Cultivar Testing and Evaluation

Variation in the Cooked and Chipping Quality of Taro

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ADDITIONAL INDEX WORDS. taste, poi, boiled taro, acidity

SUMMARY. Taro [*Colocasia esculenta* (L.) Schott] corms from 57 vegetatively propagated cultivars were evaluated for yield, physical and chemical characteristics, and either microwaved, microwaved and ground into poi, or fried. Poi color ranged from purple to orange or yellow and the dry matter content from 18.3 to 48%. The taste panel preferred poi made from a number of other cultivars than that made from the most common cultivar 'Lehua Maoli' used in Hawaii, and a darker bluish-red poi was preferred. Corm total

soluble solids were positively correlated to corm specific gravity and dry matter, and to the taste preference of microwaved corm and poi. The fried cultivars varied widely in yield and corm color varied from cream to white. Additionally, some cultivars did not have purple vascular bundles, and others were acrid after frying. Chip oil content was negatively correlated to corm weight, dry weight, and chip yield. The 'Bin Liang' cultivar was judged the best overall in fried chip taste. Considerable variation in corm yield and quality characteristics existed in this widely cultivated vegetatively propagated tropical crop.

Taro is cultivated throughout the tropics and subtropics of the world (Plucknett et al., 1970). All parts of the plant can be eaten, although cooking is required before eating (Plucknett, 1970) due to the presence of an unknown acrid principle (Paull et al., 1999). The corm is dried for flour, baked, boiled or fried prior to eating. In Hawaii, the bulk of the corms are boiled or steamed, peeled and ground to poi, a paste-like food. A different cultivar 'Bin Liang' is fried to make chips and steamed or boiled as a starch staple.

Most cultivars are vegetatively propagated selections, and considerable variation exists in plant size, type, color and corm characteristics. Many cultivars and wild forms (1,417) have been collected (Lebot and Aradhya, 1991). Whitney et al. (1939) described 84 poi types in Hawaii, based on leaf shape, leaf color, leaf venation, petiole size, and color, corm flesh color, corm fibers color and skin color. Occasionally, starch properties, acidity, color of poi, and

culinary uses are used for classification. Many proximate analyses of taro flour and poi are reported (Bradbury, 1988). Payne et al. (1941) reported that dry-land taro contains less starch but more complex sugars and ash than wetland cultivars. Taro starch is mainly amylose with smaller amounts of amylopectin (Amin, 1955) and is readily digested after preparation as poi (Standal, 1970). This study objective was to determine the variation between taro cultivars in the quality of corms used to make a boiled or microwaved food, or made into poi and fried as chips.

Materials and methods

PLANT MATERIAL. The cultivars from Fujian Agricultural College, Fuzhou, China (FAC) (Zhang and Zhang, 1990) and Gaoxiong Agricultural Improvement Station, Taiwan, were compared with the local cultivars (Table 1). The Hawaiian taro cultivars used to make poi were from the University of Hawai'i at Manoa, and all were grown on the Moloka'i Research and Demonstration Farm located at Ho'olehua, Moloka'i, Hawai'i (157° 4' 12"W, 21° 8' 15"N). The elevation was 40 m (131 ft), with an average annual rainfall of 48 cm (18.9 inches) per year and a daily mean temperature of 22.5 °C (72.5 °F). The soil was an oxisol, low-humic latosols of the Holomua soil series.

FIELD PREPARATION, PLANTING, AND MANAGEMENT. The field was plowed, tilled and dolomite was broadcast and tilled into the field at the rate of 2242 kg·ha⁻¹ (1.23 tons/acre) to adjust pH to 6.5, and to provide calcium and magnesium. Planting furrows, 20 cm (8 inch) deep were cut 144 cm (56 inch) apart. Fertilizer (10N-8.7P-16.6K) was incorporated into the furrow at a rate of 560 kg·ha⁻¹ (0.3 tons/acre). Drip irrigation lines were laid into the furrowed planting rows and emitters were spaced 30 cm (12 inches) apart. Irrigation was applied at a rate of 188.3 mm·ha⁻¹·week⁻¹ (3 inches/acre/week).

The top of the corm and 20 cm (8 inch) of the petiole were cut and dipped in sodium hypochlorite (2% v/v) to disinfect the material, dried for a day at ambient temperature, and planted at one plant per meter (1 plant/39 inches) in the furrow rows along the drip line. Plants were hilled 6 weeks after planting to cover 10 to 15 cm (4 to 6 inches) of the petiole and to bury the drip irrigation lines 30 to 35 cm (12 to 14 inches).

A combination of pre- and

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Table 1. Physical characteristics of taro cultivars used for boiled products and fried as chips.

Cultivar (local name)	Petiole color (top/middle/base)
Bin Liang (Hawaii)	Purple/ light green/ white, pinkish ring
Bin Liang Xin	Light purple/ light green/ white
FAC Special [†]	Purple hue/ light green/ white, purple ring
Feng Huang (Phoenix)	Red hue/ light green/ white with pink ring
Gaoxiong #1	Dark purple/ light green/ white
Guang Zhou Shang Yue (fragrant taro)	Purple hue/ light green/ white, pinkish ring
Guo Ti Yu (dog log taro)	Purple/ light green/ white
Hai Nan Nan Da	Purple/ light green/ white, pinkish ring
Hong Geng Yu (red stem taro)	Black/ black/ white, light green
Long Bin Liang Shan	Purple hue/ light green/ white, light pink ring
Mian Yu (noodle taro)	Light pink/ light green/ white with light green hue
Nan An (Southern Peace)	Purple hue/ light green/ white with red hue ring
Si Mao Yu (brown tip taro)	Dark purple/ green with black hue, white edge/ light green tinted black hue

[‡]The piko is the spot on the upper surface of the leaf at the junction point of the petiole and leaf. The sinus depth refers to the petiole.

[†]FAC Fujian Agricultural College, Fuzhou, China.

postemergence herbicides and field cultivation were used to manage weeds. Potassium chloride was sidedressed during the hilling operation at the rate of 224 kg·ha⁻¹ (0.12 tons/acre). Nitrogen, at the rate of 280 kg·ha⁻¹ (0.15 tons/acre), divided equally at 3 and 6 months after planting, was applied via fertigation.

The green peach aphid (*Myzus persicae* Sulzer) and the Chinese rose beetle (*Adoretus sinicus* Burmeister) were the primary insect pests. Corm rot was generally caused by *Pythium* sp. and associated with root knot nematodes *Meloidogyne* sp. No insecticides or fungicides were applied as the overall damage was minimal.

PLANT MATURITY AND DATA COLLECTION. The corm was regarded as mature when the mother plant leaves senesced and occurred by 12 months after planting, when all corms were harvested. Plants were pulled from the ground and cormels separated from the main corm. The individual main corms were weighed, and the volume determined by water displacement to determine specific gravity. The yield data does not include the weight of the cormels.

A colorimeter (Chromameter model CR-100; Minolta, Ramsey, N.J.) was used to determine corm flesh color on a freshly cut corm surface with “L” lightness, “a” red to green and “b” blue to yellow. The “a” and “b” were converted to chroma and hue (McGuire, 1992), chroma being the saturation (e.g., lightness, vividness, dullness) of a color while hue is the color. Corms were peeled, grated, and pieces were squeezed using a hand garlic press to express liquid, and the liquid centrifuged. A

refractometer was used to determine total soluble solids on the supernatant. Grated corm [10 g (0.35 oz)] was dried at 90 °C (194 °F) for 48 hours, reweighed and the percent dry weight calculated. Grated corm [2 g (0.07 oz)] was homogenized in 18 mL (0.61 fl oz) 95% ethanol and the extract used to determine phenols and total sugars. Phenol was assayed by the procedure of Singleton and Rossi (1965) with catechol as standard. Total sugars were determined by the phenol-sulfuric acid procedure of Dubois et al. (1956), with glucose as standard.

CHIP PREPARATION AND EVALUATION. The corms were weighed, peeled and sliced [1.2 mm (0.05 inches)]. The slices (250 g, 82 oz) were placed into vegetable oil at 160 °C (320 °F) and the oil temperature dropped to ca. 140 °C (284 °F), before the bath began to automatically reheat. Chips were removed when most of the boiling had subsided [150 °C (302 °F)], the time used varied with cultivar dry matter content and the reduction in boiling is used as a commercial indicator of frying end point. The fried chips were spun in a salad spinner to remove excess oil and reweighed to determine percent chip yield. Fried chips [30 g (1.06 oz)] were ground for 10 s in a small kitchen coffee mill and the color determined using the Colorimeter. The ground chips [2 g (0.07 oz)] were washed three times with 20 mL (0.68 fl oz) of acetone to extract oil, dried in air (22.5 °C, 72.5 °F), reweighed and the percentage of oil in the chips calculated.

Ten sensory panelists of various ethnic groups were first trained and then ranked every batch of chips for

appearance, crispness and taste on a scale of 0 to 5, with 5 being the best score. Chip appearance was intended to measure overall color, chip oil soaking as translucency, and the degree of chip folding that occurred during frying.

POI AND BOILED CORM PREPARATION. Corms were peeled, cut into chunks, placed in a bowl with 10 mL (0.34 fl oz) of water, covered with plastic wrap and microwaved on high power (1100 W) for 8 min. The cooked taro was presented to taste panel members directly as a microwaved product or run through a meat grinder that had 3 mm (0.12 inch) holes in the extrusion plate and presented to the panel members as poi.

TASTE PANEL COMPOSITION. Twenty-one Moloka'i members of the Alu Like, Ke Ola Pono No Na Kupuna Program, a nutritional program for Native Hawaiian elderly, participated on the taste panel. All of the participants were over 60 years of age and consumed taro as a regular part of their diet. Members of the panel were asked to evaluate overall taste and preference, and mark the sheet on a 0 to 5 scale, with 5 being the best score.

STATISTICAL ANALYSIS. Data were analyzed by GLM and correlation and regression procedure (SAS Institute, Cary, N.C.). Means were compared ($P = 0.05$) by the Duncan-Waller k ratio *t* test and standard deviation.

Results and discussion

FRIED AND BOILED CULTIVARS. The cultivars are identified by petiole color (Zhang and Zhang, 1990), that varies from red to a purple and black hue at the top to white with a pinkish ring to light green (Table 1). Corm color varied

Corm color (flesh/fibers)	Leaf (shape/ color/ piko ^z color/ sinus depth)
Chalky white/purple	Ovate/ green/ purple/ shallow
White/purple	Sagittate/ light green/ dark purple/ shallow
Cream/purple	Ovate/ green/ purple/ shallow
Creamy yellow/purple	Broadly Ovate/ green/ purple/ shallow
Cream/purple	Ovate/ light green/ purple/ shallow
Chalky white/purple	Ovate/ green/ purple/ shallow, wide
White/purple	Ovate/ light green/ purple/ shallow
Chalky white/purple	Ovate/ green/ purple/ shallow
Chalky white/yellow, cormels on long slender rhizomes	Sagittate/ dark green/ purple/ shallow
Cream/purple	Sagittate/ green/ purple/ shallow
Chalky white/yellow	Ovate/ dark green/ white/ shallow
Creamy white/purple	Ovate/ green/ purple/ shallow
Chalky white/yellow	Ovate/ dark green/ lavender/ shallow leaves are upright, almost perpendicular to ground

from cream to chalky white. Purple vascular fibers in the corm, a marked feature of the local 'Bin Liang' cultivar, were not present in all cultivars. Leaf shape can also be used as an aid in identification, with marked differences in shape, piko color (the spot on the

upper leaf surface at the point of juncture to the petiole), and petiole sinus depth. 'Hong Geng Yu', a triploid from eastern China (Zhang and Zhang, 1990), was unique in having long slender rhizomes connecting the cormels.

The local Hawaii 'Bin Liang' gave

the highest yield at 7 months of age. The non-Hawaii cultivars yields varied widely; the Fujian cultivars had the highest yield, followed by 'Gaoxiong #1' (Table 2). The corm weight of individual cultivar varied 2.7 fold, while the specific gravity was similar for all cultivars. Dry matter

Table 2. Corm characteristics of taro cultivars used for microwaved corm and fried chips.

Cultivar/notes ^z /source	Yield ^y (kg·ha ⁻¹)	Wt (g)	Specific gravity	Dry matter (%)	TSS ^x (%)	Phenol (mg·g ⁻¹ fresh wt)	Sugar (mg·g ⁻¹ fresh wt)
Bin Liang ^w							
Local cultivar, Hawaii	14,157	683 b ^v	0.99 bcd	65.5 f	10.2 a	329.9 de	8.52 cd
Bin Liang Xin							
KCC-038, Gaoxiong, Taiwan	7,492	385 c	0.98 bcd	78.8 a	7.7 c	381.8 bc	10.99 b
FAC Special							
High Starch Chinese Poi, Fuzhou, PRC	15,464	684 b	0.98 cd	68.5 de	6.8 d	343.7 cd	8.96 bcd
Feng Huang							
Eastern Guangdong							
Province, China, Fuzhou, PRC	12,415	626 b	0.98 bcd	65.0 f	6.8 d	144.6 g	5.22 f
Gaoxiong #1							
KCC-033, Gaoxiong, Taiwan	14,157	713 ab	1.00 bc	66.9 ef	8.6 b	292.8 e	7.77 de
Guang Zhou Shang Yue							
Fuzhou, PRC	12,197	612 b	0.97 cd	67.2 ef	6.4 d	212.2 f	5.77 ef
Guo Ti Yu							
KCC-029, Gaoxiong, Taiwan	6,795	315 cd	1.01 ab	73.7 bc	6.8 d	368.0 bcd	1.01 bc
Hai Nan Nan Da							
Name of city—West Hainan, Fuzhou, PRC	11,761	599 b	0.91 e	71.0 cd	6.0 ef	331.1 cde	10.66 b
Hong Geng Yu							
KCC-002, Gaoxiong, Taiwan	6,316	315 cd	0.97 cd	75.5 b	---	451.0 a	8.08 cd
Long Bin Liang Shan Chuan							
Name of village, Fuzhou, PRC	5,227	260 d	0.97 d	71.7 c	6.4 de	414.6 ab	10.12 bcd
Mian Yu							
KCC-055, Gaoxiong, Taiwan	7,841	412 c	1.03 a	75.3 b	---	362.6 cd	8.38 cd
Nan An							
Protein OK, Fuzhou, PRC	16,771	808 a	1.00 bcd	66.0 ef	6.8 d	180.0 fg	5.18 f
Si Mao Yu							
KCC-023, Gaoxiong, Taiwan	7,405	297 cd	0.99 bcd	81.0 a	5.7 f	370.2 bcd	14.87 a

^zFAC = Fujian Agricultural College, Fuzhou, China; KCC = Gaoxiong Cultivar Improvement Farm, Gaoxiong, Taiwan.

^y1 kg·ha⁻¹ = 0.892 lbs/acre; 1 g = 0.035 oz; 1 µg·g⁻¹ = 1 ppm; 1 mg·g⁻¹ = 1000 ppm.

^xTSS = total soluble solids.

^wBin liang Hawaii cultivar was 7 months old, while all others were harvested when 12 months old. No cormel weights were included.

^vMeans followed by the same letter were not significantly different ($P < 0.05$) by Waller-Duncan k ratio t test.

Table 3. Quality characteristics of chips made from taro cultivars grown for microwaved corms and chips.

Cultivar	Chip yield ² (%)	Chip oil (%)	Chip color			Taste		
			L ^y	Chroma	Hue	Appearance	Crispness	Taste
Bin Liang—Hawaii cultivar	44.2 a	23.3 c	65.73 f	248 f	68 e	4.0 ab	4.1 ab	4.0 ab
Bin Liang Xin	33.0 f	34.9 a	70.78 c	674 d	85 c	4.2 a	3.6 b	2.1 d
FAC [*] Special	41.1 bc	21.3 cde	63.99 g	202 gh	62 gh	4.1 a	4.0 ab	4.1 a
Feng Huang	43.7 a	18.9 e	66.00 ef	177 hi	61 hi	4.1 a	4.0 ab	3.8 ab
Gaoxiong #1	43.5 a	23.4 c	61.62 h	165 l	59 ij	4.2 a	4.4 a	4.0 ab
Guang Zhou Shang Yue	43.2 ab	18.9 e	65.85 f	185 hi	63 fg	3.6 bc	3.9 ab	4.0 ab
Guo Ti Yu	36.3 e	28.0 b	67.17 e	333 e	75 d	3.4 cd	3.8 ab	3.0 c
Hai Nan Nan Da	39.9 cd	22.2 cd	63.00 g	230 fg	61 gh	3.6 bc	3.9 ab	3.9 ab
Hong Geng Yu	32.3 f	28.3 b	74.95 a	1146 a	92 a	---	---	---
Long Bin Liang Shan Chuan	40.3 cd	22.2 cd	60.88 h	247 f	63 f	3.1 d	4.1 ab	3.4 b
Mian Yu	38.3 de	33.7 a	72.04 b	744 c	90 b	---	---	---
Nan An	44.7 a	19.9 de	66.18 ef	162 i	58 j	4.2 a	4.3 a	4.1 a
Si Mao Yu	31.3 f	35.3 a	68.46 d	1088 b	84 c	4.2 a	4.1 ab	3.7 ab

²Means followed by the same letter were not significantly different ($P \leq 0.05$) by Duncan Waller k ratio t test.

^yL^y Commission Internationale de l'Eclairage (CIE), lightness value, dark to light.

percentage varied from 65% to 81%, and total soluble solids from 5.7% to 8.6%. The sugar content was not significantly related to total soluble solids. Phenols content that could impart astringency to a boiled or fried product varied over a 3-fold range. The total sugar and phenol content of boiled and fried chips from 'Bin Liang' was in the middle of the range.

Chips from 'Hong Geng Yu', the only cultivar with cormels on rhizomes, were inedible, as were chips from 'Mian Yu', due to the high acidity that remained after frying. Chips from the other cultivars had satisfactory appearance (value greater than 3), crispness, and taste, except for the taste of 'Bin Liang Xin' that was rated as poor (Table 3). Chip oil content varied from about 19% to 35%. 'Nan An', 'Fujian special', 'Si Mao Yu', 'Gaoxiong #1', 'Bin Liang Xin', and 'Bin Liang' the best overall chip taste, while 'Hong Geng Yu' and 'Mian Yu' had redder chip color than

the other cultivars (Table 3).

Corm weight was negatively correlated with corm dry matter content while chip yield was positively correlated to corm weight matter content (Table 4). Taro chip oil content was negatively correlated to corm weight, dry matter, and chip yield. The oil percent in potato (*Solanum tuberosum* L.) chips is negatively correlated with tuber specific gravity, and positively correlated to chip yield (Lulai and Orr, 1979; Gould, 1989), however, no similar relationships were found for taro cultivars (Table 4). Oil uptake by potato chips is a function of moisture replacement, crust formation, interfacial tension, and capillary action (Saguy and Pinthus, 1995). Conflicting results may be related to the lower dry matter percentage and the lower specific gravity of taro corms than potato tubers. Taro chip yield was positively correlated to dry matter and chip oil percentage (Table 4). There were no significant coefficients ($P > 0.05$) with

corm specific gravity, corm total soluble solids, corm sugar, chip appearance, and chip crispness. The absence of these relationships may be related to corm maturity, as larger corms were produced on more mature plants.

Hawaii Table and Poi Type Cultivars: Corm fresh weight and dry matter percentage varied widely from 372 to 1590 g (13.1 to 56.1 oz) and 12.4% to 44.4%, respectively, while specific gravity varied within a narrow range between 0.8 to 1.01 mg·mL⁻¹ (Table 5). Corm total soluble solids ranged from 4.4% to 6.5%. Corm flesh color varied from purple to orange and yellow and a similar range of variation occurred in poi made from these corms (Table 6).

The dry matter content of the poi varied from 18.3% to 48.3% and was linearly related ($r^2 = 0.811$, $P = 0.0001$) to corm dry matter percentage. The common taro cultivar used to make poi in Hawaii is 'Lehua Maoli' (Table 6), however, the taste panel preferred poi

Table 4. Pearson correlation coefficients for relationships between taro chip quality parameter of fried and microwaved corm cultivars.

Parameter	Corm wt	Dry matter	Phenol	Chip yield	Chip oil	Color		
						L ^y	Chroma	Hue
Dry matter	-0.8252***							
Phenol	-0.7373**	0.7091**						
Chip yield	0.8185***	0.9573***	-0.7212**					
Chip oil	-0.6743*	-0.9129***	0.6309*	-0.8452***				
CIE L	NS	0.5788*	NS	-0.6535*	-0.6544*			
Chroma	0.6803*	0.8427***	0.6137*	-0.8837***	0.8186***	0.8062***		
Hue	-0.7167**	0.8339***	0.6632*	-0.8476***	0.8917***	0.8783***	0.9179***	
Taste	0.6729*	-0.6777*	NS	-0.6935*	NS	NS	NS	-0.7434**

^yL^y Commission Internationale de l'Eclairage (CIE), lightness value, dark to light.

NS, *, **, ***, **** Significant Pearson correlation coefficient nonsignificant or $P < 0.05$, 0.01, 0.001, or 0.0001.

Table 5. Corm characteristics of a range of boiled for table use and poi type taro cultivars grown at Moloka'i.

Cultivar	Normal use	Fresh ^z wt (g) ^x	Dry matter (%)	Specific gravity	TSS ^y (%)	Color		
						L ^w	Chroma	Hue
Akuugawai (Tahitian)	Boiled	1243 ± 146	32.0 ± 0.6	0.94 ± 0.01	4.4 ± 0.3	87 ± 1	28 ± 5	67 ± 5
Apowale	Poi	841 ± 184	38.8 ± 3.7	1.00 ± 0.02	5.8 ± 0.1	76 ± 0.4	18 ± 5	15 ± 4
Apuwai		372 ± 236	21.9 ± 5.2	0.96 ± 0.11	4.3 ± 0.1	85 ± 0	41 ± 0	82 ± 1
Bin Liang	Leaf, Boiled	1814 ± 252	31.8 ± 1.6	0.97 ± 0.01	5.9 ± 0.9	84 ± 2	39 ± 4	62 ± 9
Eleele Makoko	Poi	1211 ± 215	35.7 ± 1.8	0.99 ± 0.01	5.7 ± 0.1	79 ± 1	12 ± 0.3	18 ± 3
Eleele Naioea	Poi	1321 ± 263	26.0 ± 0	0.99 ± 0.01	5.4 ± 0.2	75 ± 1	14 ± 0.3	6 ± 11
Fa Eleele (Samoan)		945 ± 125	33.3 ± 0.4	0.99 ± 0.01	6.1 ± 0.1	83 ± 3	41 ± 0	48 ± 1
Haokea		1174 ± 293	31.2 ± 0.9	0.99 ± 0.03	5.9 ± 0	86 ± 2	44 ± 3	73 ± 3
Kai Ala	Poi	1415 ± 172	21.0 ± 5.0	0.92 ± 0.01	5.1 ± 0.1	84 ± 3	29 ± 5	75 ± 0.3
Kai Kea	Poi	1007 ± 8	21.9 ± 1.3	0.93 ± 0.01	5.4 ± 0.3	81 ± 1	14 ± 1	25 ± 1
Kai Uliuli	Poi	1135 ± 46	28.2 ± 0.5	0.98 ± 0.01	5.9 ± 0	84 ± 1	41 ± 1	79 ± 1
Kakakura Ula	Boiled	1229 ± 206	37.7 ± 1.4	0.94 ± 0.04	5.3 ± 0.4	84 ± 1	25 ± 1	40 ± 3
Kumu-eleele	Boiled	551 ± 44	34.4 ± 1.9	0.98 ± 0	6.2 ± 0.9	85 ± 1	23 ± 8	40 ± 3
Kuoho	Poi	1104 ± 289	37.7 ± 1.1	0.97 ± 0	5.5 ± 0.1	82 ± 1	26 ± 1	59 ± 3
Lauloa Eleele-ula	Poi	872 ± 0	32.2 ± 5.0	0.91 ± 0	4.7 ± 0.1	82 ± 2	30 ± 2	65 ± 8
Lauloa Keokeo	Boiled	1235 ± 248	39.5 ± 1.5	0.96 ± 0.01	5.9 ± 0.1	87 ± 2	20 ± 2	40 ± 3
Lauloa Palakea-eleele	Boiled, medicinal	1151 ± 176	35.2 ± 0.3	0.95 ± 0.02	5.0 ± 0.1	85 ± 0	51 ± 10	51 ± 10
Lauloa Palakea-keokeo	Boiled	1439 ± 277	34.7 ± 2.3	0.95 ± 0.01	4.8 ± 0.4	82 ± 2	28 ± 10	61 ± 5
Lauloa Palakea-papamu	Boiled	1429 ± 69	35.5 ± 4.2	0.98 ± 0.04	5.4 ± 0	87 ± 1	35 ± 15	73 ± 13
Lauloa Palakea-ula	Boiled	1248 ± 189	37.7 ± 0.4	0.96 ± 0.02	5.2 ± 0.3	85 ± 1	17 ± 6	37 ± 11
Lehua Eleele		1039 ± 426	34.4 ± 0.8	1.00 ± 0.04	5.5 ± 0.4	76 ± 0.3	14 ± 1	15 ± 0
Lehua Keokeo	Poi	1438 ± 273	38.9 ± 1.4	0.99 ± 0.05	5.7 ± 0.1	84 ± 0	14 ± 0.5	51 ± 10
Lehua Maoli	Poi	1386 ± 372	33.2 ± 4.8	0.98 ± 0.03	6.0 ± 0.1			
Lehua Palaii	Poi	802 ± 305	24.5 ± 0.3	0.89 ± 0.01	5.6 ± 0	79 ± 2	25 ± 2	30 ± 4
Maea	Boiled	842 ± 222	36.3 ± 1.3	0.95 ± 0.01	5.0 ± 0.1	86 ± 1	51 ± 5	76 ± 1
Mana eleele	Boiled	1217 ± 216	25.2 ± 1.6	0.94 ± 0.02	5.7 ± 0.4	83 ± 2	61 ± 9	82 ± 11
Mana Lauloa	Boiled	1505 ± 175	34.3 ± 0.9	0.98 ± 0.02	5.7 ± 0.5	85 ± 11	53 ± 12	89 ± 3
Mana Okoa	Boiled	1395 ± 630	27.4 ± 2.7	0.97 ± 0.01	6.4 ± 0.13	85 ± 1	58 ± 1	101 ± 1
Mana Opelu	Boiled	1249 ± 134	30.3 ± 1.6	0.98 ± 0.01	5.1 ± 0.4	81 ± 1	343 ± 15	78 ± 0.1
Mana Ulaula		1041 ± 180	31.3 ± 2.5	0.97 ± 0.02	5.0 ± 0	82 ± 1	4.89 ± 46	89 ± 1
Mana Uliuli	Poi	1227 ± 298	36.9 ± 1.6	0.99 ± 0	5.9 ± 0.1	84 ± 1	35 ± 13	82 ± 5
Mana Ulu		983 ± 370	29.0 ± 0.6	0.95 ± 0.01	4.9 ± 0.1	83 ± 0.4	529 ± 27	93 ± 2
Manini Kea	Poi	1195 ± 168	31.2 ± 1.2	0.95 ± 0.03	5.5 ± 0.2	87 ± 0.4	63 ± 12	98 ± 3
Manini Owali	Boiled	1526 ± 508	32.9 ± 1.3	0.93 ± 0.02	5.2 ± 0.1	84 ± 1	55 ± 29	57 ± 10
Manini-Opelu	Boiled	1336 ± 77	26.1 ± 8.4	0.93 ± 0.03	5.2 ± 0.1	85 ± 3	55 ± 29	107 ± 1
Manini Toretore	Boiled	1311 ± 42	33.8 ± 0.3	0.95 ± 0.04	4.7 ± 0.1	85 ± 1	56 ± 7	79 ± 1
Manini Uliuli	Boiled, poi	1339 ± 980	31.7 ± 1.6	0.92 ± 0.04	5.4 ± 0.3	86 ± 0.5	46 ± 2	104 ± 1
ML		1477 ± 575	34.6 ± 0.7	0.98 ± 0	5.0 ± 0	79 ± 2	14 ± 2	14 ± 8
Moi	Poi, Boiled	1084 ± 241	33.9 ± 1.7	0.96 ± 0.02	6.4 ± 0.6	84 ± 1	38 ± 8	73 ± 9
Nawao	Boiled	1413 ± 214	33.1 ± 0.3	0.98 ± 0.02	5.2 ± 0.2	85 ± 1	36 ± 3	63 ± 2
Nihopuu	Poi	1691 ± 138	30.1 ± 0.3	0.92 ± 0.01	5.5 ± 0.2	88 ± 2	40 ± 1	81 ± 1
Niue		710 ± 11	31.4 ± 3.6	0.94 ± 0.02	5.1 ± 0.1	83 ± 1	29 ± 8	44 ± 14
Niue-ulaula	Boiled	1009 ± 4	29.6 ± 3.9	0.93 ± 0.01	5.2 ± 0.6	88 ± 3	61 ± 4	81 ± 3
Ohe	Poi	1511 ± 759	36.6 ± 4.2	0.97 ± 0.03	5.5 ± 0.1	80 ± 0.2	13 ± 0	22 ± 4
Piko Eleele		1152 ± 144	36.4 ± 1.3	0.99 ± 0.01	4.9 ± 0.4	86 ± 1	56 ± 1	88 ± 0
Piko Keokeo	Poi	1166 ± 59	28.5 ± 0.7	0.95 ± 0.11	6.1 ± 0.4	84 ± 0	95 ± 25	99 ± 1
Piko Lehua-apei	Poi, leaf	1113 ± 104	27.4 ± 0.9	0.93 ± 0.01	4.5 ± 0.1	75 ± 1	34 ± 1	33 ± 3
Piko Ulaula	Poi	1499 ± 76	36.3 ± 1.7	0.96 ± 0.04	6.5 ± 0.7	81 ± 0.2	30 ± 4	31 ± 0.1
Piialii		1590 ± 76	35.0 ± 1.4	0.97 ± 0.01	5.1 ± 0.7	80 ± 0.2	15 ± 5	19 ± 6
Pololu	Poi	815 ± 47	44.4 ± 0.8	0.95 ± 0	5.9 ± 0.6	86 ± 1	51 ± 3	101 ± 2
Red Moi		862 ± 248	36.1 ± 3.0	1.00 ± 0.01	5.7 ± 0.4	83 ± 2	39 ± 8	82 ± 1
Talo Manua (Samoan)		981 ± 194	38.7 ± 0.4	1.01 ± 0.01	5.1 ± 0.1			
Uahiapele	Poi, medicinal	965 ± 13	28.0 ± 3.1	0.92 ± 0	6.3 ± 0.5	86 ± 2	56 ± 3	82 ± 3
Ulaula Kumu	Boiled	1051 ± 105	33.6 ± 3.2	0.91 ± 0.01	5.1 ± 0.1	83 ± 1	38 ± 7	70 ± 1
Ulaula Moano	Poi, Boiled	1094 ± 42	35.2 ± 3.4	0.93 ± 0.04	5.8 ± 0.4	86 ± 2	37 ± 10	56 ± 5
Ulaula Poni	Boiled	889 ± 210	12.4 ± 6.0	0.80 ± 0.06	5.0 ± 0.4	89 ± 13	52 ± 14	68 ± 3
Wehiwa	Poi, leaf	1257 ± 174	42.8 ± 3.9	0.98 ± 0.01	6.5 ± 0.1	88 ± 3	30 ± 5	64 ± 14

^zMean ± SD^yTSS = total soluble solids.^x1 g = 0.035 oz.^wL^{*} Commission Internationale de l'Eclairage (CIE), lightness value, dark to light.

Table 6. Poi and microwaved corm characteristics of taro cultivars harvested at 10 months.

Cultivar	Dry matter ^a (%)	Poi color			Acceptability	
		L ^y	Chroma	Hue	Poi	Microwaved
Akuugawai (Tahitian)	35.2 ± 0.9	70 ± 1	20 ± 24	42 ± 38	3.69 ± 1.3	3.67 ± 1.29
Apowale	44.3 ± 2.0	55 ± 0.1	10 ± 2	4 ± 3	4.46 ± 0.78	4.17 ± 0.94
Bin Liang	38.6 ± 1.0	77 ± 2.0	40 ± 8	49 ± 11	2.69 ± 1.74	2.54 ± 1.62
Eleele Makoko	43.1 ± 3.6	57 ± 3	10 ± 2	8 ± 5	4.07 ± 1.00	4.15 ± 1.14
Eleele Naioea	40.4 ± 0.8	56 ± 3	10 ± 0.1	179 ± 253	4.35 ± 1.11	4.31 ± 0.95
Fa Eleele (Samoan)	38.2 ± 3.1	63 ± 1	17 ± 2	33 ± 3	3.47 ± 1.25	3.54 ± 1.07
Haokea	36.1 ± 2.0	72 ± 0.5	34 ± 2	73 ± 0.2		
Kai Ala	28.5 ± 6.1	66 ± 1	4 ± 3	27 ± 13	3.69 ± 1.11	3.58 ± 1.24
Kai Kea	31.3 ± 1.7	62 ± 2	13 ± 5	28 ± 8	4.15 ± 0.40	3.73 ± 1.22
Kai Uliuli	34.3 ± 3.8	62 ± 0.1	3 ± 0.6	186 ± 235	3.60 ± 1.18	3.71 ± 1.07
Kakakura Ula	43.9 ± 1.3				3.44 ± 1.46	3.40 ± 1.24
Kumu-eleele	44.2 ± 4.1				3.69 ± 1.41	3.73 ± 1.35
Kuoho	39.7 ± 1.5	64 ± 1	15 ± 3	50 ± 3	3.13 ± 1.41	3.42 ± 0.90
Lauloa Eleele-ula	33.2 ± 1.9	64 ± 1	7 ± 1	22 ± 15	3.44 ± 1.26	3.13 ± 1.41
Lauloa Keokeo	42.8 ± 0.7	70 ± 3	29 ± 8	45 ± 2	3.50 ± 0.97	3.46 ± 1.08
Lauloa Palakea-eleele	36.5 ± 0.4	72 ± 1	26 ± 2	90 ± 1	3.53 ± 1.06	3.93 ± 1.00
Lauloa Palakea-keokeo	38.1 ± 2.8	62 ± 0.3	4 ± 0.1	5 ± 4	4.08 ± 0.94	3.83 ± 0.98
Lauloa Palakea-papamu	39.0 ± 0.9	71 ± 3	27 ± 2	65 ± 3	3.60 ± 1.06	3.58 ± 1.20
Lauloa Palakea-ula	45.3 ± 2.1	62 ± 1	16 ± 1	27 ± 1	3.60 ± 1.06	3.57 ± 1.22
Lehua Eleele	38.9 ± 0.7	56 ± 4	10 ± 1	355 ± 1		
Lehua Keokeo	44.8 ± 0.7	67 ± 1	18 ± 10	47 ± 5	3.93 ± 1.33	4.27 ± 1.10
Lehua Maoli	35.8 ± 3.6	58 ± 3	8 ± 1	1 ± 0.1	3.73 ± 1.03	4.00 ± 1.00
Lehua Palaii	30.2 ± 0.6	66 ± 1	31 ± 8	43 ± 5	4.54 ± 0.52	4.17 ± 1.19
Maea	44.9 ± 4.0	71 ± 3	75 ± 8	69 ± 1	4.46 ± 0.78	4.09 ± 0.94
Mana eleele	33.7 ± 4.4	68 ± 1	13 ± 0.4	44 ± 3	3.93 ± 1.08	4.00 ± 0.77
Mana Lauloa	34.1 ± 1.5	67 ± 1	15 ± 3	54 ± 13	3.79 ± 1.15	3.77 ± 0.97
Mana Okoa	30.5 ± 2.0	71 ± 1	33 ± 1	55 ± 1	3.69 ± 1.40	3.62 ± 1.56
Mana Opelu	33.6 ± 1.6	69 ± 0.1	633 ± 17	91 ± 1		
Mana Ulaula	35.7 ± 2.5	66 ± 1	610 ± 126	94 ± 1	3.13 ± 1.23	3.00 ± 1.35
Mana Uliuli	40.9 ± 2.2	70 ± 3	22 ± 6	55 ± 4	3.44 ± 1.03	3.31 ± 1.66
Mana Ulu	32.7 ± 1.5	67 ± 2	428 ± 52	97 ± 0.1		
Manini Kea	32.6 ± 2.1	74 ± 1	33 ± 3	80 ± 1	2.87 ± 1.47	2.54 ± 1.75
Manini-Opelu	29.0 ± 1.7	71 ± 1	17 ± 2	92 ± 4		
Manini Owali	36.4 ± 0.6	67 ± 2	7 ± 2	21 ± 1	3.40 ± 1.3	3.77 ± 1.29
Manini Toretore	37.3 ± 1.7	73 ± 1	46 ± 0.3	79 ± 1	4.31 ± 0.85	3.92 ± 1.00
Manini Uliuli	31.7 ± 2.2	73 ± 1	34 ± 0.1	96 ± 0.4		
ML	41.3 ± 2.5	58 ± 2	9 ± 1	355 ± 2		
Moi	36.1 ± 2.6	66 ± 1	17 ± 0.5	47 ± 7		
Nawao	38.9 ± 3.6	66 ± 0.3	29 ± 1	45 ± 2	3.93 ± 0.88	3.79 ± 1.48
Nihopuu	31.2 ± 1.1	73 ± 1	25 ± 10	71 ± 11	3.91 ± 1.41	3.20 ± 1.14
Niue	37.7 ± 5.1				4.15 ± 1.05	3.50 ± 1.16
Niue-ulaula	41.0 ± 6.4	69 ± 2	35 ± 17	67 ± 5	4.38 ± 0.74	4.00 ± 0.95
Ohe	48.3 ± 2.0	57 ± 4	6 ± 1	4 ± 5		
Piialii	35.0 ± 1.8	56 ± 3	11 ± 2	177 ± 245		
Piko Eleele	37.6 ± 0.4	70 ± 2	24 ± 4	72 ± 5		
Piko Keokeo	29.8 ± 0.4	66 ± 2	5 ± 3	59 ± 24	3.87 ± 0.92	4.00 ± 0.13
Piko Lehua-apei	22.4 ± 0.9	51 ± 3	12 ± 5	346 ± 9	3.38 ± 1.5	3.47 ± 1.55
Piko Ulaula	35.8 ± 2.6	66 ± 0.1	14 ± 2	23 ± 1	3.67 ± 1.45	3.43 ± 1.55
Pololu	48.5 ± 1.9	77 ± 2	47 ± 19	94 ± 5	4.00 ± 0.82	3.42 ± 0.93
Red Moi	42.3 ± 1.4	69 ± 0.5	30 ± 12	73 ± 2	4.23 ± 0.73	4.08 ± 0.67
Talo Manua (Samoan)	46.2 ± 3.0	65 ± 0.1	17 ± 5	50 ± 3	4.15 ± 1.03	3.92 ± 1.24
Uahiapele	35.8 ± 2.4	72 ± 1	44 ± 33	76 ± 11	3.60 ± 1.30	3.50 ± 0.80
Ulaula Kumu	43.1 ± 2.3	65 ± 5	11 ± 3	23 ± 1	3.29 ± 1.2	3.91 ± 1.04
Ulaula Moano	38.8 ± 2.4	68 ± 2	20 ± 9	33 ± 14	4.00 ± 1.13	3.93 ± 1.00
Ulaula Poni	18.3 ± 5.9	64 ± 2	41 ± 37	52 ± 15	3.47 ± 1.46	3.23 ± 1.19
Wehiwa	45.4 ± 2.4	71 ± 1	35 ± 1	58 ± 1	3.33 ± 1.45	3.15 ± 1.31

^aMean ± SD.^yL' Commission Internationale de l'Eclairage (CIE), lightness value, dark to light.

Table 7. Pearson correlation coefficients and probability for relationships between poi and microwave corm taro taste panel preference and other corm or product characteristics.

	Pearson correlation coefficient		P	
	Poi taste	Microwaved taste	Poi taste	Microwaved taste
Corm dry matter	-0.1213	0.0835	ns	ns
Specific gravity	0.2519	-0.0478	0.019	ns
Total soluble solids	-0.5626	0.3688	<0.0001	0.0004
Corm CIE				
L ^z	-0.0352	-0.2781	ns	0.0095
Chroma	-0.0461	-0.1608	ns	ns
Hue	-0.1253	-0.1049	ns	ns
Product dry matter	0.0079	0.1494	ns	ns
Product CIE				
L	-0.8645	0.4614	<0.0001	<0.0001
Chroma	0.9995	-0.7111	<0.0001	<0.0001
Hue	0.0408	0.0112	ns	ns

^zL' Commission Internationale de l'Eclairage (CIE), lightness value, dark to light.

^{ns}Nonsignificant at $P > 0.05$

made from 'Eleele Naioea', 'Eleele Makoko', 'Lauloa Palakea-keokeo', 'Kai kea', 'Manini Toretoe', 'Lehua Palaii', 'Apowale', 'Pololu', 'Red Moi', 'Talo Manua', and 'Nuie'. Microwaved corm from 'Lehua Maoli' was the most preferred and highly regarded, and it along with 'Lehua Palaii', 'Apowale', 'Lehua Keokeo', 'Eleele Naioea', 'Eleele Keokeo' had a higher acceptance than 'Lehua Maoli' (Table 6). 'Eleele Naioea', 'Lehua Palaii', and 'Apowale' had the highest taste acceptance both as microwaved corm and poi than by 'Eleele Makoko', 'Nuie-ulaula', 'Maea', and 'Red Moi'.

Taste panel members preferred the poi and microwaved taro from the darker bluish red corms (Table 7). There were negative correlation coefficients between corm color "L" lightness value, Chroma and hue and microwaved corm and poi taste, indicating that darker yellow boiled corm or poi were less liked. The dry matter percentage of corm was positively correlated with specific gravity (dry matter = $-61.0542 + (97.7434 \times \text{specific gravity})$; $F \geq 0.0001$, $r^2 = 0.601$). There were negative correlations between corm total soluble solids and both corm specific gravity ($F \geq 0.0402$; $r^2 = 0.273$), and corm dry matter ($F \geq 0.0563$; $r^2 = 0.254$). Mealiness of cooked potatoes, (dry flaky texture), within a cultivar is high correlated to specific gravity but this relationship does not extend between cultivars (Liyan and Smith, 1964). However, no significant correlations were found between the taste of different poi or boiled types and corm specific gravity (Table 7). Potato specific gravity is influenced by genetics

and environmental growing conditions (Gould, 1989). Poi and microwaved corm taste was possibly more dependent upon texture and viscosity however, these mouth feel textural characteristic are not easily determined and are related to cell strength in potatoes (Nonaka and Timm, 1983).

Considerable variation occurred in the yield and quality of fried chip, microwaved corm and poi made from taro corms. This finding agrees with the reported phenotypic variations (Whitney et al. 1939), isozymic variation (Lebot and Aradhya, 1991) and ploidy level (Zhang and Zhang, 1990) of cultivated taro. Cultivated taro is propagated vegetatively and sexual reproduction is rare in cultivated materials, though it may occur in the wild (Matthews, 1997). The variation in taro and corm characteristics and differences in human preferences for fried chips, microwaved corm and poi made from different cultivars make this widely distributed crop, adaptable to many situations.

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