Natural variability in the nutrient composition of California-grown almonds

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Highlights:

- Major California almond varieties have similar macronutrient and micronutrient profiles
- Nutrient profiles were based on multi-harvest and multi-orchard sampling
- Total fat content of California almond varieties tested was not significantly different
- Variety, year and/or region effects were significant for some individual nutrients

Summary:

Comprehensive macronutrient and micronutrient profiles of several of the major California almond varieties, based on multi-year and multi-region sampling, were compared to provide information on the natural variability in almond composition. This study was part of a larger investigation by the Almond Board of California to better understand the natural variability among the major almond varieties currently grown in California. Varietal nutrient composition data have not been published previously and would be useful in identifying similarities or differences among the most common commercial varieties.

Seven major almond varieties (Butte, Carmel, Fritz, Mission, Monterey, Nonpareil, and Sonora) were collected over three separate harvest years and from various orchards in the north, central, and south growing regions in California. Comprehensive nutritional analysis (macronutrients, micronutrients, and phytosterols) of almond samples was carried out by accredited commercial laboratories.

The overall macronutrient and micronutrient profiles of the 7 almond varieties were notably similar (Table 1). The 3-year-mean contents of protein, total lipid (fat), fatty acids, and dietary fiber for these major varieties varied by no more than 1.2-fold. Small but statistically significant differences were observed in the 3-year-mean contents of protein, sucrose, and some micronutrients (α-tocopherol, riboflavin, niacin, P, K, Zn, β-sitosterol, stigmasterol), as indicated by the P values shown for each nutrient in Table 1. Small but statistically significant differences in the mean contents of saturated fatty acids (SFA) and polyunsaturated fatty acids (PUFA) were also observed among some varieties, but all varieties had similar mean contents of total lipid and monounsaturated fatty acids (MUFA).

The study also evaluated the effects of harvest year and growing region on nutrient composition variability in Butte, Carmel, and Nonpareil almonds. Among macronutrients, the total lipid and dietary fiber contents were significantly affected by harvest year, but not by growing region. Almonds from the 2005 harvest had a slightly lower mean content of total lipid (~48 g/100 g) than the 2006 and 2007 samples (~51 g/100 g). Mean dietary fiber contents of ~11, 12, and 14 g/100 g were found in the samples harvested in 2005, 2006, and 2007, respectively. Growing region had a significant effect on the content of ash and all minerals tested; however, no region had almond samples with consistently high or low mean contents of a majority of minerals.

The similarity in the overall nutrient profiles is not unexpected given the interrelatedness of most of the commercial almond varieties. Genetic characterization of commercial almond varieties indicates that the majority of today's commercial almond varieties in California are interrelated and are dominated by descendants of Nonpareil and/or Mission varieties.

Table 1. Profiles of nutrient composition (per 100 g kernels, fresh weight)[a] of major California almond varieties obtained over 3 harvest years

Nutrient	Unit	Almond variety							ANOVA
		Butte	Carmel	Fritz	Mission	Monterey	Nonpareil	Sonora	*P* value
Water	g	4.7 ± 0.9	4.1 ± 0.6	4.6 ± 1.1	4.6 ± 0.6	3.9 ± 0.6	3.9 ± 0.6	4.1 ± 0.7	0.051
Protein	g	20.5 ± 0.8 b	20.2 ± 0.6 b	22.5 ± 0.4 a	20.9 ± 0.7 ab	21.3 ± 2.4 ab	20.2 ± 0.9 b	22.4 ± 0.3 a	<0.001
Total lipid (fat)	g	50.0 ± 2.5	50.1 ± 2.8	48.4 ± 3.2	49.6 ± 2.1	49.4 ± 2.6	49.6 ± 1.9	50.2 ± 2.0	0.902
SFA	g	4.1 ± 0.3 a	3.9 ± 0.1 a	3.4 ± 0.2 b	3.7 ± 0.0 ab	3.7 ± 0.1 ab	3.8 ± 0.1 a	3.9 ± 0.2 a	<0.001
MUFA	g	29.4 ± 2.2	29.7 ± 2.4	30.5 ± 2.5	31.6 ± 1.8	32.3 ± 2.6	31.3 ± 2.5	31.4 ± 1.1	0.053
PUFA	g	13.9 ± 1.2 a	13.8 ± 0.7 a	12.0 ± 0.6 ab	11.6 ± 0.4 bc	11.2 ± 0.6 bc	11.7 ± 1.3 bc	12.4 ± 1.4 ab	<0.001
Dietary fiber (total)	g	12.2 ± 1.7	12.5 ± 1.8	11.0 ± 2.7	13.5 ± 2.4	11.8 ± 2.3	12.9 ± 1.2	11.8 ± 2.7	0.292
Sucrose	g	3.1 ± 0.5 b	3.4 ± 0.4 ab	3.0 ± 0.0 ab	2.9 ± 0.2 b	3.7 ± 1.3 ab	4.1 ± 0.6 a	3.1 ± 0.2 ab	0.006
Ash	g	2.8 ± 0.2	2.9 ± 0.2	2.9 ± 0.1	3.0 ± 0.1	3.0 ± 0.1	2.9 ± 0.3	3.1 ± 0.3	0.166
Calcium (Ca)	mg	288 ± 55	279 ± 49	290 ± 16	330 ± 30	252 ± 32	261 ± 53	234 ± 30	0.219
Iron (Fe)	mg	3.27 ± 0.47	3.27 ± 0.25	3.63 ± 0.73	3.34 ± 0.41	3.58 ± 0.27	3.47 ± 0.50	3.84 ± 0.41	0.375
Magnesium (Mg)	mg	263 ± 24	262 ± 17	260 ± 15	272 ± 17	278 ± 3	275 ± 23	256 ± 4	0.578
Phosphorus (P)	mg	463 ± 52	462 ± 21	466 ± 60	512 ± 23	524 ± 29	455 ± 36	526 ± 26	0.029
Potassium (K)	mg	664 ± 21 b	679 ± 44 ab	664 ± 105 ab	724 ± 17 ab	766 ± 102 ab	762 ± 85 a	773 ± 52 ab	0.003
Zinc (Zn)	mg	2.98 ± 0.41 b	2.77 ± 0.33 b	2.82 ± 0.55 b	2.76 ± 0.22 b	2.79 ± 0.54 b	3.23 ± 0.34 ab	3.80 ± 0.20 a	0.002
Copper (Cu)	mg	0.92 ± 0.38	1.09 ± 0.13	0.85 ± 0.10	0.72 ± 0.15	0.94 ± 0.39	1.05 ± 0.24	0.90 ± 0.11	0.390
Manganese (Mn)	mg	2.00 ± 0.47	2.14 ± 0.36	2.08 ± 0.68	2.20 ± 0.06	2.12 ± 0.36	2.21 ± 0.38	3.04 ± 1.03	0.093
α-Tocopherol	g	27.6 ± 2.7 ab	29.9 ± 1.5 a	26.3 ± 0.8 abc	28.3 ± 0.5 ab	21.9 ± 3.7 c	26.0 ± 1.9 bc	31.0 ± 1.3 a	<0.001
Riboflavin	mg	1.68 ± 0.52 a	1.17 ± 0.35 b	1.01 ± 0.33 b	1.11 ± 0.48 b	1.00 ± 0.37 b	1.32 ± 0.49 b	1.25 ± 0.25 ab	<0.001
Niacin	mg	2.71 ± 0.70 b	2.90 ± 0.54 ab	2.52 ± 0.43 ab	3.72 ± 0.34 ab	3.35 ± 1.49 ab	3.49 ± 0.71 a	2.73 ± 1.06 ab	0.008
β-Sitosterol	mg	128 ± 18 b	157 ± 28 a	149 ± 20 ab	137 ± 25 ab	130 ± 20 b	134 ± 18 b	144 ± 18 ab	<0.001
Stigmasterol	mg	3.9 ± 0.7 b	2.5 ± 0.5 b	1.9 ± 0.4 b	2.3 ± 1.0 b	4.3 ± 3.4 ab	6.3 ± 2.4 a	2.7 ± 1.0 b	<0.001
Campesterol	mg	5.1 ± 0.8	5.0 ± 0.6	5.3 ± 0.5	4.7 ± 0.4	4.9 ± 0.4	6.0 ± 2.2	5.0 ± 0.4	0.570

[a] Nutrient values are the mean ± SD; n = 9 (Butte, Carmel, and Nonpareil) and n = 3 (Fritz, Mission, Monterey, and Sonora). Within each row, means with different lowercase letters are significantly different as tested by Tukey's ($P < 0.05$).