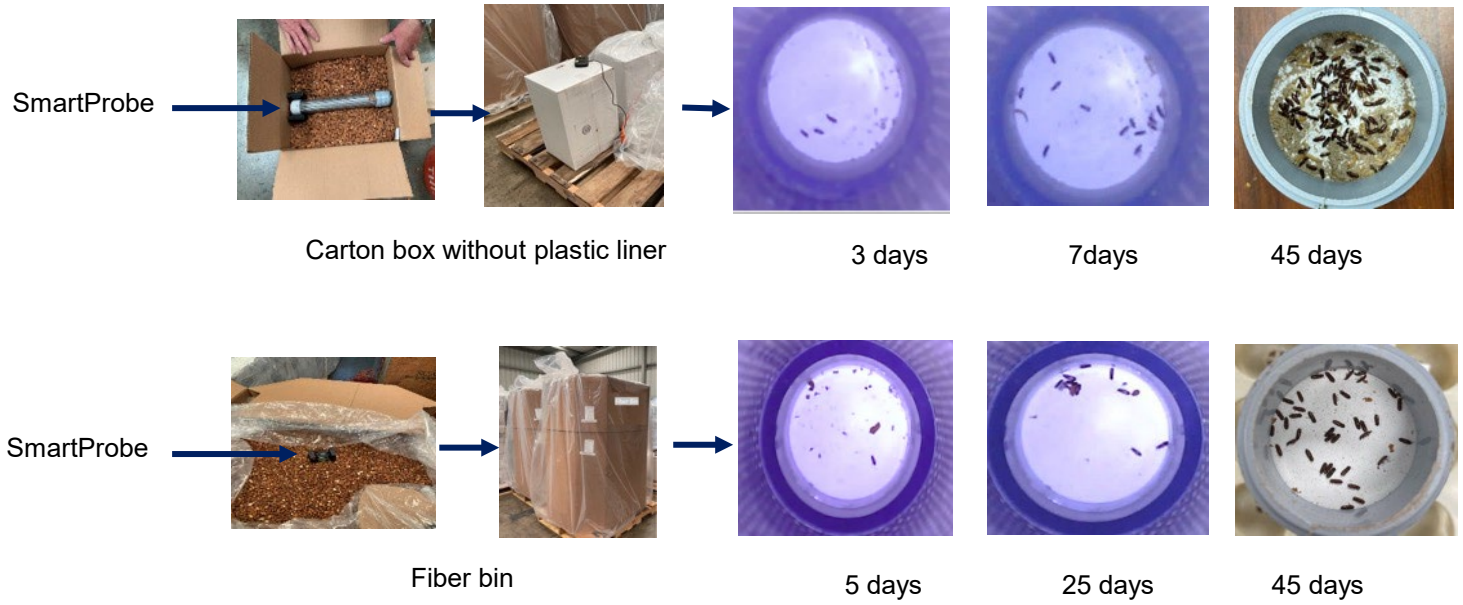
Trap 4 installed in rejected kernels

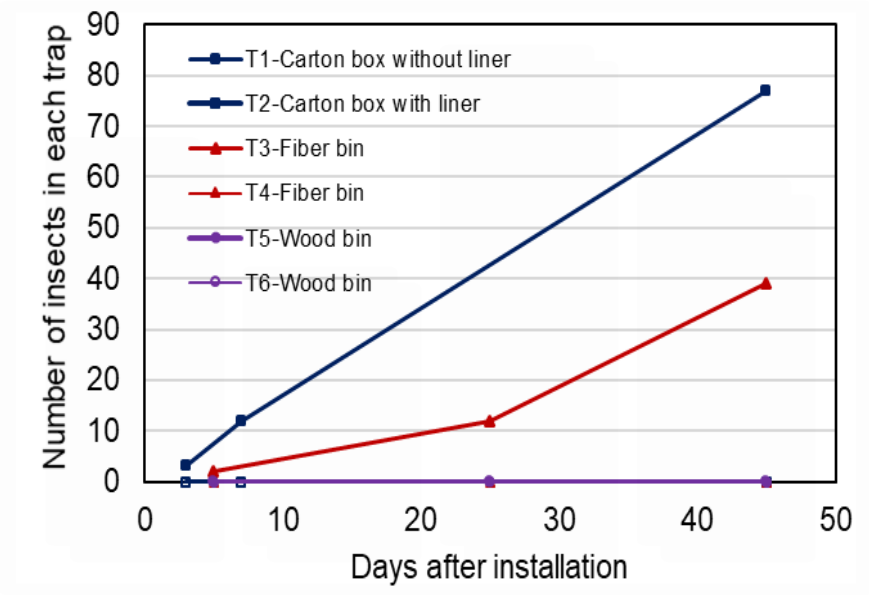




Results 2021– Almond Processor

- Insect detection results
  - Detected in carton box without plastic liner, but no insect detected for the box with a plastic liner.
  - In one of the two fiber bins.
  - No insects were detected in the two bins of rejected kernels.
- Average temperatures: 32.7 - 31.9ºC.
- Relative humidity: 41.8 - 40.7%.

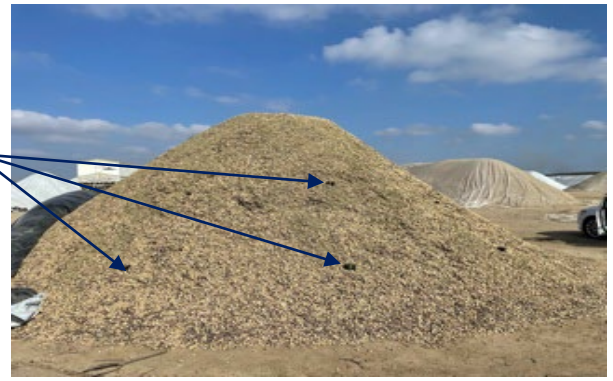




Results 2021 – Almond Huller and Sheller

– Insects were detected in 5 of 6 devices after 1 week of installation for <u>stockpiles</u>

Installed SmartProbe in stockpile



Trap No.	Installation date	Inspection Date					
		11/11/2021		12/2/2021		1/7/2022	
		Number of Insects	Type of Insects	Number of Insects	Type of Insects	Number of Insects	Type of Insects
T1	11/3/2021	1	Bug	2	RFB (died)	0	-
T2		1	Larva (NOW)	4	Moth (died)	0	-
T3		1	Bug	0		0	-
T4		2	Bug	0	-	0	-
T5		0	-	0	-	0	-
T6		2	Larva (NOW)	0	-	0	-

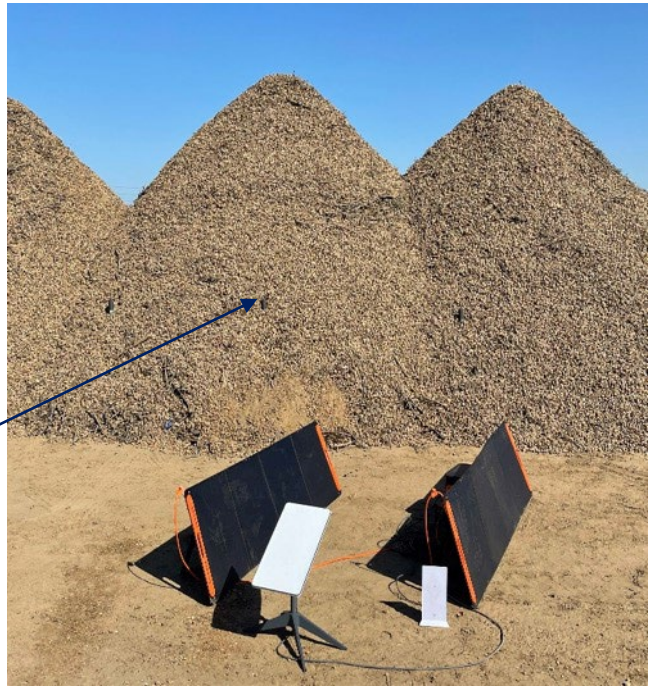
Fumigated on 11/11/2021 after inspection

Experiments in 2022

- Stockpiles
- In bins
- In air

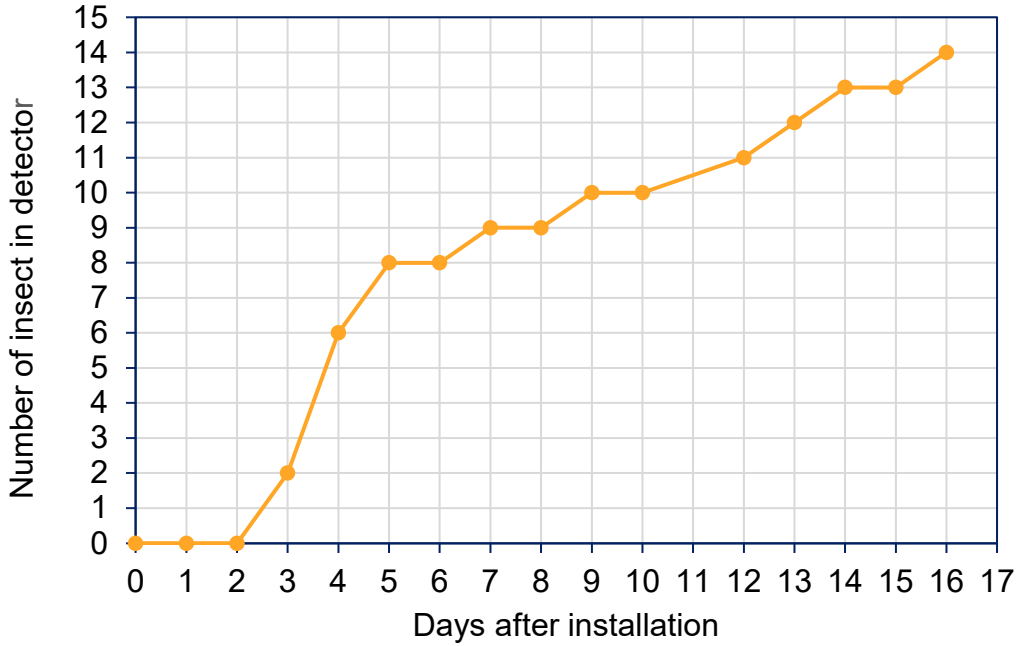
Experiments in 2022

- Company #1
  - Packaging room
  - Wood bins of the finished product
  - Stockpiles



Installed SmartProbes

Results 2022 – Company #1



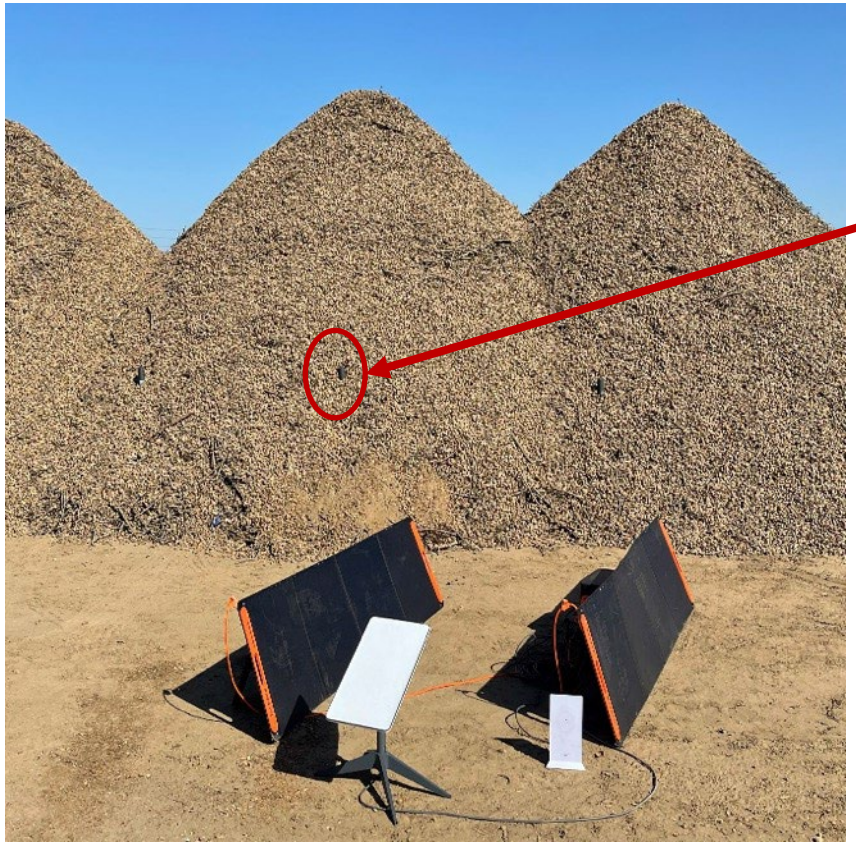
2 days

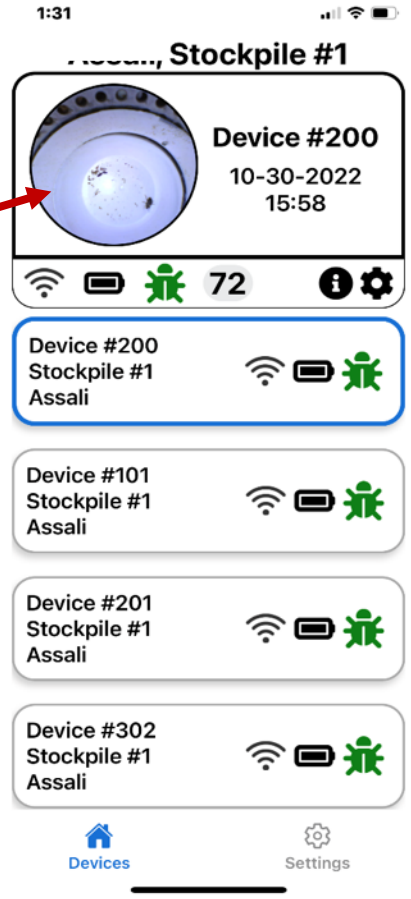
7 days

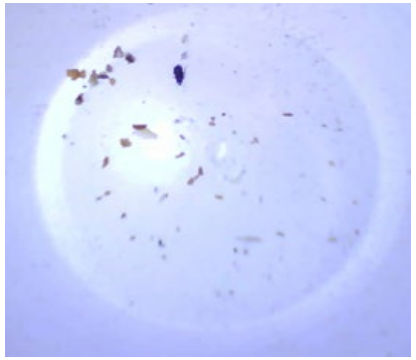
10 days

15 days

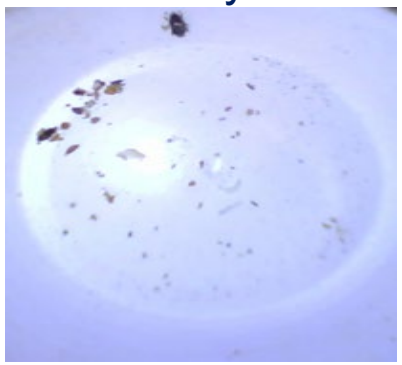
Results 2022 – Company #1



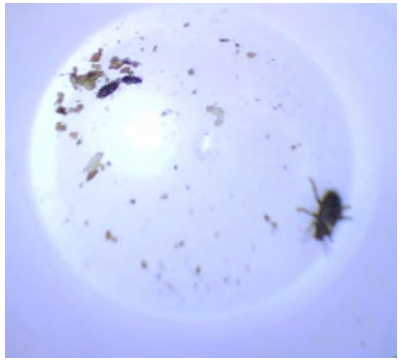




2 days



3 days



4 days

Experiments 2022 – Company #2

Probes with live video cameras and temperature and relative humidity sensors to Investigate insect infestation and its location characteristics

SmartProbe

Conclusions

- Insect infestation caused significant damage to almonds in a very short time.
  - One insect caused 25% damage during 4-week storage
- SmartProbe technology
  - Achieved early detection of insects.
  - Detected various types of insects, including the larva of navel orangeworm, red flour beetles, bugs, and moths.
  - Measured the temperature and relative humidity of almonds for monitoring storage conditions and quality control.
  - Can be installed in products or hanged in air
  - Replaced human inspection
  - Provided a novel tool for pest management and quality control
  - Received AE50 Outstanding Innovation Award from American Society of Agricultural and Biological Engineers
  - Can be purchased from AIVision Food Inc.

ASABE AE50 outstanding innovations AWARD

AIVISION FOOD

www.aivisionfood.com
zlpan@ucdavis.edu

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  - Silver Creek Almond Co.
  - California Grown Nut Co.
  - Select Harvest USA
  - Wonderful Co.
  - Bluediamond Growers
- Almond Board of California
  - Guangwei Huang


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